

Crop Profile for Winter Wheat in Colorado

Prepared: September, 2000

Revised: September, 2003

Triticum aestivum (Poaceae)

General Production Information

Colorado facts

	1997	1998	1999	2000	2001
Acres in Colorado:	2,700,000	2,550,000	2,400,000	2,350,000	2,000,000
Percent U.S. Acreage:	6.5%	6.4%	6.7%	6.7%	6.4%
National Ranking:	5 th	5 th	4 th	5 th	5 th
Per Acre Value:	\$95.61	\$91.63	\$101.00	\$79.80	\$90.75
Value of Production in Colorado:	\$273,888,000	\$247,631,000	\$230,136,000	\$184,005,000	\$181,500,000

Data from 1997-2001 Colorado and National Agricultural Statistics Services

Description of Crop

Winter wheat is an annual grass with spiked inflorescence. The head usually has short, spreading awns and three or more fertile florets per spikelet. There are five market classes: Hard Red Winter Wheat, Soft Red Winter Wheat, Durum Wheat, Soft White Wheat and Hard White Wheat. Hard White Wheat is the newest market class. Wheat is used to produce flour (for bread, pasta, pastries and macaroni) or livestock feed.

Cropping system

Winter wheat is planted between September 1 and October 15. If the crop is planted too early, there is a

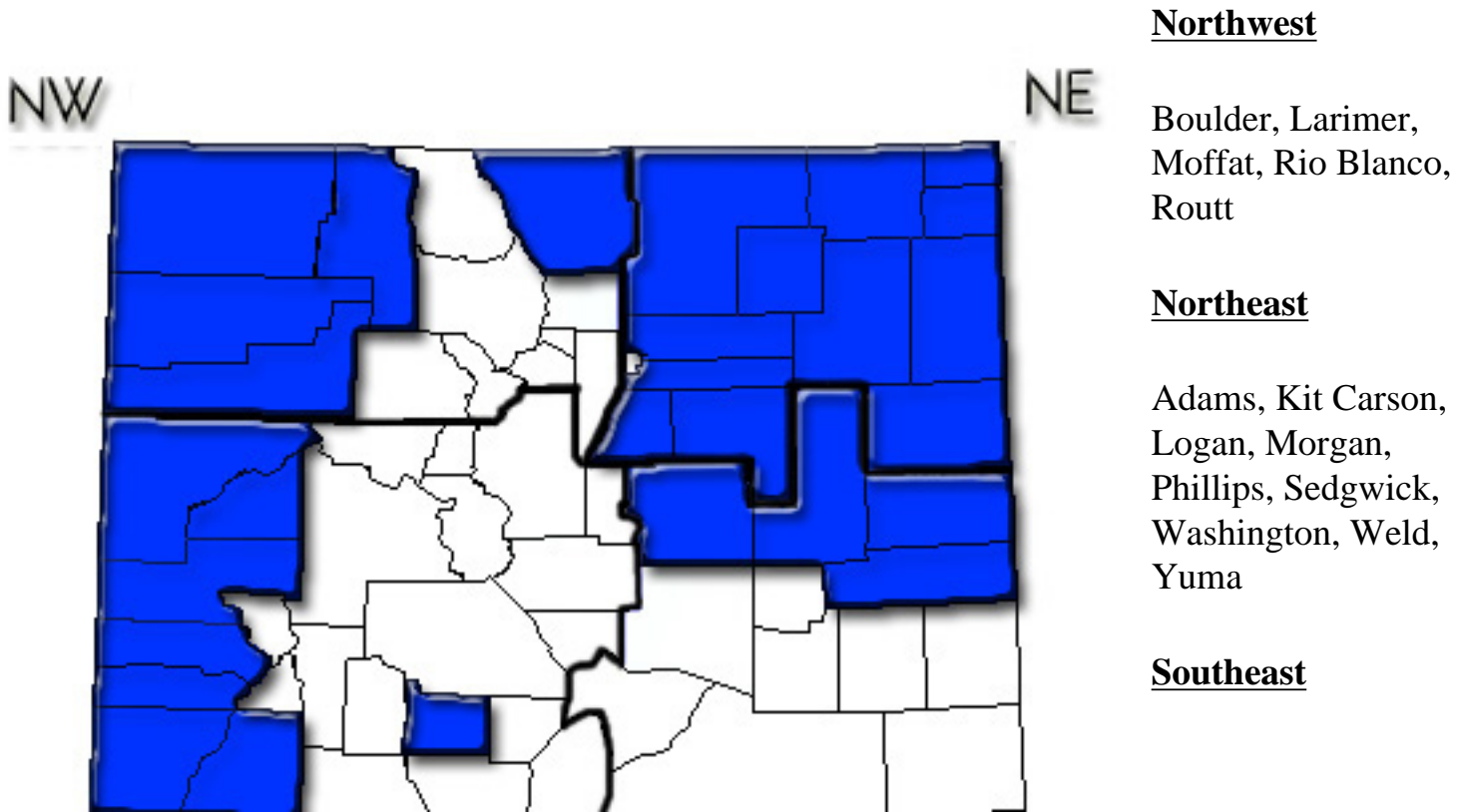
higher risk for hessian fly and viral infestations. However, the hessian fly is only a minor pest for Colorado wheat growers. However, if wheat is planted too late, the plants may be underdeveloped when overwintering occurs (4 - 5 leaf stage is the optimal stage for overwintering). The wheat plants will vernalize during overwintering if they are properly developed. Vernalization is required to allow the shift from vegetative growth to reproductive growth. Preferred soil texture is well-drained, with a soil temperature of 60 F or lower. Seed should be planted at a depth of 1 - 3". Rows are generally 7 - 12" wide. Six inch row spacings are primarily used for irrigated systems. Optimal planting density is 500,000 - 1,000,000 plants or more per acre, depending upon whether it is a dryland or irrigated system (in dryland systems, there are fewer plants per acre). This is equivalent to 30 - 50 lb of seed per acre in dryland systems and 75-90 lb of seed per acre for irrigated systems depending on the market class planted.

The following are common crop rotations: wheat-corn-fallow; wheat-sorghum-fallow; wheat-proso millet-fallow; wheat-corn-proso millet-fallow. Sunflowers may also be added into the rotation. However, the dominant rotation is still wheat-fallow. It is recommended to plant winter wheat following fallow; if this is not possible, plant a short season annual forage in the spring and harvest it prior to August 1.

No tillage is necessary when planting wheat; wheat is planted directly into forage stubble. However, most growers following a wheat-fallow rotation will clean till the seed bed before planting.

Winter wheat is usually harvested from late June to late July. The crop is directly combined unless it is weedy.

Location of Production





Southwest

Delta, Dolores, Douglas, Garfield, La Plata, Mesa, Montezuma, Montrose, Rio Grande, San Miguel

Note: Shaded boxes indicate counties where the crop is grown. Regions have been delineated by Interstates I-70 and I-25.

Insect Pests

Key Insects

Army Cutworm, *Euxoa auxiliaris*

Army cutworm is one of several species of caterpillars that attack wheat in Colorado. Adult moths are brown with light brown or black markings on the forewings and have a wingspan of about 2". Larvae vary in color from dull green to brown with faint stripes on the back and have brown heads. Army cutworms produce one generation per year. Eggs hatch in the fall with sufficient moisture. Army cutworm larvae spend the winter as partially grown caterpillars. They feed only on warm days in the winter; feeding is more frequent in the spring. Army cutworms always feed above ground during the night and/or on cloudy days. They are found under soil clods and other debris during the day. Cutworm larvae build small pupation chambers several inches below the soil surface. Moths emerge in May and June and migrate to higher elevations in the Rocky Mountains to escape high summertime temperatures. In late summer and early fall the moths return to the plains to lay their eggs in wheat fields and in other cultivated areas. With adequate moisture, eggs hatch and larvae of the next generation begin feeding as weather conditions permit. Army cutworm caterpillars feed on plant foliage. Their feeding has the most effect on yield when there is relatively little foliage for them to feed on, which increases the likelihood of damage to the crown.

Brown Wheat Mite, *Petrobia latens*

Brown wheat mites are important pests of wheat in Colorado. Mites are microscopic arthropods that feed on the sap of host plants. They have eight legs (six in the first stage). Brown wheat mites are about 0.025" long, oval shaped and dark red or brown. They spend the summer in the soil as white eggs resisting hot, dry conditions. In the fall, as temperature and moisture increase, eggs develop and hatch after 10 days of incubation. Females follow in about two weeks. These females lay round, red eggs which give rise to further fall (1 or 2) and spring (2 or 3) generations. As summer conditions return, a

generation of females is produced which lay only white, over-summering eggs. Both egg types are placed in the soil near the plant base. Brown wheat mites feed during the day and spend the night in the soil. Their activity peaks at about mid-afternoon on warm, calm days. This mite is not affected by cold temperatures, but populations are quickly reduced by driving rains of 0.33" or more. Brown wheat mite is a serious pest for many Colorado wheat producers.

Cereal Leaf Beetle, *Oulema melanopus*

Adult cereal leaf beetles are about 3/16 inch long, with a metallic blue head and wing covers, a red pronotum (neck) and orange-yellow legs. *Colops* spp. are the most common beetles confused with the cereal leaf beetle. However, it is a dull dark blue rather than a bright metallic blue and is about 1.5 times larger than the cereal leaf beetle. Adult cereal leaf beetles are very active during the cool parts of the day, and evening, but may disappear during the heat of the day. They fall off the plant when disturbed. Adult beetles prefer to feed on actively growing leaves. They chew completely through the leaf, between the veins, resulting in a linear streaking of the leaf. Larvae feed only on the upper surfaces of the leaf. Larva feeding is distinguished from adult feeding because it is wider and limited to the upper part of the leaf. Beetles become active when temperatures are above 50F. Females mate in spring and lay eggs about two weeks later. One female lays more than 300 eggs over a six-week period. Eggs hatch in 4 to 23 days and the larvae feed for 10 to 21 days before crawling down the plant to pupate in the top two inches of soil. Cereal leaf beetles have been controlled biologically in many states.

Pale Western Army Cutworm, *Agrotis orthogonia*

Pale western army cutworm is one of several species of caterpillars that attack wheat. Adult moths emerge from the soil in late summer and fall. Eggs are deposited in loose soil and usually hatch in late winter. Under some conditions, eggs hatch in the fall and the insect overwinters as a partially grown caterpillar. Egg hatch may be delayed for up to several months if moisture and temperature conditions are unfavorable. Larvae prefer loose, sandy or dusty soil and are found most easily in the driest parts of the field, such as hilltops. After feeding is complete, pale western cutworm larvae move to pupal chambers constructed several inches below the soil surface. Adults begin to emerge in August, but most egg laying occurs in September. Pale western cutworm is a subterranean cutworm, feeding on stems at the crown. Heavy feeding on the crown results in severed stems. Entire fields may be lost in a matter of days. Outbreaks are associated with dry conditions in the previous spring.

Russian Wheat Aphid, *Diuraphis noxia*

Russian wheat aphid is one of the most destructive insect pests in Colorado. The Russian wheat aphid (RWA) damages small grains by injecting saliva with a toxin into the plant and sucking sap from plants. Yield losses due to Russian wheat aphid damage are 50% or more if economic infestations are left untreated. RWA are yellow-green or gray-green and are often covered with wax. RWA are small, less than 0.09" in length, and are convex and elongate. The two forms of RWA are found in Colorado during the year are wingless and winged females. In Colorado, most severe spring infestations are caused by

wingless aphids. Winged aphids begin to appear in Colorado in April and May and flights peak in July. At this time winged aphids include both local aphids and immigrants from the south. Winged aphids infest late maturing winter wheat and spring grains. Grasses serve as alternate hosts for RWA during the period between grain harvest. Weather conditions that favor cool season grasses and volunteers will increase the number of aphid infestations. Aphid feeding prevents young leaves from unrolling. RWA colonies are found within the tubes formed by these tightly curled leaves. This not only makes it difficult to achieve good insecticide coverage, but also interferes with the ability of predaceous and parasitic insects to reach and attack aphids. Leaves infested by RWA have long white, purple or yellowish streaks. Heavily infested plants are stunted and some may appear prostrate or flattened. A Russian wheat aphid resistant variety of **TAM 107** wheat was released by CSU in 1998. Resistance in this variety is conferred by the gene Dn4. In 2003, a new strain (known as a "biotype") of Russian wheat aphid (RWA) has been found in Colorado and it is virulent to all CSU varieties containing Dn4. In Colorado, we now have the original biotype (Biotype A) and the new biotype (Biotype B) of Russian wheat aphid. Currently, Biotype B populations of RWA can be identified when symptoms appear on resistant varieties. Biotype B infestations will need to be managed conventionally on all Colorado wheat varieties. This means that the crop will need to be scouted and treated with an insecticide if economic thresholds exist. Economic thresholds or percentages of infested tillers above which an insecticide application will be cost effective are calculated by: $(\text{The cost of control per acre including insecticide and application} \times 200) \div (\text{Expected number of bushels per acre} \times \text{market value per bushel})$. Cultural controls used to reduce RWA include: control of volunteer wheat and barley, adjusting planting dates, and maintaining healthy, stress-free crops. Applications of carbofuran, chloropyrifos, dimethoate, disulfoton, imidacloprid, lambda-cyhalothin, methyl parathion, phorate, and thiamethoxam can all control RWA, but should not be applied until the economic threshold has been surpassed. Russian wheat aphid must be managed with a combination of management tactics if we are to minimize the development of future biotypes.

Say's Stink Bug, *Chlorochroa sayi*

Say's stink bugs are large insects with a triangular-shaped thorax (body). Adults are green during the summer and fade to brown or gray in the fall. Females lay small, cylindrical eggs in groups on plant surfaces which later hatch into nymphs. Nymphs appear as small, underdeveloped adults and go through gradual transformation (metamorphosis) more than three to four weeks as they turn into adults. Stink bugs overwinter as adults underneath plant debris. Generally, there is only one generation per year in the northern areas. Both nymphs and adults have piercing mouthparts which they insert into plant tissue and suck out juices. They prefer developing grains of barley, wheat, and other grasses. Shriveled and deformed grains result from this feeding. Stem damage can result in sterile, sun-bleached heads. Three to four adult stink bugs per 100 sweeps with a standard insect sweep net (diameter of 15") may warrant an insecticide treatment such as lambda-cyhalothin.

Wheat Curl Mite, *Aceria tosichella*

Wheat curl mite is a microscopic eriophyid mite of great economic significance in Colorado. It vectors the wheat streak mosaic virus and High Plains disease. Wheat curl mites are long, slender mites, visible

with the aid of a hand lens (at least 10X). Eggs, immature stages and adult wheat curl mites are found in the winter on wheat and other nearby perennial grasses. As temperatures rise in the spring, mite populations develop under leaf sheaths, inside newly emerged leaves, and eventually on green tissues in the head. Eggs are laid along leaf veins. An average complete generation requires 8 - 10 days. Most mites are found on the upper surface of the youngest fully expanded leaf, adjacent to the ligule. They prefer the most tender leaf tissue and therefore move to each new leaf as it emerges. As the wheat plant dries down, wheat curl mites congregate on green tissue in the upper parts of the plants where they are picked up by wind currents and carried to their summer grass hosts. As summer hosts dry down, the reverse process occurs and mites are carried by winds to newly emerged winter wheat. They are often found in the spaces between leaf veins. Damaged leaves are tightly rolled. Plants infected with wheat streak mosaic virus show chlorotic speckles or streaks and stunting.

Additional Insects

Armyworm, *Pseudaletia unipuncta*

In Colorado, the armyworm is mainly a pest of spring grains. The armyworm occurs in Eastern Colorado and in the San Luis Valley. Mature larvae are about 1.5" in length, smooth-bodied, and dark gray to greenish-black in color. They are characterized by five stripes, three on the back and two on the sides, running the length of the body. While the stripes on the back vary in color, whereas the stripes on the sides are pale orange with a white outline. The head capsule is remarkable for its "honeycomb" of black markings. The armyworm is unable to survive Colorado winters. Instead, armyworm moths migrate into Colorado in early summer. They lay their eggs in rows or clusters on the lower leaves of various grass crops. Dense grassy vegetation is preferred for oviposition. Newly hatched larvae move with a looping (inchworm) action. Larvae feed at night and on cloudy days, and hide under crop debris during sunny periods. One or more generations may occur each year. Armyworms feed on leaves, kernels, and beards of heads of small grains. Their most obvious damage to small grains is by clipping the heads, causing them to fall.

Banks Grass Mite, *Oligonychus pratensis*

Banks grass mites are important pests of wheat in Colorado. Mites are microscopic arthropods that feed on the sap of host plants. They have eight legs (six in the first stage). Banks grass mites are extremely small, 0.001", and yellow to cream colored. Heavy populations of Banks grass mite can kill small plants and reduce kernel size in larger plants. They produce heavy webbing to protect colonies consisting of eggs, larvae and adults. Damaged leaves first become yellow, then brown and finally necrotic. The overwintering form of the mite is bright orange. With the onset of winter, the mites move to wheat plant crowns where they feed until spring when they travel to corn plants either by walking short distances or by "ballooning" - becoming windborne on a web spun silk thread over longer distances. Small pearly white eggs are laid which eventually give rise to pale to bright green male and female adults. Banks grass mites are most likely to infest water-stressed plants, so irrigation can be an important cultural control mechanism. Factors that encourage Banks grass mite infestations include host drought stress,

high temperatures, low rainfall, low humidity, absence of two-spotted spider mites (*Tetranychus urticae*), lack of natural enemies, insecticide use against other target pests, and adequate moisture for alternate hosts during the previous growing season. Most Banks grass mite problems occur in the drier growing areas of Colorado and are always associated with grasses. For example, as wheat in adjacent fields dries down the mites move into new fields of wheat as well as corn.

Bird Cherry Oat Aphid, *Rhopalosiphum padi*

Bird cherry oat aphids are olive-green with a reddish-orange area on their rear end. They are medium sized aphids, 0.05 - 0.10" with long antennae, long dark tube-shaped cornicles, and dark colored legs. The aphids feed on wheat by sucking plant sap. Bird cherry oat aphids vector barley yellow dwarf virus.

Corn Leaf Aphid, *Rhopalosiphum maidis*

Corn leaf aphids are small, 0.59 - 0.98", bluish-green insects with a purplish patch around the base of the cornicles. They are usually wingless with short antennae and prominent cornicles. Aphids feed in groups, first appearing in the whorl. Adult females give birth to live young - they do not lay eggs - generally producing two nymphs per day. These aphids suck plant sap but damage is usually minor. However, they are vectors of barley yellow dwarf virus. Heavily infested leaves may wilt and have yellow or dead areas. Also, honeydew secreted by the aphids may accumulate on the plant facilitating mold growth and giving leaves a purplish-black appearance.

English Grain Aphid, *Sitobion avenae*

English grain aphids are yellow green to reddish brown, medium sized aphid with antennae greater than half the body length. Their cornicles are medium sized and black. Antennae and leg joints are dark colored. This aphid overwinters mainly in the mature and nymphal stages, but a few individuals may overwinter in the egg stage. Only females overwinter, and with warm spring temperatures they begin giving birth to live young. Males appear during the fall and mate with true females. English grain aphid colonies often develop on leaves and then move to heads in the boot stage. Aphids may cluster around the bracts of wheat heads or other grains. Wheat kernels may shrivel as a result of aphid feeding. This aphid is a vector of barley yellow dwarf virus.

Grasshoppers

Grasshoppers follow roughly a 22-year cycle in Colorado, with the last major outbreak occurring in the late 1970s and early 1980s. Grasshoppers vary considerably depending on the species. Grasshopper nymphs have a similar appearance to adults but are smaller in size. Grasshoppers lay eggs in undisturbed areas, usually in late summer and early fall. Small nymphs or "hoppers" hatch the following spring. Winged adults will appear 5 - 6 weeks after egg hatch. A few Colorado grasshopper species have eggs that hatch in late summer and overwinter as nymphs. Winged adults of these species usually appear early in the following summer, often causing undue alarm about unusually early grasshopper activity. Some of

these species are important on rangeland, but none are considered a threat to field crops. The usual pattern of grasshopper damage in field crops is for early development to occur in weedy areas of roadsides, fence rows, irrigation ditches, and other non-crop areas. As these food sources are exhausted or begin to dry down, the grasshoppers leave in search of other food - often an irrigated crop. Here they will first feed in the field margins and subsequently spread throughout the field. Most field crop damage is caused by the differential, red-legged, two-striped, and migratory grasshoppers.

Greenbugs, *Schizaphis graminum*

Greenbugs are light green aphids; their legs are also green, but their feet are black. The cornicles (small pipes near the rear end) are green with black tips. Adult aphids have a darker green stripe down the back and may be winged or wingless. All wingless greenbugs are female and they give birth to females. During the summer, females begin to reproduce within a week and may produce as many as 80 female offspring during their 25-day adult life span. Generally, greenbugs are found in colonies on the underside of the lower leaves. They may also be found in the whorl of the plant until the head emerges. Greenbugs migrate north from Texas and Oklahoma on weather fronts. This migration generally occurs in late May or early June but usually does not reach economic levels until late June or July. In the process of feeding, greenbugs inject toxins into the plant, which apparently break down cell walls to facilitate feeding. The toxins cause a red discoloring of the leaves, which in conjunction with removal of the cell contents, will cause the death of the leaf if enough greenbugs are feeding. Greenbugs leave honeydew on the leaves, which interferes with the transpiration process of the plant.

Hessian Fly, *Mayetiola destructor* (Say)

Hessian fly larvae are small, 0.19", greenish-white, legless, headless maggots found underneath lower leaf sheaths. The pupal stage appears as a small, 0.19", brown seed-like case containing a maggot, often referred to as a "flaxseed," and found at the base of old plant crowns. Adult flies resemble mosquitos, are about 0.17" long, and have a dusky, grey body and wings. Adult females have a red abdomen due to the development of the eggs inside of the abdomen. Hessian flies overwinter in volunteer wheat. After adults emerge in the spring they mate, lay eggs, and die 1 - 2 days later. Females lay eggs on the upper leaf surfaces that hatch in about 3 -10 days. Newly hatched maggots crawl down the leaf and enter the plant at the junction of the sheath and stem. There may be one or more generations in the spring and in the fall. Maggots feed by rasping plant tissue and sucking plant juices which are emitted from the irritated surface of the stems of wheat and barley. Plant tissues near feeding sites are stunted and abnormal. Leaves may appear thickened, erect, and bluish-green in color. The central stem is often missing. Infested stems usually lodge at the time of head formation. Cultivars resistant to Hessian Fly are available. Hessian fly is very rare in Colorado.

Wheat Stem Sawfly, *Cephus cinctus*

The adult wheat stem sawfly is a wasp-like insect about 0.75" long. It has smoky colored wings and shiny a black body with three yellow bands across the abdomen. When present in the field, adults are

often seen resting upside down on the wheat stem. Sawflies are active in the field when temperatures are above 50F and conditions are calm. They are not strong fliers and usually only fly until they find the nearest wheat field. For this reason, more serious problems often occur at field margins. The sawfly larvae feed within the stem and gradually move down the stem, feeding as they move for about 30 days. The most dramatic impact of the wheat stem sawfly is stem lodging and subsequent yield losses. Additionally, sawfly larvae cause physiological damage of 10 - 15% to the infested stems. Wheat stem sawfly is rare on wheat in Colorado.

Key Insect Management Strategies

Wise management decisions lead to a better cropping system with fewer pest problems. Wheat is planted later to avoid wheat curl mite, hessian fly, and other aphid infestations. Cultural controls used to reduce Russian wheat aphid (RWA) include: control of volunteer wheat and barley, adjusting planting dates, and maintaining healthy, stress-free crops. Applications of carbofuran, chlorpyrifos, dimethoate, disulfoton, imidacloprid, lambda-cyhalothin, methyl parathion, phorate, and thiamethoxam can all control RWA, but should not be applied until the economic threshold has been surpassed. Managing resistance requires proper pesticide use. Killing volunteer wheat in adjacent fields three weeks prior to planting helps control wheat curl mite. Wireworms can be controlled with seed treatments such as imidacloprid and the remaining insect pests can be controlled with threshold-based insecticides.

Insecticides -

- Pesticide: **carbaryl** (Sevin XLR Plus)
- Target Pests: Cereal leaf beetle, Armyworms
- Recommended rate: 14-21 fl oz ai/A (1-1.5 qt product/A)

Pesticide: **carbofuran** (Furadan 4F)

- Target Pests: Russian wheat aphid, grasshoppers
- Recommended rate: 0.11-0.22 oz ai/1000 row ft (0.25-0.5 oz product/1000 row ft)
- Comments: **24c registration** for grasshoppers, Russian wheat aphid, Wheat curl mite

Pesticide: **chlorpyrifos** (Lorsban 4E-SG)

- Target Pests: Russian wheat aphid, aphids other than Russian wheat aphid, brown wheat mite, grasshoppers
- Recommended rate: 4.8 oz ai/A (8-16 oz product/A)
- Comments: Preharvest interval 28 days
- Use Data:
 - 1992= rate used- 0.91 lb ai/A
 - 5% of total acres treated

1997= rate used- 0.50 lb ai/A
4% of total acres treated

Pesticide: **dimethoate** (Dimethoate)

- Target Pests: Russian wheat aphid, Aphids other than Russian wheat aphid, brown wheat mite, grasshoppers
- Recommended rate: 6 oz ai/A (0.50-0.75 pt product/A)
- Use Data:
 - 1992= rate used- 0.33 lb ai/A
1% of total acres treated
 - 1997= rate used- 0.38 lb ai/A
1% of total acres treated
- Comments: Preharvest interval 35 days

Pesticide: **disulfoton** (Di-Syston 15G)

- Target Pests: Russian wheat aphid, Aphids other than Russian wheat aphid, Hessian fly
- Recommended rate: 0.25 oz ai/1000 row ft (1.67 oz product /1000 row ft)

Pesticide: **disulfoton** (Di-Syston 8E)

- Target Pests: Russian wheat aphid
- Recommended rate: 3.4-10.2 oz ai/A (4-12 oz product/A)
- Comments: Maximum one aerial application
- Use Data:
 - 1992= rate used- 0.72 lb ai/A
1% of total acres treated
 - 1997= rate used- 0.70 lb ai/A
1% of total acres treated
- Comments: Preharvest interval 30 days

Pesticide: **imidacloprid** (Gaucho 480S)

- Target Pests: Russian wheat aphid, Aphids other than Russian wheat aphid, Hessian fly, Wireworms
- Recommended rate: 0.4-1.2 oz ai/100 lb seed (1-3 oz product)
- Comments: 45 days to graze and feed, May not perform well in dry soil

Pesticide: **lambda-cyhalothrin** (Warrior)

- Target Pests: Russian wheat aphid, Aphids other than Russian wheat aphid, Cereal leaf beetle,

- Say's stink bug, Armyworms, Pale Western Army cutworm
- Recommended rate: 0.29-0.44 oz ai/A (2.56-3.84 oz product/A)
- Comments: Preharvest interval 30 days

Pesticide: **methyl parathion** (PennCap-M)

- Target Pests: Russian wheat aphid, Aphids other than Russian wheat aphid, Armyworm
- Recommended rate: 6.7-10.0 oz ai/A (32-48 oz product/A)
- Comments: Preharvest interval 15 days

Pesticide: **phorate** (Thimet 20G-Lock 'n Load (BASF))

- Target Pests: Russian wheat aphid, Aphids other than Russian wheat aphid, Hessian fly, grasshoppers
- Recommended rate: 0.24 oz ai/1000 row ft (1.2 oz product/1000 row ft)
- Use Data:
 - 1992= rate used- 0.76 lb ai/A
 - 1% of total acres treated
 - 1997= rate used- 0.80 lb ai/A
 - 1% of total acres treated

Pesticide: **thiamethoxam** (Cruiser 5FS)

- Target Pests: Russian wheat aphid, Aphids other than Russian wheat aphid, Hessian fly, and Wireworms
- Recommended rate: 0.36-0.63 oz ai/100 lb seed (0.75-1.33 oz product/100 lb seed)
- Comments: Rotation crop restrictions

Weeds

Key Weeds

Annual Rye, *Secale cereale*

Annual rye, a member of the Grass family, is also called feral rye as well as common, cereal and winter rye. The first blade is tall, narrow, and vertical. Blades are covered with short hairs and have prominent veins above and a midrib below. Sheaths are covered with short hairs. The spikes are 4 - 6" long, slender, and long-bearded. Annual rye can be found throughout eastern Colorado in wheat fields, roadsides, ditches and waste areas. It has become a major problem in the wheat fields of Colorado and is estimated to cost growers 8 - 10 bushels of wheat yield per acre.

Canada Thistle, *Cirsium arvense*

Canada thistle, a member of the Sunflower family, was introduced from Europe. It is a creeping perennial which reproduces by seed and fleshy, horizontal roots. Canada thistle is on the Colorado noxious weed list as well as marked as one of the top ten most widespread weeds causing the greatest economic impact to the State of Colorado. Stems are erect, hollow, smooth and slightly hairy, 1 - 5' tall, simple, and branched at the top. The leaves are set close on the stem, slightly clasping, and dark green. Leaf shape varies widely from oblong to lance-shaped. There are numerous sharp spines on the outer edges of the leaves, branches and main stem. The flowers are small and compact, about 0.75" or less in diameter, and light pink to rose-purple in color, occasionally white. The seed are oblong, flattened, dark brown, and approximately 0.125" long. Canada thistle emerges in April or May in most parts of Colorado. Infestations are found in cultivated fields, riparian areas, pastures, rangeland, forests, lawns, gardens, roadsides, and waste areas. Because of its seeding habits, vigorous growth, and extensive underground root system, control or eradication is difficult. It is distributed across Colorado in elevations ranging from 4,000 - 9,500'.

Downy Brome, *Bromus tectorum*

Downy brome, a member of the Grass family, is an annual or winter annual introduced from Europe. Downy brome is on the Colorado noxious weed list. It usually germinates in the fall, lies dormant, and produces seed early in the spring. It has smooth, slender, erect stems. The plant grows 6" - 2' tall from a much-branched base. The sheathes and leaves are covered with fine, soft hairs. Leaves are 0.125 - 0.25" wide and flat. Seed heads are branched and somewhat drooping. Seed are long and flat with an awn about as long as the seed. Downy brome matures and sets seed in early spring, before most other grass species or crops. It is a strong invader and creates a serious fire hazard when mature plants dry. Mature plants turn purple or brown. It is widely distributed in Colorado from 4,000 - 9,000' in elevation, and is a serious problem in small grains.

Field Bindweed, *Convolvulus arvensis*

Field bindweed, a member of the Morning-glory family, is a creeping perennial introduced from Europe. It reproduces by seed and horizontal roots. Field bindweed is on the Colorado noxious weed list as well as marked as one of the top ten most widespread weeds causing the greatest economic impact to the State of Colorado. The stems are smooth, slender, slightly angled, 1 - 4' long and spread thickly over the ground or wind around erect plants and other objects. Leaves are alternate, 1 - 2" long, with great variation in shape. They are somewhat arrow-shaped with spreading, pointed, or blunt lobes at the base. Flowers are bell or trumpet-shaped, white, pink, or variegated, and about 0.75 - 1" in diameter. Flowering is from June to September. Field bindweed is one of the most competitive perennial weeds. A two or three-year food supply is stored in the extensive underground root system. This makes it difficult to kill by cultivation because roots will live as long as their food reserve lasts. Seed remain viable in the soil for up to 40 years. It is found in both cultivated and uncultivated areas such as pastures, lawns,

gardens, roadsides, and waste areas throughout Colorado from 4,000 - 8,000' in elevation.

Field Penny Cress, *Thlaspi arvense*

Field penny cress, a member of the Mustard family, is also called fanweed because of its flat, broadly winged seed capsule. It is an annual that flowers in late spring to early summer. Flowers are white, pinkish or lavender and found in clusters at the ends of a racemic inflorescence. Circular pods form a chamber in which two seeds develop. Field penny cress reproduces solely by seed. Basal leaves are lanceolate, simple, entire to lobed. It is often found in grain fields, roadsides and other disturbed areas. Field penny cress has a strong odor, even causing cows to produce bitter flavored milk after eating it.

Flixweed, *Descurainia sophia*

Flixweed, a member of the Mustard family, is very similar to, and often confused with tansy mustard, *D. pinnata*. It is an introduced annual or winter annual which reproduces by seed. Flixweed is on the Colorado noxious weed list. Stems are erect, branched, and 4 - 30" high. Leaves are alternate, 2 - 4" long, dissected to give a lacy appearance. The stem and leaves are covered with fine hairs. Flowers are small, pale yellow, and grow in small clusters at the tips of elongated racemes. Seed pods are 0.25 - 0.75" long and on a stalk. Flixweed is widely distributed and is one of the first weeds to appear in spring. Most of the *Descurainia* in Colorado is flixweed. It is scattered across Colorado up to 8,000' in elevation.

Jointed Goatgrass, *Aegilops cylindrica*

Jointed goatgrass, a member of the Grass family, is native to southern Europe and Western Asia and is closely related to wheat. Jointed goatgrass is on the Colorado noxious weed list. In fact, the two species can interbreed. Jointed goatgrass seeds are difficult to screen out from wheat seed because they are very similar in size and shape. It spreads exclusively by seed. It is generally a winter annual, but about 5% of a population may be spring annuals. Leaves grow up to 0.5" wide, and have evenly spaced fine hairs along the leaf edges and down the sheath openings. The ligule is short and membranous, auricles are short and hairy. Stems can grow up to 4' tall and are tipped with slender, cylindrical spikes that appear to be a series of joints stacked on top of each other. Reddish to straw-colored spikes emerge in May and June, and most upper joints are tipped by straight, short awns. Up to three seeds are enclosed in each joint.

Kochia, *Kochia scoparia*

Kochia, a member of the Goosefoot family, is native of Eurasia. It is an annual, reproducing solely by seed. Kochia is on the Colorado noxious weed list. Flowering season is from July to October. Stems are erect, round, slender, pale green, branched, and 1 - 6' tall. Leaves are narrow, bright green, hairy, numerous and are attached directly to the stem. Upper leaves are more narrow than lower leaves. Flowers are inconspicuous in the upper leaf axils. Seeds are about 0.063" long, wedge-shaped, dull

brown, and slightly ribbed. Kochia can be found throughout Colorado up to 8,500' in elevation. It has become a major problem on roadsides, waste areas, and non-cultivated fields. In the fall, plants become red, later turning brown and breaking away from the root, causing them to tumble over the ground scattering large amounts of seed. Many kochia populations in Colorado are resistant to sulfonyleurea, imidazolinone, triazine and benzoic acid herbicides, representing three very different modes of action. Therefore, care should be taken when using herbicides to control kochia. Some alternative herbicides include: fluroxypyr, bromoxynil, MCPA ester, isoxaflutole, pyridate, flufenacet, fomesafen, glyphosate, lactofen and clomazone. It is important to rotate herbicide modes of action to prevent future cases of herbicide resistance.

Sunflower, *Helianthus annuus*

Sunflower, a member of the Sunflower family, is a native weed. It is an annual, 1 - 10' tall. Stems are erect, simple to branched and rough. Leaves are alternate, simple, rough, and hairy. Ray flowers are yellow to orange-yellow and disk flowers are brown. Flowering is from July to September. Seed are the only source of reproduction.

Tansy Mustard, *Descurania pinnata*

Tansy mustard, a member of the Mustard family, is a native winter annual, 4 - 32" tall. The plant is covered with fine hairs. The stem is erect, branched and 4 - 30" high. The flowers are small, pale yellow, and occur in small clusters at the tips of elongating racemes. Leaves are alternate and pinnately dissected, 2 - 4" long. Tansy mustard has stellate pubescence and racemic inflorescences. Petals are yellow, yellowish-green to cream. Pods are linear with two rows of seed in each seed pod. Tansy mustard spreads by seed from early to late summer. It is dispersed throughout Colorado up to 8,000' in elevation.

Additional Weeds

Blue Mustard, *Chorispora tenella*

Blue mustard, a member of the mustard family, is a winter annual. Seed germinates in late summer and fall. Blue mustard is on the Colorado noxious weed list. The plant overwinters as a rosette. The flower stalk usually elongates in March. The flowers are bluish-purple to purple and appear in early April. Viable seed can be produced approximately 10 days after bloom. Blue mustard is a problem in winter annual crops, such as winter wheat.

Green Foxtail, *Setaria viridis*

Green foxtail, a member of the Grass family, is generally shorter than other foxtails. Green foxtail is on the Colorado noxious weed list. Other characteristics distinguishing it from other foxtail species include:

roughened leaf sheaths, lack of hairs, and smaller seed than other foxtails. Seed are broadly oval, green and found in spike-like panicles that are 1 - 4" long. Green foxtail is native to Eurasia, but common throughout most of North America. Green foxtail is responsible for reductions in yields, increased seed cleaning costs, and expensive control measures. Flowering and seed production are in July, August and September.

Purslane, *Portulacca oleracea*

Purslane, a member of the Purslane family, is a fleshy, prostrate annual with smooth reddish or flesh colored stems. Branches radiate from a central rooting point, reach lengths in excess of 12" and form dense vegetative mats. Smooth, shiny, succulent leaves are somewhat teardrop-shaped, wider at the tip than at the base. Five petalled yellowed flowers are borne singly in leaf axils, and open only in the sunshine. Extensive seed production throughout the growing season and its ability to resprout following cultivation make this plant especially difficult to control.

Redroot Pigweed, *Amaranthus retroflexus*

Redroot pigweed, a member of the Amaranth family, was introduced from Europe and tropical America. It is an annual that reproduces by seed. The stem is light green, erect, stout, tough, rough-hairy, branched and 1 - 6" tall. The taproot is long, red and somewhat fleshy. Leaves are alternate with the lower leaves ovate, about 3 - 6" long, pointed at the tip, dull green, rough-hairy, with prominent ribs and veins. Upper leaves are smaller, narrower, and more lance-shaped. Flowers are small, green, and densely crowded in large, bristly, simple, or branched, terminal or axillary clusters. Redroot pigweed grows in cultivated fields, pastures, roadsides, and waste places in Colorado in elevations up to 8,500'. It is one of the most prominent, non-native annual plants found in cultivated fields in eastern Colorado. Redroot pigweed is resistant to ALS herbicides.

Russian Thistle, *Salsola iberica* and *S. collina*

Russian thistle, a member of the Goosefoot family, was introduced from Russia. It is an annual and reproduces by seed. It is on the Colorado noxious weed list. It is a round, bushy, branched plant growing 1 - 3.5' high. The branches are slender, succulent when young, and woody when mature. The first leaves to develop are alternate, dark green, soft, slender, and 1 - 2.5" long. These senesce early and new leaves form which are alternate, short, stiff, spiny, and not over 0.5" long, with two sharp-pointed bracts at the base. The flowers are small, inconspicuous, green-white or pink, and are usually solitary in the leaf axils. Seed are conical and 0.063" in diameter. Russian thistle grows in dry plains, cultivated fields, roadsides, and waste areas, primarily in grain-growing areas of the state. At maturity, the plant breaks off at the base. Its round shape allows it to tumble, scattering seed for long distances. It is widespread over Colorado in elevations up to 8,500'.

Wild Buckwheat, *Polygonum convolvulus*

Wild buckwheat, a member of the Buckwheat family, is an annual weed with arrowhead shaped leaves. It has trailing stems that wind around other plants and is often mistaken for field bindweed. Its leaves are heart shaped, alternate and more pointed than those of field bindweed. The leaves have an inconspicuous papery sheath that encircles the stem at the base of each petiole. Stems can be 8 - 40" long. In contrast to field bindweed, wild buckwheat has small, green flowers in the leaf axils. Seed are triangular, black and slightly roughened. Seed are the sole source of reproduction.

Wild Oats, *Avena fatua*

Wild oats, a member of the Grass family, are an annual weed, 1- 4' tall with erect, hollow stems. Although oats are grown in Colorado as a crop, the wild species is very different and is on the Colorado noxious weed list. Leaf blades are 0.125 - 0.625" wide with open sheaths and membranous ligules. Seedling leaves twist counterclockwise. The inflorescence is an open panicle, 4 - 18" long, drooping, spikelets contain 2 - 3 florets which disarticulate above the glumes. Seed are yellow to black, narrowly oval, 0.25 - 0.5" long. This species is distinguished from domestic oats by the twisted awn which bends at right angles and a horseshoe-shaped scar at its seed base.

Key Weed Management Strategies

A good stand without skips in planting helps control the germination of early spring weeds.

Clearfield wheat cultivars adapted to Colorado have been developed and Beyond (**imazamox**) herbicide has been formulated for use in this wheat.

Herbicides (crop use) -

Pesticide: **2,4-D** (Hi-Dep)

- Target Pests: Perennials require higher rates
- Recommended rate: 4-16 oz ai/A (0.75-2.0 pt product)

Pesticide: **2,4-D** (Savage)

- Target Pests: Perennials require higher rates
- Recommended rate: 6-9 oz ai/A (6.4-9.6 oz product)

Pesticide: **2,4-D** (Salvo)

- Target Pests: Perennials require higher rates
- Recommended rate: 9-19 oz ai/A (0.7-1.5 lb product)
- Use Data:

1992= rate used- 0.42 lb ai/A
39% of total acres treated
1997= rate used- 0.31 lb ai/A
40% of total acres treated
2001= rate used- 0.33 lb ai/A
9% of total acres treated

- Comments: Preharvest interval of 14 days

Pesticide: **bromoxynil** (Buctril; Broclean)

- Target Pests: Several winter annual weeds, Mustards, Sunflowers, Wild Buckwheat
- Recommended rate: 5-10 fl oz ai/A (1-2 pt product/A)
- Use Data:
 - 1992= rate used- 0.29 lb ai/A
1% of total acres treated
 - 1997= rate used- 0.37 lb ai/A
5% of total acres treated

Pesticide: **bromoxynil + MCPA** (Bronate)

- Target Pests: Several winter annual weeds, Mustards, Sunflowers, Wild Buckwheat
- Recommended rate: bromoxynil: 0.32-0.64 fl oz ai; MCPA: 0.34-0.68 fl oz ai (1-2 pt product/A)

Pesticide: **imazamethabenz** (Assert)

- Target Pests: Mustards, Wild Oats
- Recommended rate: 5.6-6.4 oz ai/A (1.3-1.5 pt product/A)

Pesticide: **imazamethabenz** (Assert SG)

- Target Pests: Mustards, Wild Oats
- Recommended rate: 5.0-7.5 oz ai/A (9.7-11.2 oz product/A)

Pesticide: **imazamox** (Beyond)

- Target Pests: For use on weeds in Clearfield wheat
- Recommended rate: 0.48-0.73 fl oz ai/A (4-6 fl oz product/A)
- Comments: Apply after third leaf and before jointing stage

Pesticide: **metsulfuron** (Ally)

- Target Pests: Mustards, Pigweeds, Sunflower, Velvetleaf

- Recommended rate: 0.06 oz ai/A (0.1 oz product/A)
- Use Data:
 - 1992= rate used- 0.004 lb ai/A
24% of total acres treated
 - 1997= rate used- 0.004 lb ai/A
24% of total acres treated

Pesticide: **thifensulfuron + tribenuron** (Harmony Extra)

- Target Pests: Canada Thistle
Recommended rate: thifensulfuron: 0.15-0.3 oz ai/A; tribenuron: 0.07-0.15 ai oz/A (0.3-0.6 oz product/A)

Pesticide: **triasulfuron** (Amber)

- Target Pests: Certain annual grass and broadleaf weeds
- Recommended rate: 0.16-0.35 oz ai/A (0.28-0.47 oz product/A)
- Comments: Resistant biotypes affect rates
- Use Data:
 - 1997= rate used- 0.01 lb ai/A
12% of total acres treated

Pesticide: **tribenuron** (Express)

- Target Pests: Mustards, Field penny cress, Flixweed, Russian thistle*, Canada thistle*, Kochia*
- Recommended rate: 0.21-0.35 oz ai/A (0.17 to 0.33 oz product/A)
- Comments: * Resistant biotypes affect rates
- Use Data:
 - 1992= rate used- 0.008 lb ai/A
5% of total acres treated
 - 1997= rate used- 0.006 lb ai/A
11% of total acres treated
 - 2001= rate used- 0.006 lb ai/A
2% of total acres treated

Herbicides (fallow use) -

Pesticide: **2,4-D** (Weedar 64)

- Target Pests: Perennials require higher rates
- Recommended rate: 3.7-14.7 fl oz ai/A (0.5-2 pt product/A)

- Use Data:
 - 1992= rate used- 0.42 lb ai/A
39% of total acres treated
 - 1997= rate used- 0.31 lb ai/A
40% of total acres treated
 - 2001= rate used- 0.33 lb ai/A
9% of total acres treated

Pesticide: **2,4-D + 2,4-DB** (Weedone 638)

- Target Pests: Certain annual grass and broadleaf weeds
- Recommended rate: 2,4-D: 1.1-4.4 fl oz ai/A; 2,4-DB: 1.9-7.8 fl oz ai/A (0.5-2 pt product/A)
- Comments: Controls perennials, but risk of crop injury

Pesticide: **2,4-D + glyphosate** (Landmaster BW)

- Target Pests: Emerged weeds prior to planting, Bindweed Control
- Recommended rate: 2,4-D: 8.3-13.2 oz ai/A; glyphosate: 5.2-8.3 oz ai/A (40-64 oz product/A)

Pesticide: **chlorsulfuron + metsulfuron** (Finesse)

- Target Pests: Certain annual grass and broadleaf weeds
- Recommended rate: chlorsulfuron: 0.12-0.31 oz ai/A; metsulfuron: 0.02-0.06 oz ai/A (0.2-0.5 oz product/A)
- Comments: Soil type and Resistant biotypes affect rates

Pesticide: **clopyralid + 2,4-D** (Curtail)

- Target Pests: Several broadleaf weeds
- Recommended rate: clopyralid: 1.6-2.1 oz ai/A; 2,4-D: 12.4-16.2 oz ai/A (2.0-2.6 pt product/A)
- Comments: Do not tank mix with 2,4-D or dicamba unless risk of crop injury is acceptable.

Pesticide: **dicamba** (Clarity)

- Target Pests: Broadleaf weeds
- Recommended rate: 1.6-2.2 fl oz ai/A (0.18-0.25 pt product/A)
- Use Data:
 - 1992= rate used- 0.22 lb ai/A
9% of total acres treated
 - 1997= rate used- 0.12 lb ai/A
11% of total acres treated
 - 2001= rate used- 0.17 lb ai/A

6% of total acres treated

Pesticide: **dicamba + glyphosate** (Fallow master)

- Target Pests: Mustards, Goatgrass, Wild Oats, Russian thistle
- Recommended rate: 0.55-0.89 lb ai/A (32-52 oz product/A)

Pesticide: **glyphosate** (many)

- Target Pests: Canada thistle, Redroot pigweed, Sunflower
- Recommended rate: 12-20 fl oz ai/A (1.5-2.5 pt product/A)
- Comments: Apply at least 30 days prior to planting
- Use Data:
 - 1992= rate used- 0.50 lb ai/A
1% of total acres treated
 - 1997= rate used- 0.46 lb ai/A
16% of total acres treated
 - 2001= rate used- 0.69 lb ai/A
6% of total acres treated

Pesticide: **paraquat** (Cyclone)

- Target Pests: All weedy species
- Recommended rate: 7-28 fl oz ai/A (1-4 pt product/A)

Pesticide: **paraquat** (Gramoxone Max)

- Target Pests: All weedy species
- Recommended rate: 9.1-18.9 fl oz ai/A (1.3-2.7 pt product/A)
- Use Data:
 - 1997= rate used- 0.55 lb ai/A
3% of total acres treated

Pesticide: **picloram + 2,4-D** (Tordon 22K + 2,4-D Amine)

- Target Pests: Canada thistle, Russian thistle, pennysress, wild buckwheat, pigweed, wild mustard, sunflower
- Recommended rate: picloram: 0.24-0.36 fl oz ai/A; 2,4-D: 3.7-7.4 fl oz ai/A (1 to 1 ½ fl oz Tordon is mixed with ½ to 1 pt 2,4-D Amine)

Pesticide: **triallate** (Far-Go)

- Target Pests: Wild oats, Downy brome
- Recommended rate: 16-20 oz ai/A (2-2.5 pt product/A)

Critical Pest Issues

Volunteer wheat sometimes acts as a carrier or transitional host for some pests, including the wheat curl mite and certain viruses. Therefore, it is imperative to destroy volunteer wheat and allow a 2-3 week fallow period before planting winter wheat. The planting of cultivars that are well adapted to local growing conditions reduces insect, disease and weed problems. Minimum or no-till increases the incidence of diseases like cephalosporium stripe, take-all and tan spot. Although currently, these diseases are not prevalent in Colorado.

Jointed goatgrass is a common weed problem in wheat cropping systems, and is very difficult to control. Clearfield wheat is being marketed for use as a management tool against jointed goatgrass populations.

Sulfonylurea herbicides are not registered for use in the San Luis Valley.

ALS herbicide resistance can be selected for very quickly, even after two applications. More commonly, population pressure due to consecutive applications or continuous production of the same crop year after year using only ALS herbicides selects for resistance. In many situations, resistance is selected for along right-of-ways and then resistant biotypes move into agricultural fields. It is important to rotate herbicide modes of action to prevent future cases of herbicide resistance.

Weeds, diseases, and insects can all develop resistance over time to pesticides. When the same pesticide is used consecutively over a period of time, the target pest can become resistant to that pesticide and render the pesticide obsolete.

A new strain (or "biotype") of Russian wheat aphid has recently been found in Colorado. It is not clear yet if this new biotype (Biotype B) is only different from the existing biotype (Biotype A) by its virulence to Colorado's resistant wheat varieties or if there are other biological or economic differences that might affect other management recommendations. For more information on management tactics go to the Russian wheat aphid description in the Key Insect Section of this profile.

Diseases

Key Diseases

Barley Yellow Dwarf

Barley yellow dwarf is caused by a group of barley yellow dwarf viruses that infect many crops including barley, corn, oats, and wheat. The vectors are a group of aphids, including greenbugs, bird cherry-oat aphids, corn leaf aphids, and English grain aphids. Plants are stunted and have a stiff, crumpled appearance. Tillering is reduced and heads do not fill. Individual leaves turn yellow from the tips in a zigzag pattern that leaves the mid-vein green. The virus survives in aphids, grassy weeds, volunteer plants, and fall-planted cereals. Infected plants are located at random in a field where winged adults have landed. These plants develop into foci of disease. Barley yellow dwarf is favored by cool, wet weather in the spring and early summer. Barley yellow dwarf causes losses of 5 to 30 % in wheat and barley. Management of barley yellow dwarf virus depends on late planting of winter cereals that will serve as a bridge to the following year and to avoid fall infection or early planting of spring cereals to avoid infection at early growth stages. Controlling the vectors is a primary management tactic. Although, the use of insecticides is seldom economical.

Common Root Rot, *Fusarium*, *Rhizoctonia solani*, and other soil fungi

Soil borne fungi such as *Fusarium*, *Rhizoctonia solani*, *Pythium*, *Phytophthora*, and *Rhizopus* cause rots of various plant parts. Symptoms of root and crown rots are seen first in the above ground parts of the plant as chlorosis, wilting, stunting, necrosis, collapse, reduced yield, and plant death. The affected roots, crown or stem will have darkened lesions and cankers. Common root rot causes a darkening of the stem and less notable symptoms, but can cause significant yield loss. Crop rotation to broadleaf crops is the most effective method of control. Tillage to bury plant residues is also effective. Root rot is a serious problem for Colorado producers and requires more management possibilities.

High Plains Disease (HPD)

HPD is a newly discovered disease caused by a virus. Although HPD and wheat streak mosaic are frequently found together, HPD seems to be less common and less important than wheat streak mosaic. Symptoms of doubly-infected plants are severe chlorosis, strong mosaic, severe stunting, and rapid plant death. Occasionally, singly-infected plants have been found. Symptoms of pure HPD infection are quite variable. Some leaves have green and yellow stripes at the leaf tips similar to wheat streak mosaic, and others have yellow spots. Still others have green islands on a light green background and look similar to soil-borne mosaic. All of these types of leaves can occur on the same plant. Hail at harvest and wet summer weather favor the growth of volunteer wheat. When wheat is planted near volunteer wheat or early planting wheat, there is an increased incidence of HPD. Also, warm fall temperatures favor the wheat curl mite vector. Yellow areas in fields appear in the spring especially near the edges adjacent to volunteer wheat.

Stripe Rust, *Puccinia striiformis*

Stripe rust infection usually appears as small, yellow pustules on the leaves and heads, often arranged in conspicuous stripes. Individual pustules are small, but a series of pustules can form in a line between vascular bundles and progress the length of the blade. On seedlings, the pustules appear individually, not

in a line. Near the end of the season, the fungus produces a black spore stage (teliospores) in and around the yellow pustules (urediniospores). The fungus is assumed to overwinter in southern production areas, and then the yellow spores are blown northward in the spring. Stripe rust infects wheat as well as barley and numerous grasses. Controls include crop rotation, planting resistant varieties, and timely application of labeled fungicides such as: mancozeb, propiconazole, pyraclostrobin and azoxystrobin.

Wheat Streak Mosaic Virus (WSMV)

Wheat streak mosaic virus (WSMV) is a rymovirus transmitted up to 1.5 miles by the wheat curl mite and from plant to plant by leaf contact. The virus is worse in early-seeded, fall fields that are already infected. Wheat streak mosaic virus can cause severe losses. 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. Light green to faint yellow blotches, dashes and streaks parallel to the veins develop in the wheat leaves. Destroy all volunteer wheat plants and grassy weed hosts. Use recommended seeding dates for winter wheat. Avoid planting winter wheat next to green corn fields where wheat streak mosaic has been a problem in the past. If necessary to plant along side corn, wait until the latest planting date possible to reduce the incidence of this disease. Wheat cultivars differ in their level of tolerance. Resistant cultivars are currently under development. WSMV continues to be a serious problem for Colorado producers.

Additional Diseases

Bacterial Leaf Blight, *Pseudomonas syringae* subsp. *syringae*

Bacterial leaf blight occurs in poorly drained wet areas. The bacterium is easily spread in the field by tillage equipment, surface water and animal life in the soil. Bacterial leaf blight usually only occurs on the upper leaves. Small, water-soaked lesions form that eventually coalesce into larger lesions that may cover the entire leaf. These spots can advance rapidly to cause blight and are generally associated with sprinkler irrigation in cool wet weather. The bacteria overwinter on and in seed and in debris. Management practices for bacterial diseases include use of pathogen-free or treated seed, crop rotation, field sanitation, and use of copper-based bactericides.

Black Chaff or Bacterial Streak, *Xanthomonas campestris* pv. *translucens*

Black chaff is caused by a bacterium, *Xanthomonas translucens* pv. *translucens*, which may be seed borne. Severe epidemics occur periodically in irrigated wheat. Symptoms generally appear after boot stage. Leaves develop small water-soaked spots which develop into tan to dark brown necrotic spots or streaks surrounded by lime-green chlorotic tissue that merges out to the healthy tissue. Initial symptoms frequently are on upper leaves in the middle of the blade. Entire leaves may die prematurely; if before the soft dough stage, yield reductions and shriveled grain of low test weight may result. Symptoms in

heads consist of dark brown or black streaks and blotches, frequently concentrated on the upper portions of the glumes. Diseased heads mature late and may be sterile if infected before flowering. Use of certified seed and rotation out of wheat for at least two years are used to manage black chaff.

Black Point, *Helminthosporium*, *Alternaria*, *Fusarium*

Black point, or smudge, reduces germination and lowers grain grade. Rain events that occur after the wheat has matured encourages the development of these fungi. Black point is associated with many fungi and physiological circumstances. The embryo end of the kernel becomes black and kernels may become shriveled. There are other fungi that can cause black point, but the three mentioned above are the most common. Losses are due to discounted prices of discolored grain and viability of the seed also may be reduced. Always use clean, pathogen-free, seed for planting.

Cephalosporium Stripe, *Cephalosporium gramineum* (*Hymenula cerealis*)

Cephalosporium stripe is usually found in low spots or drainage ways in fields of winter wheat. It is rarely seed-borne in wheat. It has a characteristic symptom of a yellow stripe from the tip of the leaf to its base. To date no chemical has been found, neither a seed treatment nor foliar spray, that controls Cephalosporium stripe. When first studied, Cephalosporium stripe was found primarily around the periphery of the wheat region at higher elevations. It is now more widespread. Early seeding increases disease. Infected straw on the soil surface favors disease more than buried straw, so minimum tillage tends to increase inoculum levels.

Common Bunt or Stinking Smut, *Tilletia tritici* and *T. laevis*

Common bunt is caused by two closely related fungi, *Tilletia tritici* and *T. laevis*. Symptoms of common bunt usually are not apparent until heading time. On emergence from the boot, smutted wheat heads are slender and maintain their green color longer. The glumes of some or all of the spikelets are spread apart because they contain smutted kernels, or smut balls, in place of normal kernels. These smut balls resemble normal kernels but are shorter and thicker and a dull gray-brown. Each smut ball contains a mass of sooty, black powder, the individual particles of which are the spores or "seed" of the fungus. Seed contaminated with smut has a distinctive fishy odor. When the wheat is harvested, the mature smut balls break, releasing the spores that contaminate soil and healthy seed. Soil-borne spores of common bunt remain infective in areas where the soil remains dry from time of threshing until after seeding. Following seeding, as the young wheat sprout grows from the seed to the surface of the soil, spores on the seed or in the soil germinate in response to moisture and form slender infection threads (mycelium) that enter the seedling. As the plant grows the smut fungus grows inside it, finally replacing the kernel with fungus spores. The only effective and economical control of common bunt is through seed treatment fungicides such as carboxin, difenconazole, or PCNB and consistent use of certified seed.

Dwarf Bunt, *Tilletia controversa*

Tillers infected with dwarf bunt are severely stunted, anywhere from half to a quarter normal height. Small smut balls are formed that are very black and have a "fishy" odor especially when moist. The fungicide difenconazole (Dividend) is the only registered seed treatment that successfully controls the soil-borne phase of dwarf bunt. Wheat cultivars adapted to Western Colorado, where the disease has been found, are available.

Ergot, *Claviceps purpurea*

Ergot is a fungus that attacks wheat. The hard black sclerotia of the fungus germinate stroma, which form ascospores carried by wind or insects to the flowering cereal. A conidial stage, or honeydew, forms on the infected head; insects can transmit these conidia to uninfected flowers. Sclerotia formed on the heads drop to the ground or are mixed with seed for the next year. Infections frequently spread from wild grasses into cultivated cereals. If livestock eat grain containing the sclerotia spontaneous abortion, loss of milk, and dry gangrene can occur. The most conspicuous symptoms are hard, pointed, black to deep purple sclerotia that replace one or more kernels within the head. Sclerotia are several times longer than the kernels and are easily observed on the head or mixed with grain. Best control is obtained through sanitary measures such as removing sclerotia from seed before planting and planting seed deeper than three inches to reduce the ability of the fungus to produce primary inoculum. Allowing two-year intervals between wheat crops can provide time for the sclerotia to disintegrate and reduce primary inoculum. Plants infected with ergot are destroyed.

Leaf Rust, *Puccinia recondita*

Leaf rust appears as small, round-to-oval, orange-yellow dusty pustules on the leaves and sheaths, sometimes the stems and occasionally the glumes and awns. On resistant wheat only small yellow flecks or spots without uredia develop. As wheat matures, glossy, dark gray to black covered telia are produced. The rust fungus overwinters in the urediospores and spreads northward as the season progresses. Resistance is the most common control tactic. Fungicidal sprays such as mancozeb, propiconazole, pyraclostrobin and azoxystrobin need to be accurately timed and applied before 5% of the flag leaf is covered by rust. Extensive research has shown that these fungicides are seldom economical.

Loose Smut, *Ustilago tritici*

Loose smut destroys the grain and all glume structures of the spike leaving only the central rachis which head early. Infected plants, produce smut spores that are wind-borne to healthy plants at flowering time. Spores germinate and germ tubes penetrate the young wheat ovaries where the fungus remains dormant until those seed germinate. Use of seed treatment fungicides such as carboxin, difenconazole, or PCNB as well as disease-free seed will prevent this disease.

Powdery Mildew, *Erysiphe graminis*

Powdery mildew affects small grains when humidity is high. The white web-like covering on the top and bottom of leaves identifies powdery mildew. It can occur under wet or dry conditions and does not require a film of water on the leaf surface for infection to take place. Spores are produced continuously day and night throughout the summer. Fungi overwinter as mycelium on buds, twigs and fallen debris. They also produce a sexual structure, a cleistothecium, which produces ascospores in the spring. Management of powdery mildew is primarily through use of resistant cultivars. Cultural practices that increase airflow and enhance leaf drying are useful management tools. Protectant fungicides such as propaconazole can be used when necessary.

Scab, *Fusarium* spp.

Scab is caused by several *Fusarium* spp., fungi that live in soil and on old stubble and straw. They may also cause disease of the root and crown of wheat. The pathogens have simple nutritional requirements and are as omnipresent as saprophytes. Lack of moisture during the flowering period usually is the limiting factor for parasitism. Infected kernels may contain a mycotoxin that can induce muscle spasms and vomiting in people and certain other nonruminant animals. On emerged immature heads, one or more spikelets or the entire head appears prematurely bleached. Salmon-pink sporulation on rachis or glumes is diagnostic. Bleached spikelets usually are sterile or contain only partially filled seed. Seed treatments such as captan are available and they are other fungicides such as carboxin and PCNB available depending on the type of application required. Use of clean seed is imperative to keep this disease out of a field. Overall, this disease is extremely rare in Colorado.

Septoria Glume Blotch and Septoria Leaf Spot, *Septoria tritici* and *S. nodorum*

The fungi *Septoria tritici* (leaf blotch) and *S. nodorum* (glume blotch) survive between crops on infected wheat stubble, volunteer wheat, and secondary weedy hosts. *S. nodorum* may be seed borne, but the importance of this in the disease cycle is unknown. The fungi spread by wind and rain. Leaf blotch appears first on lower leaves as light green or yellow spots between leaf veins. Spots spread rapidly to form brown, irregular blotches that tend to follow the leaf veins. Tiny dark dots (pycnidia), the fungal spore-producing chambers, form later in the brown lesions. Glume blotch has leaf symptoms similar to leaf blotch. Lesions are lighter brown and often lens-shaped with a darker brown center. Pycnidia of this fungus are difficult to detect without magnification. Lesions are dark brown and have a raised, crusty appearance. Seed from infected heads are shrunken and wrinkled. Although both diseases can occur on the heads, glume blotch is more severe than leaf blotch. Crop rotation, weed management and proper irrigation should reduce the problems associated with this disease. A key to managing this disease is the use pathogen-free, clean seed. Resistant cultivars are the best option for control.

Take-All, *Gaeumannomyces graminis* var. *tritici*.

Take-all is caused by the fungus, *Gaeumannomyces graminis* var. *tritici*. It is most serious in sandy, alkaline, infertile soil where wheat is grown intensively. Winter wheat is more seriously damaged than spring wheat. Affected plants are stunted to severely dwarfed in localized areas. Such plants have a

reduced number of tillers, somewhat yellowed leaves, ripen early, may lodge, and develop white heads that are sterile or poorly filled and later darkened by sooty molds. Roots, crowns and stem bases develop a brittle, dry, brown-to-black rot. A superficial, coal-black mycelial mat forms under the lower leaf sheaths. The fungus survives in soil as well as on cereal and grass debris. Crop rotation is the most effective control and it is recommended that the field be without wheat for at least two years. Weed control, lime applications and appropriate fertilization can help reduce the incidence of this disease. Take-all is favored by early planting of wheat and plants should be plowed down soon after combining to enhance residue decomposition and reduce volunteer wheat. The disease appears to be restricted to temperate wheat-growing areas.

Tan Spot, *Pyrenophora tritici-repentis*

Tan spot can occur on top and bottom leaf surfaces. Initial symptoms will be tan-brown flecks and the spots will enlarge into lens-shaped lesions. The fungus grows as a saprophyte on crop residue. Therefore, it has been observed to be more severe in no-till wheat. Cultural practices such as deep burial of straw and rotation will help reduce tan spot. Fungicides such as mancozeb and propaconazole may be economical if the crop has a potential yield of 40 bushels or more per acre.

Wheat Soil-Borne Mosaic Virus, (SBWMV)

SBWMV is a furovirus associated with a soil-borne fungus. Symptoms of SBWMV appear early in the spring, usually when weather is cool and damp, but are rarely seen in fall or winter. Fields observed from a distance have irregular patches of light green or yellow plants. Symptoms on plant leaves range from mild green to yellow mottling and striping, giving the mosaic appearance. Stunting varies from moderate to severe. Symptom expression favors temperatures below 68 F. Symptoms gradually disappear before harvest time if normal temperature persists. The soil-borne fungus, *Polymyxa graminis*, which is a parasite of roots of many grass plants, is the vector of SBWMV. Virus particles are either inside fungal spores or are attached to the spores. The fungus invades the roots in the fall, when soils are cool and wet, carrying the virus particles with it. There is no practical way to rid the soil of the SBWMV. Rotation out of wheat to other crops reduces losses.

Key Disease Management Strategies

Cultural Controls

Reduced tillage increases stored soil moisture which leads to healthier, pest resistant plants.

Planting cultivars resistant to leaf rust and stem rust will reduce pesticide use in fields during the current crop season, but spores of rust fungus blow in from the south every year. Proper crop rotation that leaves the field out of wheat for 2 - 3 years will help to avoid take-all and common dryland root rot.

Fungicides -

Pesticide: **carboxin** (Vitavax 34)

- Target Pests: Damping off, Seedling blights, Bunt, Loose smut
- Recommended rate: rate per 100 lb seed, 0.6-1.0 oz ai (2.0-3.0 oz product)
- Comments: Seed treatment

Pesticide: **carboxin** (Vitavax 200)

- Target Pests: Damping off, Seedling blights, Bunt, Loose smut
- Recommended rate: rate per 100 lb seed, 0.6-0.8 oz ai (3.0-4.0 fl oz product)
- Comments: Seed treatment

Pesticide: **carboxin-thiram** (RTU-Vitavax-Thiram)

- Target Pests: Loose smut, Common bunt
- Recommended rate: rate per 100 lb seed, carboxin: 0.50-0.68 fl oz ai; thiram: 0.50-0.68 fl oz ai (5.0-6.8 fl oz product)
- Comments: Higher rates are recommended where disease is severe

Pesticide: **difenconzole** (Dividend XL)

- Target Pests: Bunt, Smut, seedborne diseases of Septoria, Fusarium, Pythium
- Recommended rate: rate per 100 lb seed, 0.33 oz ai (2.0 oz product)
- Comments: Seed Treatment

Pesticide: **mancozeb** (Dithane M45)

- Target Pests: Helminthosporium, Septoria leaf blotch, Rust, Tan spot
- Recommended rate: 25.6 oz ai/A (2.0 lb product/A)

Pesticide: **mancozeb** (Penncozeb 75 DF)

- Target Pests: Helminthosporium leaf blight, Septoria leaf blotch, Rust, Tan spot
- Recommended rate: 12-24 oz ai/A (1.0-2.0 lb product/A)

Pesticide: **mancozeb** (Manzate Flowable)

- Target Pests: Helminthosporium leaf blight, Septoria leaf blotch, Rust, Tan spot
- Recommended rate: 19 fl oz ai/A (1.6 qt product/A)

Pesticide: **PCNB** (RTU-PCNB)

- Target Pests: Bunt, Smut, Rhizoctonia and Fusarium seed diseases
- Recommended rate: rate per 100 lb seed, 0.72 fl oz ai (3.0 fl oz product)
- Comments: Seed Treatment

Pesticide: **propiconazole** (Tilt)

- Target Pests: Helminthosporium leaf blight/Spot blotch, Powdery mildew, Stem rust, Stripe rust, Leaf rust, Septoria leaf blotch, Tan spot
- Recommended rate: 1.6 oz ai/A (4.0 fl oz product/A)
- Comments: Only 4.0 oz product/A per season

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