

# Crop Profile for Soybeans in Colorado

**Prepared: September, 2000**

**Revised: September, 2003**

*Glycine max* (Fabaceae)

## General Production Information

### Colorado facts

Soybean has only recently been cultivated in Colorado, so there is very little statistical analysis to present. It has enormous potential in irrigated agricultural lands as a leguminous rotation crop.

### Description of Crop

An annual legume with pubescent stems and large pinnate leaves. Flowers are white or purple and found in axillary racemic clusters. The seedpods are pubescent, bearing 1 - 4 spherical seed. The seed are harvested and used for vegetable oils, shortening, margarine, bread flour, soy milk, meat substitutes, fibers, plastics, ink, and as protein supplements for livestock feed. Minor uses also include: adjuvants, pesticide carriers and bases for pharmaceuticals.

### Cropping System

Soybean should be planted in mid-May, but no later than early June. The optimal soil temperature is 60 F; optimal air temperature is 86 F. The planting depth should be 1 - 1.5". Approximately 150,000 seed per acre for indeterminate varieties and 225,000 seed per acre for determinate varieties are the suggested planting densities. All soybean seed should be inoculated with the appropriate *Rhizobium*, or symbiotic nitrogen-fixing soil bacteria, to ensure adequate nitrogen fixation and nodulation (swelling of root with bacteria). This is currently very important in the production in Colorado where soybean have not been grown in the rotations. Soybean are normally planted with a drill to encourage early canopy but also respond well to planting in 30" rows with a conventional corn planter.

There has been some discussion about the use of narrow row widths: 10" is the most narrow width feasible, but 20" is an average. Decreasing row spacing results in more rapid canopy closure and increased light interception. Canopy closure at or shortly after flowering will maximize yields in ideal conditions. However, narrow a row soybean (10") should not be grown on high pH soils where iron chlorosis is possible.

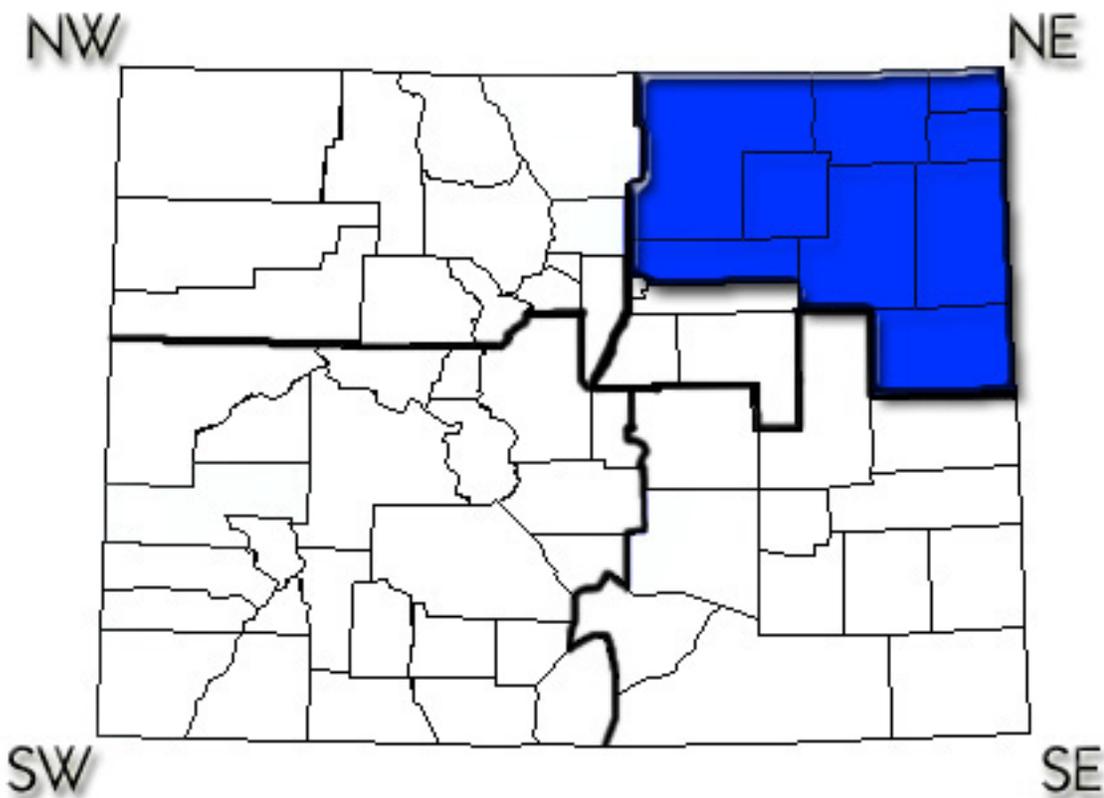
Adequate irrigation is essential at the pod and bean development stage of soybean, if water is abundant it is also recommended to pre-irrigate as well as irrigate at pod development. Soybean fill and oil content is later in the life cycle than corn, therefore apply irrigation at early pod fill stage to maximize yield under limited irrigation wells. High levels of irrigation during flowering have been shown to decrease yield. In a restricted growing season, maintaining high soil water content in the later stages of growth can decrease yields by delaying maturation.

The following commodities work well when grown in rotation with soybean: alfalfa, small grains, corn and grain sorghum. To maximize yields and minimize pest problems, soybean should not be continuously cropped, or rotated with other legumes or sod. Soybean are directly combined during harvest in October. Seed pod shattering is a problem in Colorado due to the dry, low humidity environment. Timely harvest is essential to prevent a smaller harvest. Soybean can dry down very fast in Colorado's warm fall climate. It is common to lose one point of moisture per day and a soybean crop can go from wet to harvest to seed shatter in very few days.

Soybean fit well in a no-till environment due to Roundup Ready Technology.

Reduced- or no-till systems are optimal to reduce soil water loss, but reduced tillage will cause the weed seed to be concentrated in the 1 - 3" of soil where germination is most favorable. This will lead to weed pressure and an increase in herbicide use. Wet, cold, poorly-drained soils are more susceptible to disease infestation, so soil tillage strategy should reflect these potential problems.

**Location of Production**



**Northeast**

Adams, Kit Carson, Logan, Morgan, Phillips, Sedgewick, Washington, Weld, Yuma

**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

#### **Bean Leaf Beetle, *Certoma trifurcata* (Forster)**

Bean leaf beetles are about 0.25" long, with considerable variation in color patterns. The background color may be yellow, green, tan, or red. Most beetles have four black spots and black stripes along the edges of the wing covers. A black triangle is always present at the base of the wing covers just behind the prothorax. The larvae are white, with dark brown areas at both ends. When mature, the larvae are about 0.375 - 0.5" long. Bean leaf beetles overwinter as adults under debris in protected areas. When temperatures rise in the spring, beetles fly into alfalfa and clover fields to feed but do not lay eggs there. As soon as beans begin emerging, the beetles abandon alfalfa and clover fields to colonize bean fields. Females lay eggs in the soil around the base of the plant. The lemon shaped eggs are laid in clusters of 12 - 24 and are orange. The eggs hatch in 1 - 3 weeks depending on the weather. Larvae feed on the roots and nodules of the plants then form an earthen pupation cell. The pupal stage lasts approximately one to two weeks. When adults emerge, they feed on soybean foliage. In most parts of Colorado, bean leaf beetles complete one generation per year. There has been some indication that a complete or partial second generation may occur in southern parts of the state. The injury caused by the bean leaf beetle is two-fold. The adults feed on the leaves of the plants causing the characteristic "shot-hole" appearance on the leaves. They also feed on the roots and underground portion of the stem, girdling and killing the plant. Late in the season, bean leaf beetles may chew on pods. Their feeding creates scars that allow infection by some fungal diseases. Mild infection results in seed staining; severe infection results in seed contamination.

#### **Mexican Bean Beetle, *Epilachna varivestris* (Mulsant)**

The Mexican bean beetle can be a serious pest of beans in Colorado. The adult Mexican bean beetle is 0.25 - 0.33" in length and has an oval, pale-yellow, convex body when newly emerged. As the adult matures, it changes to a copper brown color. It has 16 black spots on its back. Larvae are yellow-orange, about 0.33" in length, and are covered with dark, branched spines that give them a fuzzy appearance. The adults overwinter at the soil surface under plant debris and sometimes in large groups in hedgerows adjacent to bean fields. When temperatures rise in the spring, beetles fly into alfalfa and clover fields to feed but do not lay eggs there. As soon as beans germinate and begin to grow, the beetles abandon alfalfa and clover fields to colonize bean fields. Seven to 10 days after feeding, females will begin to lay yellowish orange eggs in clusters of 40 - 60 on the undersides of the bean leaves. Each female may lay up to 500 eggs in a 5 week period. In the early part of the season, the eggs take approximately 12 days to hatch, while later in the summer they take only 5 days. The larvae take about 25 days to mature. Mature larvae attach themselves to the underside of the leaves and weeds to pupate, and are inactive for about a week. The pupae are round, smooth, yellow, and quite often have the last larval skin still attached.

Generally, two generations per year develop in Colorado. Eggs of the first generation will hatch in late June or July, and larvae develop through July into August. The next generation of adults will emerge in late July or early August and lay eggs in August. Larvae of the second generation pupate in late August or early September. Larvae and adults feed on the undersides of leaves, leaving the upper surface intact. The upper leaf surface dries up and falls out so that damaged leaves have open, ragged holes. The larvae feed along parallel lines, leaving strips of uneaten leaves in between. When abundant, these pests also feed on bean pods and stems. Injury reduces plant vigor and in extreme cases, foliage is reduced to shreds, causing plant death.

### **Thrips, *Thrips spp.***

Thrips are minute insects that feed on tender plant tissue. They rasp leaf tissue and drain the exuding sap, causing stunted and deformed plants. Thrips are usually a pest of seedling plants but may attack plants in any stage. Insecticides should be applied when thrips are present and plants show damaged terminal buds and leaf cupping.

Colorado experienced an infestation which made thrips a major pest for one year.

## **Additional Insects**

### **Corn Earworm, *Helicoverpa zea***

The corn earworm may appear in various colors, including yellow, pink, green, and black. Their bodies have alternating light and dark stripes and are covered with small spines. Regardless of body color, all have yellow-brown head capsules, except when newly hatched. Fully developed larvae are 1.5 - 2" long. Adult moths are buff to grayish-brown with a wingspread of about 1.5". Most adult moths migrate north from the southern states in the spring. Female moths lay a single off-white colored egg. First and second generation corn earworms feed primarily on corn. However, corn is usually too mature to be attractive to third generation corn earworms, so they seek out alternate feeding sources - namely soybean. The degree of injury to soybean depends upon the size and timing of corn earworm infestation. Soybean plants can withstand considerable injury, including defoliation and heavy flower feeding. If the infestation is early, primary damage will be defoliation. This causes a delay in pod set. Pod loss up to 20 - 30% can be sustained by soybean with no notable yield loss. Plants will easily make up for the pod loss by increasing seed size in the remaining pods, or by setting new pods as long as plants are not moisture stressed. Later infestations, which coincide with pod formation and filling, have more potential to reduce yields.

### **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 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.

### **Japanese Beetles, *Popillia japonica***

Japanese beetles have a one-year life cycle and spend about ten months as a grub in the soil feeding on the roots of various plants. Grubs do not cause much damage to soybean since the majority of their feeding occurs when soybean are out of season. They tunnel into the soil in late summer and adults do not emerge until June or July. As they emerge, the adults feed on soybean plants in groups, beginning at the top of the plant and working their way downwards. Since soybean are hearty, it is important to monitor damage levels in the field before treating for Japanese beetles. When soybean are in pre-bloom stages, 35% damage can be tolerated before control measures are necessary. During and after bloom, at least 20% damage can be tolerated.

### **Potato Leafhoppers, *Empoasca fabae* (Harris)**

The potato leafhopper can be a serious problem in dry beans early in the season. It overwinters in the Gulf Coast area, and its migration into this region usually occurs in too low of numbers and too late in the season to cause serious damage. Potato leafhoppers are wedge shaped and green, with six white spots on their prothorax. Potato leafhoppers inject a toxin during leaf feeding that damages the plant and results in leaf discoloration and stunting.

### **Stink Bugs, *Nezara viridula***

All adult stink bugs, *Nezara viridula*, are shield-shaped. Stink bugs are bright green and are 0.55 -0.74" long. The major body regions of the green stink bug are bordered by a narrow, orange-yellow line. When first laid, the barrel-shaped green stink bug eggs are yellow to green, later turning pink to gray. Stink bugs inflict mechanical injury to the seed as well as transmit yeast spot disease. The degree of damage caused by this pest depends to some extent on the developmental stage of the seed when it is pierced by the stink bug's needle-like mouthparts. The younger the seed when damaged, the greater the yield reduction. Although late season infestations may not affect yield, bean oil content and germination will be reduced. Stink bugs overwinter as adults and become active in spring when temperatures are above 70F. Each female deposits up to several hundred eggs, usually in mid to late June. These eggs are

laid in clusters (averaging 36 eggs) primarily on leaves and stems but also on pods. Nymphs hatch from these eggs and pass through five instars before becoming adults. Approximately 5 weeks elapse between egg hatch and adult emergence. Stink bugs generally reach high population levels in late September or early October. It is then that stink bugs may become a problem on soybean.

### **Two-spotted Spider Mite, *Tetranychus urticae***

Adult females are pale to dark green with conspicuous dark spots on each side. Food particles showing through the transparent body wall causes these darkened areas. Eggs are spherical, clear and colorless when first laid, becoming opaque and turning ivory just before hatching. Newly hatched larvae are initially colorless and become green after feeding. Individuals from both nymphal stages are green to pale yellow. Adult females usually overwinter on the host plant or in nearby debris. Overwintering females are pale orange to straw-colored and active, though they do not produce eggs during the winter. Two-spotted spider mites usually begin colonies on the undersides of plant leaves. Webbing is visible to the naked eye and all stages of mite development occur in and beneath the webbing. Many female mites may be present on each infested leaf. Small colonies usually begin near a leaf vein, and with favorable weather, spread rapidly to nearby leaves and plants. Development from egg to adult requires 5 - 15 days. Feeding usually takes place on lower leaf surfaces, though upper leaf surfaces are occasionally infested. Light to moderate infestations on lower leaf surfaces can be detected by a marked stippling on upper leaf surfaces. As feeding continues and the mite population increases, leaf color becomes lighter as a result of chlorophyll removal from leaf tissue. Heavily damaged leaves turn tan or bronze, become desiccated and usually die. Optimum temperatures for two-spotted spider mites are 86 - 90F; they occur in more humid growing areas such as along river bottoms.

## **Key Insect Management Strategies**

There are no known consistent major pests of soybean in Colorado. The exact nature of insect pests of soybean in Colorado is not known due to the low volume produced each year.

### **Insecticides-**

Pesticide: **carbaryl** (Sevin 80S)

- Target Pests: Bean leaf beetle, Mexican Bean beetle, Corn earworm, Potato leafhopper, stink bugs
- Recommended rate: 8.5-24.0 oz ai/A (0.66 to 1.88 lb product/A)
- Comments: Pre harvest Interval of 14 days for forage and 21 days for dried beans

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

- Target Pests: Bean leaf beetle, Grasshoppers

- Recommended rate: 1.7-3.5 fl oz ai/A (0.25 to 0.5 pt product/A)
- Comments: Restricted Use pesticide, Pre Harvest Interval of 21 days

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

- Target Pests: Bean leaf beetle, Mexican bean beetle, Corn earworm, Grasshoppers, mites\*
- Recommended rate: 7.2-14.4 fl oz ai/A (1-2 pt product/A)
- Comments: \*Use on mites requires follow-up scouting and possibly application with separate product to control, Pre Harvest Interval of 28 days

Pesticide: **dimethoate** (Dimethoate 400)

- Target Pests: Bean leaf beetle, Mexican bean beetle, Grasshoppers, Spider mites, Leafhoppers
- Recommended rate: 7 oz ai/A (1 pt product/A)
- Comments: Pre Harvest Interval of 21 days

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

- Target Pests: Mexican bean beetle, Mites, Thrips, Leafhoppers
- Recommended rate: 1.2 oz ai/1000 row ft (8 oz product/ 1000 row ft, 6 in minimum)
- Comments: Restricted Use pesticide, Pre Harvest Interval of 75 days

Pesticide: **esfenvalerate** (Asana XL)

- Target Pests: Bean leaf beetle, Mexican bean beetle, Corn earworm, Grasshoppers, Japanese beetle (adult), Leafhoppers
- Recommended rate: 0.015-0.05 oz ai/A (2.9-9.6 fl oz product/A)
- Comments: Pre Harvest Interval of 21 days

Pesticide: **lambda-cyhalothin** (Warrior 1E; Warrior)

- Target Pests: Bean leaf beetle, Mexican Bean beetle, Thrips, Corn earworm, Spider Mites, Grasshoppers, Potato leafhopper, Stink bugs, Japanese beetle (adult)
- Recommended rate: 0.015-0.03 oz ai/A (1.92-3.84 fl oz product/A)
- Comments: Restricted Use pesticide, Do not graze or harvest treated soybean for livestock feed

Pesticide: **methomyl** (Lannate)

- Target Pests: Bean leaf beetle, Mexican Bean beetle, Thrips, Corn earworm
- Recommended rate: 2/5 to 3/4 pt product/A conserves natural predators; for heavy infestations: up to 6.5 fl oz ai/A (up to 1.5 pt product/A may be applied)
- Comments: Pre Harvest Interval of 14 days

Pesticide: **methyl parathion** (PennCap-M; Methyl Parathion)

- Target Pests: Bean leaf beetle, Mexican Bean beetle, Thrips, Grasshoppers, Spider, mites, Potato leafhopper, Stink bugs, Japanese beetle
- Recommended rate: 3.4-10.0 fl oz ai/A (1 to 3 pt product/A)
- Comments: Pre Harvest Interval of 20 days

Pesticide: **permethrin** (Ambush)

- Target Pests: Bean leaf beetle, Mexican Bean beetle, Corn earworm, Potato leafhopper, Japanese beetle
- Recommended rate: 0.05-0.2 oz ai/A (3.2-12.8 oz product/A)
- Comments: Pre Harvest Interval of 60 days

Pesticide: **phorate** (Thimet)

- Target Pests: Early season control of: Mexican bean beetle, Thrips, Mites, Leafhoppers
- Recommended rate: 1.35 oz ai/1000 row ft (6.75 oz/ 1000 row ft, 30 inch minimum)
- Comments: Applied at planting, do not feed the foliage of treated soybean

## Weeds

### Key Weeds

**Common Cocklebur**, *Xanthium strumarium*

Common cocklebur, a member of the Sunflower family, is a native weed. It is an annual, 2 - 4' tall, and stems are erect, branched, ridged, spotted, and very rough. Leaves are alternate, triangular or heartshaped, rough on both sides, and long-petioled. Flowers are small and in axils of the upper leaves. Male and female flowers are separate. Flowering is from July to September. Fruits are 1" long, woody, with hooked prickles and two curved spines at the tip and two seed. The dark brown seed are flattened and have barbed hooks on the tips, allowing them to be easily distributed by wildlife. Seed are the only source of reproduction. It is a prolific seed producer and competes well with soybean. New infestations appear around field edges or roadsides. Common cocklebur is especially abundant in areas where receding water has exposed previously submerged land. The burs are irritating both to humans and to animals. Young seedlings can be very poisonous but are only eaten in drought conditions due to lack of other resources.

### **Barnyardgrass, *Echinochloa crusgalli***

Barnyardgrass, a member of the Grass family, is an annual that prefers wet sites. It is not usually a problem in well-drained cultivated fields but can grow heavily around irrigation pipe leaks and other wet spots in the field. It is a vigorous, warm season annual grass reaching 1 - 5' in height with bases of many stems reddish to dark purple. Leaf blades are flat, broad, smooth, and without a ligule or auricle at the junction of sheath and blade. Seed are the only source of reproduction. It flourishes in warm conditions. Barnyardgrass is problematic in sandy soil under irrigation and can be a problem late in the season. Spot treatment with glyphosate is recommended at row closure to kill seedlings and prevent grass weed infestations.

### **Large Crabgrass, *Digitaria sanguinalis***

A weak branched summer annual that reproduces by seed, and by stems spreading at the base and rooting at the lower joints. The flat leaf blades, 1/4 to 1/3 inch broad, and the sheaths have long stiff hairs. The flowering part is made up of 3 to 11 slender, finger-like branches, 2-6 inches long, which may all arise from the same point at the stem tip (as in Bermudagrass), but usually several branches in addition arise a short distance below the tip. The small spikelets, 1/8 to 3/16 inch long, lie very close to the branch stems and come from only one side of the axis. The light yellow oval grain is about 1/12 inch long. Large crabgrass is problematic in sandy soil under irrigation and can be a problem late in the season. Spot treatment with glyphosate is recommended at row closure to kill seedlings and prevent grass weed infestations.

### **Pigweeds, *Amaranthus spp.***

Pigweeds, members of the Amaranth family, are weed pests in several cropping systems. *A. hybridus*, smooth pigweed, was the first triazine resistant plant documented. *A. retroflexus*, redroot pigweed is probably Colorado's most common pigweed. *A. lividus*, is a prostrate species with a notch in the tip of the leaf. *A. spinosus*, spiny amaranth, has sharp, strong spines on the stem. *A. graecizans*, breaks off at the ground line and being round shaped is blown around by the wind. Redroot pigweed is ALS herbicide resistant.

### **Shattercane, *Sorghum bicolor***

Shattercane, a member of the Grass family, is an annual that often becomes a nuisance in cultivated fields. It probably developed from out-crosses of cultivated sorghum. Therefore, it is highly variable. Seed are the only source of reproduction. It is a major problem because seed are several inches deep and keep coming up through the soil throughout the summer. Shattercane flourishes in warm conditions. It usually requires post-emergence herbicides for control.

### **Smartweed, *Polygonum lapathifolium***

Smartweed, a member of the Buckwheat family, can grow either very close to the ground or up to a few feet tall. If the plants around it are tall, smartweed will be close to the same height. Smartweed stalks, whether short or tall, have numerous joints on them. These joints allow the plant to grow around corners and they help make the plant tougher. Secondary branches that hold the leaves are smaller in diameter, and are more flexible. The small flowers are racemic, and can be up to 2" long. Each individual flower can be up to 0.25" long. The colors are usually pink or white. Smartweed leaves are alternate, tapered at the base, and simple with pointed tips.

### **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.

### **Velvetleaf, *Abutilon theophrasti***

Velvetleaf, a member of the Mallow family, was introduced from India and is an annual. Velvetleaf is on the Colorado noxious weed list. It is completely covered with soft hairs, has erect stems, is branched, and is 2 - 7' tall. Leaves are alternate, heart shaped, pointed at the apex, are 5" or more in width, and are attached to slender petioles. Flowers are solitary in the leaf axils with 5 yellow petals and numerous fused stamens that form a tube. Flowering and seed production occur from late June to October. Fruits are rounded with 9 - 15 arranged in a disk, each containing 3 - 9 egg-shaped, somewhat flattened, rough gray-brown seed. The seed retain viability in soil for more than 50 years, making eradication difficult. Seed are the only source of reproduction.

## **Additional Weeds**

### **Common Lambsquarters, *Chenopodium album***

Common lambsquarters, a member of the Goosefoot family, was introduced from Europe. It reproduces by seed. The stem is erect, stout, smooth, grooved, often striped with pink or purple, branched and grows 1 - 6' high. Lower leaves are alternate and ovate. Upper leaves are also alternate, but are more narrow. The flowers are small, green, and crowded in the axils and at the tips of the stems and branches. Common lambsquarters is a succulent, fast growing plant which rapidly removes moisture from the soil.

### **Field Bindweed, *Convolvulus arvensis***

Field bindweed, a member of the Morningglory 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 cultivated and uncultivated areas, pastures, lawns, gardens, roadsides, and waste areas throughout Colorado from 4,000 - 8,000' in elevation.

### **Foxtail, *Setaria spp.***

Foxtails, members of the Grass family, are native to Eurasia, but common throughout most of North America. Green and yellow foxtail are both on the Colorado noxious weed list. All foxtails bear seed in long, cylindrical panicles with crowded spikelets. These plants are responsible for reductions in yield, increased seed cleaning costs, and expensive control measures. Flowering and seed production occur from July to September. A primary control method for foxtail is the application of pre-emergence grass herbicides, which provide early season control.

### **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. Seed 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 sulfonylurea, imidazilone, 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.

## **Key Weed Management Strategies**

### **Cultural Controls**

Narrow-row soybean reach canopy closure sooner than wide-row soybean. Once the soil surface is

shaded, further weed seed germination is stopped. Varieties that emerge rapidly compete better with weeds.

## Chemical Control

Glyphosate can be required 2-3 times in a season for some weed infestations, but only in Roundup Ready soybean.

## Herbicides-

Pesticide: **acifluorfen** (Blazer)

- Target Pests: Cocklebur, Nightshade, Pigweed, Smartweed, Foxtails
- Recommended rate: 1.6-4.8 fl oz ai/A (0.5-1.5 pt product/A)

Pesticide: **alachlor** (Lasso)

- Target Pests: Pigweed
- Recommended rate: 36-43 fl oz ai/A (2.5-3.0 qt product/A)
- Comments: Preplant application

Pesticide: **alachlor + trifluralin** (Freedom)

- Target Pests: Barnyardgrass, Crabgrass, Nightshade, Pigweed
- Recommended rate:alachlor- 35.5-45.6 fl oz ai/A; trifluralin- 4.4-5.6 fl oz ai/A (3.5-4.5 qt product/A)
- Comments: do not exceed 4.5 qt/A per year

Pesticide: **bentazon** (Basagran)

- Target Pests: Broadleaf weeds
- Recommended rate: 7.0-14.0 fl oz ai/A (1.0-2.0 pt product/A)

Pesticide: **clomazone** (Command)

- Target Pests: Broadleaf weeds
- Recommended rate: 8-16 oz ai/A (1.33 to 2.66 pt product/A)

Pesticide: **dimethinamid** (Frontier 6.0)

- Target Pests: Pigweed

- Recommended rate: 12.6-20.2 fl oz ai/A (20-32 fl oz product/A)
- Comments: rate depends on soil texture and organic matter

Pesticide: **ethalfuralin** (Sonalan 10G)

- Target Pests: Barnyardgrass, Foxtails, Sandburs, Nightshade, Pigweed
- Recommended rate: 8.8-20.8 oz ai/A (5.5-13.0 lb product/A)
- Comments: Pre emergent application, higher rates for nightshade control

Pesticide: **fluazifop-P** (Fusilade DX)

- Target Pests: Crabgrass, Volunteer cereals
- Recommended rate: 4 fl oz ai/A (16 fl oz product/A)
- Comments: Pre emergent application

Pesticide: **glyphosate** (many)

- Target Pests: All weedy species
- Recommended rate: 9.6-14.4 oz ai/A (1.2-1.8 lb product/A)
- Comments: Pre Harvest Interval of 7 days

Pesticide: **lactofen** (Cobra)

- Target Pests: Cocklebur, Pigweed, Velvetleaf
- Recommended rate: 2.9 fl oz ai/A (12.5 fl oz product/A)
- Comments: Pre Harvest Interval of 45 days

Pesticide: **metribuzin** (Sencor 75DF)

- Target Pests: Pigweed, Smartweed, Sunflower, Velvetleaf
- Recommended rate: 6.0-9.6 oz ai/A (0.5 to 0.8 lb product/A)
- Comments: Can cause injury to soybean

Pesticide: **pendimethalin** (Prowl 3.3EC)

- Target Pests: Crabgrass, Foxtail, Lambsquarters, Pigweed, Smartweed
- Recommended rate: 7.2-14.4 fl oz ai/A (1.2 - 2.4 pt product/A)
- Comments: rate depends on soil texture

Pesticide: **S-metolachlor** (Dual II Magnum)

- Target Pests: Pigweed
- Recommended rate: Preplant- 13.2-17.5 fl oz ai/A (1.0-1.33 pt product/A); Fall application- 18.5-23.7 fl oz ai/A (1.4-1.8 pt product/A)
- Comments: **S-metolachlor** was **metolachlor**

Pesticide: **sethoxydim** (Poast)

- Target Pests: Grassy weeds
- Recommended rate: 2.9-7.2 fl oz ai/A (1.0 - 2.5 pt product/A)

Pesticide: **trifluralin** (Treflan HFP)

- Target Pests: Pigweed, Shattercane
- Recommended rate: Spring- 6.9-13.8 fl oz ai/A (1.0-2.0 pt product/A); Fall- 13.8-17.2 fl oz ai/A (2.0-2.5 pt product/A)
- Comments: Pre emergent application, rate depends on soil texture

## Critical Pest Management Issues

The strongest weed competitors are those that emerge with the crop. Lower planting densities under adverse planting conditions will lead to greater weed problems.

Not many soybean are grown in Colorado. The list of potential pests have been identified as common pests in soybean cropping systems in other states that would become more of a problem in Colorado if more acres of soybean were grown.

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 not only herbicides when controlling weeds, but also 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.

## Diseases

## **Anthracnose, *Colletotrichum dematium* var. *truncata* and *Glomerella glycines***

Anthracnose is caused by two fungi, *Colletotrichum dematium* var. *truncata* and *Glomerella glycines*. Both fungi produce similar symptoms. Indefinite, enlarging, reddish- or dark brown areas develop on the stems and pods. Later, these areas are covered with black fungal fruiting bodies that resemble tiny pin cushions containing black spines that are easily seen with a hand lens. Infected seed may be shriveled and moldy, or near normal in appearance. The anthracnose fungi survive as mycelium in crop debris and seed as mycelium. Planting disease-free seed, crop rotation and residue management are used to reduce the incidence of this disease.

## **Bacterial Blight, *Pseudomonas syringae* pv. *glycinea***

Bacterial 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 to larger lesions that may cover the entire leaf. These spots can advance rapidly and cause blight and generally are found 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 bacteriacides

## **Brown Leaf Spot, *Septoria glycines***

Brown leaf spot symptoms appear as small water-soaked spots most visible on the underside of young foliage. A narrow, greenish yellow border about 0.0625" wide may surround some of the lesions. However, when the lesion matures, it typically develops a "brown spot" appearance and dead tissue in the center may fall out, producing a shot-hole appearance. Infected pods may be twisted and kinked and exhibit circular, brownish water-soaked spots. It is rarely cost effective to use protectant fungicides in the early part of the season, but it could be effective during podfill if conditions persist that favor the fungus.

## **Brown Stem Rot, *Philophora gregata***

Brown stem rot usually become apparent about mid season by a dark reddish-brown discoloration inside the lower stem when the stem is split. The browning can be confused with other pathogens and should not be considered diagnostic. Certain fungal strains cause the leaves to scorch between the veins, wither and drop early. External symptoms are not observed on infected plants until pod set. The fungus survives in soybean debris as mycelium. Crop rotation or monitoring the field if in no-till rotation can reduce the incidence of this disease. The severity of the disease is directly related to the densities of inoculum from the previous soybean residues.

## **Damping Off and Seedling Blight, *Pythium* spp. and *Rhizoctonia solani***

Pre- and post-emergence damping-off and seedling blights are caused by soil-inhabiting fungi (*Pythium* spp. and *Rhizoctonia solani*). They are characterized by missing or collapsed plants. When pre-emergence damping-off occurs, seedlings fail to break the soil surface. The germinating seed is rotted while still in the ground. With post-emergence damping-off, seedlings still in the cotyledon stage will rot at the soil line. The stem appears pinched and plants fall over. Seedling blights occur after true leaves emerge. The developing root system rots and plants collapse. Seedling diseases are problems when soils are cold and wet at or immediately following planting. These conditions can delay germination or stress developing seedlings, which allows pathogens to attack. Crusting caused by poor soil preparation or hard rain, or excessive trash on the surface also contributes to disease. Fungicide seed treatment combined with avoiding cold wet soils and good soil preparation will best manage these diseases. These diseases are favored by cool, wet, poorly drained soils. Cultural practices such as avoiding piling up soil around stem and rotation with non-legume crops can help in the control of this disease. Planting pathogen-free seed is key to integrated management of this disease.

### **Frogeye Leaf Spot, *Cercospora sojina***

Frogeye leaf spot appears as small, irregular, to angular, light grey to tan spots occurring on the leaves with narrow, dark reddish-brown borders. Several lesions may merge to form large, irregular spots. Where severe, infected leaves may wither and drop early. Lesions also develop on the stems, pods and seed. The fungus overwinters in the crop debris and in seed. Management of crop debris by removal or tilling into the soil is important. Planting pathogen-free seed is key to integrated management of this disease.

### **Fusarium Wilt, *Fusarium* spp.**

Fusarium wilt symptoms are drooping and epinasty (downward twisting) of leaves followed by yellowing, stunting and death. Symptoms may be one sided and progress upward, killing foliage. A cross section of the stem near the base will have characteristic reddish vascular discoloration. Fusarium wilt is favored by high air and soil temperatures and occurs most frequently in temperate areas. This fungus survives in soil and plant debris as chlamydospores, survival structure of the fungus. It also survives in infected weeds. Control is primarily through use of resistant cultivars.

### **Nematodes**

There are twenty identified plant parasitic nematodes associated with soybean. In general, above ground symptoms are not readily noticeable. However symptoms from severe nematode damage appear as stunted growth, chlorosis and wilting during periods of high temperature and moisture stress. These symptoms can be similar to those induced by nutrient deficiencies. Root symptoms of nematode infection vary with the kind of nematode. (Also see: Soybean cyst nematode) Nematicides, crop rotation and resistant varieties are the primary tools available for nematode control.

Preplant injections of nematicides such as aldicarb into the soil can reduce the effects of nematodes by

reducing the population densities. Fallow can also reduce populations of some nematodes.

### **Pod and Stem Blight, *Diaporthe phaseolorum* var. *sojae***

*Diaporthe phaseolorum* var. *sojae* causes pod and stem blight. Plants, when near maturity, develop large numbers of black specks and fungal fruiting bodies in straight rows along the stem and scattered on dry, poorly developed pods. Heavily infected seed are dull, badly cracked, shriveled, and often covered partially or completely with a white mold growth. Sowing diseased seed commonly results in seed decay, seedling blights and often poor stands in the field. The fungus survives as mycelium in crop residues and seed. Seed treatments, clean seed, deep plowing in the fall, and rotation with cereal crops are recommended management techniques. Harvesting as early as possible can also reduce losses from this disease.

### **Purple Seed Stain, *Cercospora kikuchii***

*Cercospora kikuchii* causes purple seed stain. A pink or pale to dark purple coloration of the seed coat is the most characteristic symptom. Diseased seed are often dull, cracked and rough. Small, inconspicuous, angular, reddish-brown spots form on the leaves, stem and pods. Infected seed may reduce the stand or often produce diseased seedlings. The fungus survives in seed and crop debris as mycelium with infection favored by prolonged moist weather from pod set to harvest. Disease-free seed and crop rotation are recommended management techniques. Management of crop debris in the field is required to control this disease.

### **Phytophthora Root Rot, *Phytophthora sojae***

The fungus *Phytophthora sojae* causes Phytophthora root rot. Affected plants turn yellow, wilt, wither, and die at any age, leaving short to long gaps in rows. Seedlings may be attacked and die before or after emergence. A dark brown root rot can be found on older plants, with a dull brown discoloration extending up the stem into the lower branches. Phytophthora rot is most severe in low, poorly-drained, heavy clay soils following cool and rainy weather. The fungus survives in soil and buried crop debris as oospores or mycelium. Fungicide seed treatment combined with avoiding cold wet soils and good soil preparation will best manage this disease. Cultural practices such as avoiding piling up soil around stem and rotation with non-legume crops can help in the control of this disease. Planting pathogen-free seed is key to integrated management of this disease.

### **Rhizoctonia Root Rot, *Rhizoctonia solani***

The fungus *Rhizoctonia solani* causes Rhizoctonia root rot. Seedlings or somewhat older plants wilt, and may die from a firm, dry, brown to reddish-brown decay of the roots and stems below or near the soil line. The fungus also causes pre- and post- emergence damping off. Damage is most severe in heavy, poorly-drained soils where groups of affected plants commonly wilt and die in area 4 - 10' in diameter. The fungus survives indefinitely in soil as mycelium and sclerotia. Fungicide seed treatment combined

with avoiding cold wet soils and good soil preparation will best manage these diseases. These diseases are favored by cool, wet, poorly drained soils. Cultural practices such as avoiding piling up soil around stem and rotation with non-legume crops can help in the control of this disease. Planting pathogen-free seed is key to integrated management of this disease.

### **Soybean Cyst Nematode, *Heterodera glycines***

Soybean cyst nematode is a serious pest and major threat to soybean production. Severely infected plants are stunted and yellowed and may die in areas of fields. Lightly infected plants appear normal, especially when growing conditions for soybean are favorable. Pinhead-sized, shiny, white to yellow females or brown cysts (dead female bodies) are attached to the roots. The cysts are much smaller than the larger and loosely attached bacterial nodules. The dark brown cysts persist for years in the soil. The cysts are easily spread in even small bits of soil. Crop rotation, reduction of weeds that are hosts and resistant varieties such as Clark (CL441NRR) and Public (Anand, Delsoy 5710, Fowler, Hartwig, Ina, and LS92-4173). It is important to not only look at yields but resistance when selecting seed. Identification of the nematode is also important because root knot nematode is also present in fields and not all varieties have resistance to both (Delroy 5710, Hartwig).

### **Soybean Mosaic Virus, (SMV)**

SMV produces variable symptoms depending on the soybean cultivar and strain of virus. Diseased plants are usually somewhat stunted with distorted leaves. The symptoms are largely masked at temperature above 85 - 88 F. The pods are often stunted, flattened or curved and contain fewer seed. Certain virus strains cause a dark brown to black mottling of the seed coat. Infected seed fail to germinate or they produce diseased seedlings. The virus survives in living plants and is spread by feeding aphids and other insects and by sowing virus-infected seed. Proper management requires the use virus-free, certified seed.

### **White Mold, *Sclerotinia sclerotiorum***

White mold initially appears on plants after flowering as water soaked spots on infected leaves, stems, branches and pods. These areas enlarge into a watery rotten mass of tissue that becomes covered by a white fungal growth. Stem infection causes the part of the plant above the point of infection to wilt and die. Affected stems appear bleached and dry which differs from the tan color characteristic of mature, dry plant tissue. White mold development is influenced by prevailing weather conditions and certain cultural practices. High plant populations, narrow row widths, vigorously vining varieties, excessive fertilizers, and abundant irrigation or rainfall all favor the development of white mold. High humidity and a wet plant canopy and/or soil surface are necessary for spread. The disease may cause serious losses during wet, cool periods near the end of the growing season and even when the beans are in the windrow. Crop rotation to cereals, avoiding close planting or row spacing and planting in well drained fields are integrated management approaches.

## Key Disease Management Strategies

In general, diseases of soybean are not currently a major problem in Colorado.

### Nematicides-

Pesticide: **aldicarb** (Temik)

- Target Pests: Nematodes
- Recommended rate: 24-48 oz ai/A (10-20 lb product per acre)
- Comments: Only one application per year, Pre harvest interval of 90 days

### Fungicides-

Pesticide: **benomyl** (Benlate WP)

- Target Pests: Anthracnose, Frogeye leaf spot, Diaporthe pod and stem blight, Purple seed stain, Septoria brown spot
- Recommended rate: 0.25-0.50 ai/A (0.5-1.0 lb product/A)

Pesticide: **captan** (Captan Moly)

- Target Pests: Damping-off, seed rot
- Recommended rate: 1.0 oz ai/bu seed (2.0 oz product/bu seed)
- Comments: Seed Treatment

Pesticide: **metalaxyl** (Apron FL)

- Target Pests: Pythium damping-off, early season Phytophthora
- Recommended rate: rate per 100 lb seed, 0.2-0.4 fl oz ai/A (0.75-1.5 fl oz product)
- Comments: Seed Treatment, Pesticide resistance management important

Pesticide: **mefenoxam** (Ridomil Gold EC)

- Target Pests: Pythium diseases, Phtophthora
- Recommended rate: 9.5 fl oz ai/ A (1.25 pt product/A before planting)

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

- Target Pests: Seedling diseases
- Recommended rate: rate per 100lb seed, carboxin- 0.68 fl oz ai; thiram- 0.68 fl oz ai (6.8 fl oz product)
- Comments: Seed Treatment

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

- Target Pests: Fusarium, Rhizoctonia
- Recommended rate: rate per 100 lb seed, 0.72-1.44 fl oz ai (3-6 fl oz product)

Pesticide: **thiophanate methyl** (Topsin M WSB; Topsin M 70W)

- Target Pests: Anthracnose, Frogeye leaf spot, Diaporthe pod and stem blight, Purple seed stain, Septoria brown spot
- Recommended rate: 5.6-11.2 oz ai/A (0.5-1.0 lb product/A)

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