1996

Best Management Practices for Integrated Pest Management in the San Luis Valley

Small Grains

San Luis Valley

WATER QUALITY

Demonstration Project

XCM-195

The mission of the San Luis Valley Water Quality Demonstration Project is to *promote the adoption of water quality conservation Best Management Practices to minimize agricultural non-point source pollution of water resources in the Valley.*

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Preface and Acknowledgments

Shallow water tables, coarse soils, and intensive agricultural production systems increase the risk of agricultural non-point source pollution of water resources in the San Luis Valley of south central Colorado. In 1991, the U.S. Department of Agriculture authorized the San Luis Valley Water Quality Demonstration Project to address the issues of this risk.

The San Luis Valley Best Management Practices (BMP) Advisory Committee was formed to identify and document water quality conservation BMPs for local crops. The committee consists of a cross-section of local agricultural producers, crop consultants, fieldmen, and local government agency specialists.

The Project offers sincere thanks to the committee for their willingness and dedication to serve, advise, and support the local BMP process to conserve the quality of local water resources.

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BMP Identification and Implementation

The development of water quality conservation Best Management Practices (BMPs) is a process of identifying and implementing cultural and structural practices to minimize agricultural non-point source water pollution. The focus ranges from a regional perspective to an individual farming operation.

Important aspects of these practices are the economic and environmental soundness. Just as the water quality concerns have site-specific characteristics, local BMPs are selected to be suitable for local adoption. Often, these practices are already in place.

Critical to the success of the BMP approach is the voluntary nature of adoption. Local agricultural producers are inherently concerned about the resources they manage while making a living. Therefore, BMPs are best locally identified by those who understand the local situation and will be implementing the practices.

Broad regulatory action does not hold the promise of the more tailored BMP process. However, BMPs need to be well-adopted in a region to be effective in addressing water quality concerns. Otherwise, regulatory intervention and guidance may become necessary.

IPM-BMP Selection

Integrated Pest Management (IPM) definitions have varied since the development of the concept in the 1950s. Implementation of an integrated pest management system is based on understanding the biology and environment of a pest, then taking advantage of natural means of control.

The ideal fulfillment of IPM results in limiting a pest's impact through a combination of physical, biological, and chemical means that are safe, economical, environmentally sound, socially tolerable, efficient, and effective. Therefore, IPM is not a fast solution but instead a long-term process that includes scouting and planning, as well as treatments of an immediate problem.

The linking of water quality conservation BMPs and IPM offers a natural combination of deliberate, acceptable solutions to both pest and water quality concerns for the San Luis Valley.

Explanation of Pest Pages

The following pest and management descriptions for diseases and insects are presented with three sections.

Impact: Offers general information on common locations of infestations, degree of spread, and potential effects of a typical infestation in the San Luis Valley.

Description and Symptoms: Describes how the pest is manifested in the San Luis Valley including typical pest appearance and influence on the plant to assist in scouting efforts.

Integrated Management: Presents the management options best suited for San Luis Valley conditions.

The weed management description has a checklist for integrated weed management offering general information and a chart for specific recommendations for common weeds.

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Checklist for Healthy Small Grain Production

Healthy small grain plants are the best prevention against disease, insect and weed problems.

☑ Planning

➤ Establish permanent records of fertility, pesticide use, rotation and cultural practices for each field.
➤ Rotate small grain crop with other crop types whenever possible. Small grain crop residues can harbor disease.
➤ Sample and analyze soil annually to determine nutrient levels and fertilizer requirements.
➤ Consider salinity levels when selecting a field. Wheat is typically less tolerant to salinity than barley. For example, the same soil salinity reduces wheat yields by 25 percent and barley yields by 10 percent. However, salinity tolerances vary between varieties.
➤ Fertilize small grains for a realistic yield goal based on the variety, soil condition, and production potential. The total nitrogen (N) needed for malt barley and feed barley is 1.0 to 1.2 pounds/bushel times the yield goal bushels/acre. Example: A yield goal of 135 bushels/acre would use a total N supply of 135 to 162 pounds/acre. The N requirement for wheat is 1.6 to 1.8 pounds/bushel. Example: A 110 bushel/acre yield goal would use a total N supply of 187 to 198 pounds/acre.
➤ Select adapted small grain cultivars based on local variety trial reports.
➤ Account for all nitrogen sources including residual soil nitrogen and organic matter, added fertilizer nitrogen, and nitrogen supplied by irrigation water. Five factors that must be considered before making an accurate nitrogen fertilizer recommendation: 1) level of residual inorganic soil N; 2) previous crop residue level; 3) estimate contributions from applied irrigation water; 4) yield goal; 5) grain protein goal.

☑ Preplant and Planting

➤ Perform tillage operations necessary to manage weeds and crop residues, minimize erosion and promote proper soil tilth for planting.
➤ Avoid excessive N from over-fertilizing, which reduces crop quality, decreases N use efficiency, increases the potential for groundwater contamination, and is uneconomical.
➤ Plant at a suggested seeding depth 1/2 to 1 inch in a moderately fine but firm seedbed that maximizes contact between the seed and soil moisture for rapid, uniform germination.
➤ Always use certified seed.
➤ Use a general seed fungicide for seedling blights caused by Fusarium and Helminthosporium. Use a systemic fungicide such as Vitavax for control of loose smut.

☑ Crop Management

➤ Monitor fields for all pests and apply pesticides if necessary and economically feasible.
➤ Apply all pesticides according to the label to avoid the risk of groundwater contamination and other environmental concerns.
➤ Maintain moderate amounts of crop residue on the soil surface to reduce wind erosion. Properly managed crop residues will not interfere with proper seed placement and seedling growth.
➤ Maintain sufficient nutrient levels in the root zone early in the season to attain maximum yields, because tillers and heads are formed in the early growth stages.
➤ Schedule irrigation to match water applications to crop requirements. Scheduling requires a knowledge of crop water-use rates and plant-available soil moisture. Specific crop water-use reports are available from various local sources.
➤ Apply only light irrigations during tillering, because the roots are relatively shallow. Excessive irrigation leaches available nitrogen below the root zone, limiting yield and quality potential.
➤ Avoid moisture stress at any growth stage before grain soft dough. Drought during tillering or between the boot and flowering stages causes yield reductions and higher grain screenings.

☑ Harvest

➤ Windrow grains at physiological maturity. Harvest standing grain with a grain moisture content below 13 percent unless drying operations are available. Small grains are physiologically mature when the stem below the head turns yellow. Kernels of all small grains are fully developed when the moisture content is below 35 percent. Windrowing hastens drying of the crop and weeds allowing for earlier harvests.

☑ Post-harvest

➤ Spread straw and chaff as uniformly as practical to reduce residue management problems for the following crop and erosion protection. For conservation tillage, incorporate crop residue as soon as possible for faster decomposition. If moldboard plowing, delay tillage as long as practical. Always limit the amount of time the soil is without crop residue protection. Crop residue also is a source of local wildlife food.

☑ Storage

➤ Prepare grain storage by cleaning and treating with an appropriate insecticide as necessary. Certain insecticides are restricted depending on the intended use of the grain.

➤ Store grain with a moisture content less than 13 percent unless drying operations are in place.

➤ Prevent grain deterioration in storage by keeping the grain dry, cool, and free of insects. Problems for grain in storage, including molds, insects, loss of weight, and chemical changes, are related to grain moisture content, grain temperature or both.

Scouting: Key to success in IPM

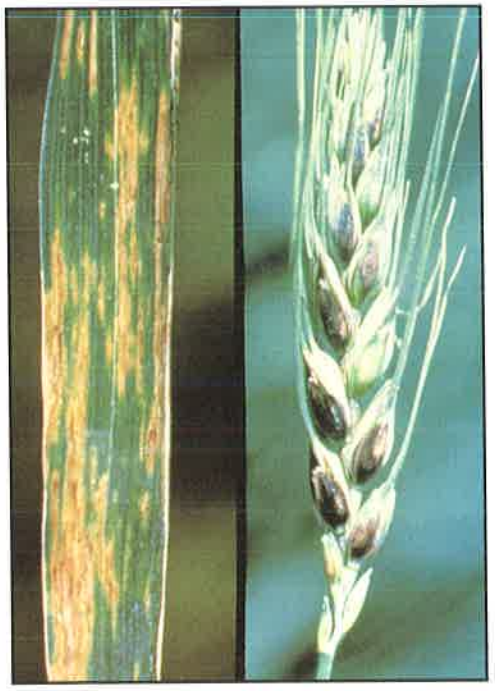
Field scouting is important in identifying pest problems before they get out of control. Some producers often use the same pest control measures on all of their fields or watch their neighbors to know when it is time to spray. IPM makes no such assumptions. Successful IPM depends on monitoring each field individually for potentially damaging pest outbreaks.

The tools for a thorough scouting program include: soil and tissue monitoring; pheromone, pan or sticky traps; hand lenses; sweep net; visual observations and a good system of field records and maps. To scout for pests:

- Acquire and understand the use of necessary scouting equipment;
- Record each trip to the field including the crop stage and condition, pest populations and distribution, date and time of day, and any control recommendations;
- Scout each field, crop and variety. Scout for pests by walking through the field - don't just check the field borders;
- Visit each field weekly. Certain crop stages may require less frequent scouting, but others may require more during critical pest phases;
- Use all appropriate scouting methods:
  Insects - regional monitoring reports, observation, leaf and stem sampling, and sweep net sampling;
  Diseases - field history, observation, plant tissue sampling, and soil sampling;
  Weeds - field history and observation;
- Follow the proper re-entry guidelines for fields treated with pesticides; and,
- Sample the pest, plant material and soil when appropriate if you notice a problem that you cannot identify and seek assistance from your nearest Colorado State University Cooperative Extension office or local crop adviser as soon as possible.

Black Chaff (Bacterial Blight)

Black chaff is the most common leaf disease in the San Luis Valley.



Black chaff on a small grain head and leaf (R. L. Forster).

Impact

Black chaff or bacterial blight is the most common disease in wheat and barley in the San Luis Valley. *Xanthomonas translucens* is the causal agent, attacking leaves, stems, and heads of barley and wheat.

Black chaff damage to the flag leaf and glumes limits the filling of the grains, resulting in lower bushel weight and yield. Black chaff is especially destructive when in the heads, potentially causing complete sterility.

Black chaff is common throughout the San Luis Valley. However, black chaff infections are more serious under center pivot irrigation.

Description and Symptoms

➤ Leaves appear initially as water-soaked spots that elongate into streaks that may extend the full length of the leaf blade. These streaks become translucent and eventually turn tan or brown.

➤ Under moist conditions, the bacteria may produce droplets that dry to a yellow, crystalline mass or that spread across the leaf surface, giving it a shellacked appearance when dry. This characteristic is an important difference between fungal and bacterial infections.

➤ Infected heads may appear blackened, greasy and chlorotic plus some kernels may be shriveled.

➤ Splashing water from rain or irrigation can spread the bacteria from diseased to healthy plants. Hail, wind, or other mechanical damage can increase infections.

➤ The bacteria have a high tolerance to temperature and moisture conditions and persists between seasons on infected seed, plant residues and some weedy grasses.

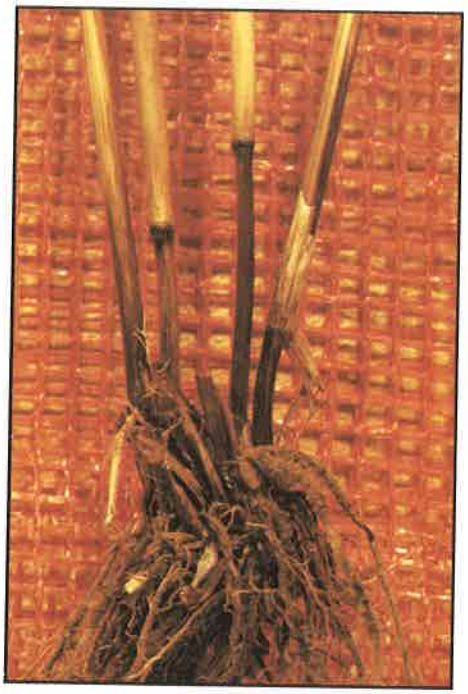
Integrated Management

- Plant disease-free or the least infected seed available. Idaho research indicates bacterial levels in the seed can impact disease development. Levels can be tested in the laboratory.
- No resistant commercial cultivars are presently available.
- Avoid planting grain into infested stubble or weedy grasses.
- No pesticides are currently available for black chaff control.
- Avoid excessive and frequent irrigation, especially under sprinkler irrigation.
- Reduce irrigation frequency as much as possible when infected plants are damaged from hail, wind or frost to reduce the potential incidence of infection.
- Apply ample irrigation water to infected plants to minimize stress. However, foliage should become dry between irrigations to limit further disease development.

Take-all

Take-all occurs throughout the San Luis Valley, and typically develops after the second year of continuous grains.

Take-all white heads in wheat.



Take-all discoloration of basal nodes.

Impact

Take-all is a soilborne fungus, *Gaeumannomyces graminis*, typically affecting barley and wheat. Influence on barley is minimal. The greatest impact can be realized after the second year of continuous wheat. Grain yield reductions can reach 60 percent.

Yields are reduced, because of inhibited grain filling. Infections that occur late in the season remain confined to the roots and usually cause little damage.

Take-all occurs throughout the San Luis Valley and typically develops after the second year of continuous grains.

Description and Symptoms

➤ Take-all infects the crown and roots of the plant.
➤ Severely infected plants are stunted, produce fewer tillers, ripen prematurely, and produce bleached-white heads, shriveled kernels or no seed.
➤ Symptoms become obvious at heading especially the white heads and stunting.
➤ Severely infected plants are easy to pull out of the soil.
➤ Uproot severely infected plants to reveal crown rot, severely pruned roots, and a shiny, steel-black stem surface under the lower sheaths.
➤ Black masses of mycelium are easily scraped off the base of the culms, a key characteristic.
➤ Early signs of infection are a darkness inside the roots.

Integrated Management

- Rotate with non-host crops such as oats, alfalfa, or other broadleaf plants. A one-year break in small grains cultivation is sufficient to reduce soilborne inoculum levels but will not eliminate the take-all fungus.

- Maintain sufficient nitrogen and phosphorus fertility to encourage root and crown development. Limit soil compaction to discourage irrigation runoff and disease development.

- Select fertilizer materials for limiting take-all development. Nitrate-based fertilizers support take-all more than ammonium or urea fertilizers. Chloride-containing fertilizers, like potassium chloride, can limit take-all in some regions.

- Maintain adequate copper levels to reduce take-all. When soil levels test low, soil apply 5 to 10 pounds of copper per acre to the soil or foliar apply 0.25 pounds per acre.

- Avoid excessive irrigation, especially during the early part of the season. Accurate irrigation management can greatly reduce take-all infection even if all other conditions support take-all development.

- Limit infection of the next crop by burying crop residues through tillage. However, soil erosion potential may increase.

Loose Smut

Yield loss is directly related to the percentage of infected heads.

Loose smut infected heads (left); and, a healthy head (right) (Clemson University).

Impact

Loose smut is a fungus disease common wherever small grains are grown. The fungus *Ustilago* is the causal agent.

Individual species and/or strains infect each type of small grain.

Yield loss is directly related to the percentage of infected heads. Losses can range from the typical 1 percent to an entire field.

Loose smut occurs throughout the San Luis Valley but typically has a limited impact. Severe cases can occur within individual fields. Disease severity depends on the infection level of the planted seed.

Description and Symptoms

➤ Loose smut symptoms are not present until heading.
➤ Infected heads emerge from the boot slightly earlier than normal and are darker than healthy heads. The darkening is due to spore masses, which replace the kernels.
➤ Spore masses are covered by a thin membrane that ruptures easily after head emergence, permitting the spores to be dispersed by wind or water. After a short time, only the naked rachis remains.
➤ Loose smut is a seedborne disease. The fungus infects the developing embryo (germ) at the time of flowering. Infected seed can germinate without showing symptoms.

Integrated Management

- Plant disease-free certified seed from fields inspected for loose smut.
- Use resistant cultivars when available.
- Use only systemic fungicidal seed treatments **specific for treatment of loose smut.** Seed-surface active fungicides are not effective. Control cannot be achieved after seed germination.

Barley Yellow Dwarf

Plant early to permit crop development prior to aphid flights.

Barley yellow dwarf infected barley (left) and infected oats (right).

Impact

Barley yellow dwarf (BYD) is caused by several related viruses. The infection is carried and transmitted by the oatbird cherry aphid, corn leaf aphid, English grain aphid, rose grass aphid, and greenbug. The Russian wheat aphid does not transmit the barley yellow dwarf virus.

Yield losses are proportional to the percentage of plants infected by the virus and the growth stage at infection. Early infection may result in high losses.

All small grains can be affected by BYD. The greatest impact of BYD in the San Luis Valley is to late-planted oat hay due to the typically late arrival of aphid populations. BYD in oats is commonly called red leaf.

Description and Symptoms

➤ The principal symptoms of BYD include leaf chlorosis, reduced root growth, and general stunting.
➤ The distinctive symptom of BYD is a bright yellowing of the leaf tips and margins and reddening in oats.
➤ Discoloration begins at the leaf tips, then enlarges toward the base of the leaf. The mid-rib area commonly stays green the longest.
➤ Severity of the infection directly affects the degree of stunting or "dwarfing."
➤ Shortened leaves and poor head development occur in severe cases.

Integrated Management

- Use resistant varieties when available.
- Plant early to permit crop development prior to aphid flights.
- Avoid moisture stress and nitrogen deficiencies to ensure rapid growth and reduce the severity of BYD in infected grains.
- Scout for aphids in late-planted grains.

Common Root Rot

Disease development depends on plant stress.

Healthy plants with intact subcrown node (left); and common root rot infected plants (right). (J. Watkins, University of Nebraska)

Impact

Common root rot is caused by a complex of soilborne fungi including *Helminthosporium* and *Fusarium* species. Disease incidence occurs throughout the San Luis Valley on individual fields.

Losses of stand or yield are low, ranging up to 10 percent. Disease development depends on plant stress. If soil moisture is adequate, some symptoms may be present, but the plant is more able to compensate.

Light infections of common root rot occur throughout the San Luis Valley. Serious problems are rare.

Description and Symptoms

➤ Infected plants appear stunted, have smaller root systems, and exhibit decay in the crown area.
➤ Commonly, tillering is reduced regardless of degree of infection.
➤ Part or all of the sub-crown internode, lower nodes, crown, and roots of an infected plant usually turn brown or reddish brown.
➤ Brown coloring sometimes extends up the stem for a few internodes.
➤ Small oval brown lesions may occur on the roots and sub-crown area.
➤ Inoculum persists on cereal and grass hosts, in crop debris and in the soil. Some fungi can exist for months in the soil without a host.

Integrated Management

- Rotate out of wheat or barley for one year to reduce fungal inoculum levels in the soil. Oats or broad leaf crops are suitable rotation crops.
- Plant resistant cultivars when available.
- Avoid soil compaction and provide good soil tilth to limit seedling stress.
- Plant early at a proper seeding depth to permit uniform germination and emergence under cooler soil temperatures, which delay common root rot infections.
- Maintain adequate nitrogen and phosphorus levels to encourage vigorous root and shoot growth, enabling plants to resist or tolerate infection.
- Avoid plant moisture stress through accurate irrigation management.

Net Blotch

Net blotch affects barley by reducing the carbohydrate content and the malt extract for brewing.

Net blotch on barley leaf (R. L. Forster).

Impact

Net Blotch, caused by *Pyrenophora teres* (the perfect stage of *Helminthosporium*), occurs occasionally in the San Luis Valley. Net blotch affects only barley and oats by reducing the carbohydrate content and the malt extract for brewing. Serious infections reduce yield and quality.

Light infections of net blotch occur through out the San Luis Valley. Serious problems are rare.

Description and Symptoms

➤ Net blotch lesions first appear as light brown patches with a pattern of dark brown inside them.
➤ The dark brown pattern of net blotch lesions takes on a net-like pattern characteristic of the disease. Surrounding areas become yellow.
➤ Net blotch lesions can spread over an entire leaf and kill it.
➤ The fungus overwinters on seed or on plant residue in the soil.
➤ Net blotch is most common in cool weather and can be found from early growth stages through maturity.
➤ Severe attacks occur mainly after flag leaf emergence causing premature leaf death.
➤ Wet weather provides favorable conditions for disease development.
➤ Lush vegetative growth can encourage disease development.

Integrated Management

- Rotate out of barley two years to reduce inoculum in the soil.
- Eliminate surface crop residue to help reduce net blotch.
- Plant resistant varieties when available.
- Avoid excessive nitrogen rates that cause lush vegetative growth favoring net blotch development.
- Decrease irrigation frequency to allow foliage to dry between irrigations.
- Apply fungicides in severe cases especially to protect the flag leaf.

Powdery Mildew

White, cottony patches of the fungus initially form on the upper surfaces of lower leaves. The patches can spread to all above ground portions of the plant.

White mildew on wheat leaf.

Impact

Powdery mildew is caused by the fungus *Erysiphe graminis,* which affects the foliage and heads of small grains. Each type of small grain is infected by a separate subspecies.

The disease damages plants by competing for plant nutrients, destroying leaf surfaces, reducing plant photosynthesis, and increasing plant respiration and transpiration rates. Serious economic loss is rare from powdery mildew due to typically low humidity in the San Luis Valley despite the higher humidity under sprinkler irrigation.

Light infections of powdery mildew occur throughout the San Luis Valley. Serious problems are rare.

Description and Symptoms

➤ White, cottony patches of the fungus initially form on the upper surfaces of lower leaves. The patches can spread to all aerial portions of the plant.
➤ Opposite sides of an infected leaf may become pale green to yellow.
➤ The patches turn dull gray or brown with age and develop dark specks.
➤ Dense plant stands, heavy nitrogen fertilization, lush growth, high humidity, and cool temperatures favor disease development.
➤ Overwintering occurs on crop residue. In the spring, inoculation occurs by wind-borne spores.
➤ Manage crop to limit excessive vegetative growth (i.e., proper fertilizer levels) to limit disease development.

Integrated Management

- Use crop rotation to reduce disease inoculum from crop residue.
- Plant resistant varieties when available. Resistance depends on the strain of the fungus.
- Apply systemic foliar fungicides only for severe infestations. Refer to the current Colorado Pesticide Guide for Field Crops.

Rusts

Historically, infections occur only late in the season on late-planted barley.

Leaf rust on wheat.

Stripe rust on barley.

Impact

Two different rust diseases, leaf rust and barley stripe rust, occur occasionally in the San Luis Valley. Each rust is caused by a different species of the fungus *Puccinia*. Each type of grain is infected by a separate species. Barley stripe rust occurs only in barley. Leaf rust infects both wheat and barley.

Wind disperses the spores. These fungi do not overwinter in the San Luis Valley. New infections depend on wind introduction each year. Rusts increase respiration and transpiration and decrease photosynthesis resulting in severe plant stress.

Light infections of rust occur throughout the San Luis Valley. Serious problems are rare.

Description and Symptoms

➤ Both rusts are spread by wind-borne spores.
➤ Leaf rust appears as small, round, light orange-brown pustules scattered on leaf sheaths and blades.
➤ Leaf rust head infections are especially damaging.
➤ Stripe rust appears in barley as yellow pustules arranged as stripes on leaves, stem, and heads.
➤ Stripe rust may be very damaging if grain is infected early. Historically, infections occur **only** late in the season on late-planted barley.

Integrated Management

- Plant resistant varieties to provide a defense against certain races of rust.
- Use appropriate systemic seed treatments **if early season infections occur regularly.**
- Avoid late planting (after May 15) to minimize rusts. Timely planting is especially effective to minimize barley stripe rust.
- Apply fungicides only in severe epidemics to protect the flag leaf.

Septoria Leaf Blotch

As lesions develop, dark specks appear in their centers.

Septoria leaf blotch with black fungus bodies in the middle.

Impact

Species of the fungus *Septoria* cause Septoria leaf blotch. Reduced seed set, poor seed filling and shriveled grain are common concerns when a Septoria outbreak is severe. *Septoria* inhibits grain filling by reducing photosynthesis and increasing respiration.

Losses are greatest when the flag leaf is affected. Septoria leaf blotch has not been a serious problem in the San Luis Valley. Low levels of leaf blotch do not affect yields significantly.

Description and Symptoms

➤ Look for symptoms of Septoria leaf blotch when prolonged periods of damp weather occur. The disease may affect plants at any stage of development under a wide range of temperatures.
➤ Symptoms are water-soaked or yellowish spots or specks that first appear on the lower leaves.
➤ Large areas of leaves may be affected. Symptoms spread to upper foliage and glumes if wet conditions persist.
➤ As lesions develop, dark specks appear in their centers. The specks are a key diagnostic feature of Septoria leaf blotch.
➤ *Septoria* survives on infected crop residue, volunteer grain and seed.
➤ Spores are produced on the surface of infected stubble or crop residue under damp conditions.
➤ Splashing water or wind move spores to the surfaces of leaves. Spores begin to germinate and infect if the leaf surface remains continuously wet for at least 6 hours.
➤ Greater infection occurs when foliage remains wet for two or three days.

Integrated Management

- Plant resistant cultivars when available. Early maturing cultivars are more susceptible in some regions.
- Manage crop residue to minimize inoculum after serious infestations.
- Rotate crops to limit inoculum survival.
- Manage crop to limit excessive vegetative growth (i.e., proper fertilizer).
- Apply foliar fungicides when Septoria leaf blotch outbreaks threaten to infect the flag leaves.

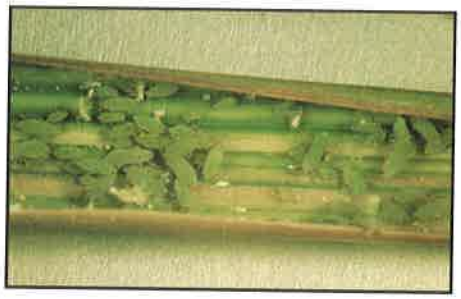
Russian Wheat Aphid

Economic threshold for wheat, before flowering:

Percent Infested Tillers = Control Costs per Acre x 200/Expected Crop Value per Acre

and, after flowering:

Percent Infested Tillers = Control Costs per Acre x 500/Expected Crop Value per Acre



Russian wheat aphid colony with leaf curling and discoloration.

Impact

Russian wheat aphids (RWA), *Diuraphis noxia,* are a localized problem in the San Luis Valley. Aphids are brought in from other areas by winds. RWA infestations are more frequent in the eastern and southern areas of the San Luis Valley.

Oats are resistant to RWA. Triticale is moderately resistant, but damage can still occur. Wheat is susceptible and **barley is the most susceptible**.

Heavy infestations may cause severe yield losses. Yields can be reduced by 50 percent. RWA does not transmit viruses.

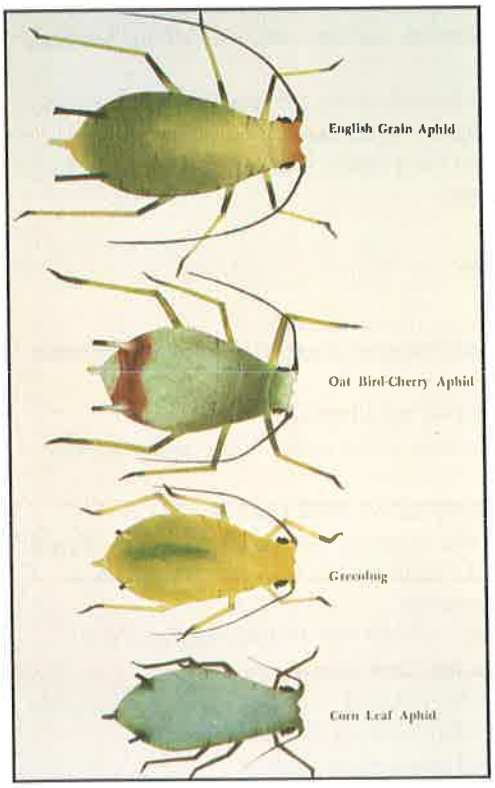
Description and Symptoms

➤ RWA are pale green, long, and spindle-shaped (football like) with no visible cornicles.
➤ Antennae are short compared with other aphid species.
➤ A projection above the tail gives Russian wheat aphids a two-tailed appearance.
➤ Colonies of aphids are produced inside rolled small grain leaves.
➤ RWA secrete a toxin that causes white or purple streaks on the leaves. Purple discoloration is more common in cool weather, while white streaks and leaf rolling are more prominent in warm weather.
➤ Heads of infested plants may become twisted and distorted and may not emerge. Some heads may emerge in a fish hook shape.
➤ Infestations can spread rapidly. As the colonies become crowded or the plant declines, wingless aphids can move to neighboring plants.
➤ Winged forms may also disperse and infest other fields.

Integrated Management

- Plant as early as possible.
- Plant resistant cultivars when available.
- Maintain a healthy grain crop to avoid plant stress that can cause greater aphid susceptibility.
- Scout suspect fields weekly for early detection.
- Estimate the economic threshold for wheat based on the following: *Percent Infested Tillers =Control Costs per Acre x 200/Expected Crop Value per Acre*
- Barley threshold is probably lower due to grain quality effects.
- After flowering, use a factor of 500 in the numerator instead of 200.
- Select contact and systemic insecticides labeled for control. Refer to Colorado Pesticide Guide.

Other Aphids



Other aphid species (Texas A&M University).

Impact

High populations of aphids other than RWA can occur but seldom require treatment. Impact varies with an aphid species and plant growth stage. Natural predators generally control aphid populations.

Description and Symptoms

➤ Aphids feed on the plant carbohydrates and can damage the flag leaf and grain head.
➤ Research in North and South Dakota and in Minnesota suggests aphid damage may be critical at late growth stages.
➤ Aphid feeding commonly creates a sticky substance or "honeydew."
➤ Typical aphids of the San Luis Valley include:

Corn leaf aphid (*Rhopalosiphum maidis*) has a pale green abdomen with dusky lateral areas. Cornicle and appendages also are dusky.
English grain aphid (*Macrosiphum avenae*) is grass-green, sometimes yellowish or pinkish brown on the head, frequently with a dusky blotch on the abdomen. The cornicle is entirely dusky to black.
Greenbug (*Schizaphis graminum*) is yellowish-green with a dark green longitudinal stripe. The cornicles are pale with a dusky tip.
Oatbird cherry aphid (*Rhopalosiphum padi*) is dark with an orange posterior. Cornicles are brownish with black tips.

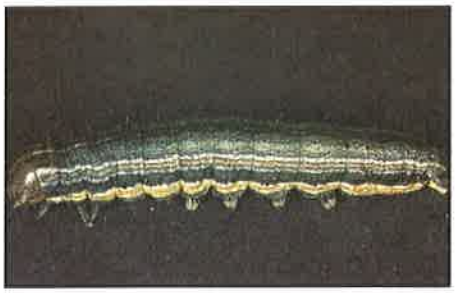
Integrated Management

- Scout fields regularly when aphid populations appear.
- Use the following chart for economic thresholds to decide when to treat aphids other than the RWA with a pesticide.

	Average number of aphids per plant				
Type of aphid	**Seedling**	**boot to heading**	**flowering**	**milky ripe**	**milk to medium dough**
Greenbug	5-15	25	>25	>25	>25
Corn leaf aphid	20	30	>25	>25	>25
Oatbird cherry	20	30	5	10	>10
English grain	30	50	5	10	>10

Armyworm

Armyworms move and clip heads; Army cutworms do not.



Armyworm.

Impact

Armyworms, *Pseudaletia unipuncta*, can occasionally cause severe damage to crops throughout the San Luis Valley. This insect prefers grass crops, including small grains, but will feed on some broadleaf crops such as potatoes after grain maturity. The greatest threat in small grains is head clipping in barley.

Description and Symptoms

➤ Mature larvae are about 1 1/2 inches in length, smooth-bodied, and dark grey 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. The stripes on the sides are pale orange with a white outline. The head capsule is remarkable for its honeycomb of black markings.
➤ Dense vegetation is preferred for egg laying.
➤ 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.
➤ Several generations can occur per year with the first damage occurring very early in the growing season.
➤ Larvae overwinter in upper layers of the soil or under crop debris.
➤ Population increases are dramatic from a single hatch, which is a serious threat to neighboring fields. The new larvae may feed and move together like an army.
➤ Crop damage can range from early season seedling destruction to late season clipped heads. Larvae feed on green plant material throughout the season. Head clipping is more common in barley.
➤ Large flocks of blackbirds in a grain field have been noted in the San Luis Valley as an indication a high population of army cutworms.

Integrated Management

- Scout often for armyworm in field margins, low areas with rank growth, or areas of lodged plants. Look for feeding damage, droppings around base of plant, or dropped plant material. Check for larvae in and under debris, around damaged plants and in heads of barley or wheat.

- Treat armyworm infestations if all of the following conditions are met: 1) larval counts exceed action threshold; 2) worms are 3/4 to 1 1/4 inches in length; 3) most larvae are not parasitized (look for white eggs behind the head or small brown cocoons attached to the body); and, 4) leaf feeding or head clipping is evident. Insecticides labelled for these crops can be found in the current Colorado Pesticide Guide for Field Crops.

Situation	Action threshold
Small grains (preheading, defoliation in lower leaves)	5 larvae per square foot
Small grains (head clipping)	2 larvae per square foot

Army Cutworm

Army cutworms often are confused with armyworms. Army cutworms spend most of their time underground.

Army cutworm.

Impact

Army cutworms, *Euxoa auxiliaris*, can feed on a wide range of plants. Greatest concern is with small grains and alfalfa.

Description and Symptoms

➤ Army cutworms overwinter as larvae. Larvae can be active at low temperatures (40 degrees F).
➤ Larvae pupate in early spring. Adults emerge and lay eggs in late summer and fall.
➤ Adults are commonly referred to as miller moths.
➤ Larvae are pale gray and splotched with light markings. The upper body is lighter colored with a dark strip down the middle of the back. A light strip runs along the sides.
➤ Larvae grow to 1 1/2 to 2 inches long.
➤ Larvae will climb a plant to reach green vegetation. When green vegetation is scarce in the spring, army cutworms will devour entire small grain seedlings. This is a common indication of a serious population.
➤ Regrowth of damaged seedlings can occur if green matter is present and the crown is not damaged. However, seedling damage is rare.

Integrated Management

- Scout until grain maturity.
- Protect natural predators which can control moderate populations.
- Apply insecticides when populations are high, two to four larvae per square foot. Pyrethroid insecticides are the most effective, but spraying is rarely necessary.

Checklist for Integrated Weed Management

☑ General

➤ Integrated weed management (IWM) is critical in small grain production for high yields and quality grain.

➤ IWM involves the use of best management practices including cultural, mechanical, biological, and chemical strategies.

➤ Pesticide use poses a potential risk to water quality. However, when pesticides are properly applied and integrated into a management system, the risk is minimized.

➤ In an effective IWM system, the prevention of future infestations is as critical as controlling the immediate problem i.e., mowing before weeds go to seed.

➤ Weed competition can greatly reduce grain yields, often in direct relation to the number of weeds present.

University of Idaho has found that if a wild oat population reaches one per 20 square yards or 242 plants per acre, the impact on the grain yield will be minimal. However, if 25 percent of the potential seeds produced from each of those plants germinate the next year, the wild oat population will jump to three seeds per square yard or 14,500 plants per acre. The potential seed production from these plants left uncontrolled is 75 seeds per square foot or 3.3 million seeds per acre. Many weeds have a similar seed multiplication potential.

☑ Cultural

➤ Plant certified, weed-free seed. Certified seed is inspected for noxious weed seed.

➤ Keep nearby non-crop areas (sprinkler corners, fence rows, ditches, roadsides, etc.) free of weeds. When appropriate, replant with desirable species (crop, grass, etc.) to avoid erosion, weed re-infestation and similar problems.

➤ Clean all machinery and implements between fields to remove seeds, rhizomes and other reproductive plant structures.

➤ Rotate crops to limit increases of weed seed in the soil and perennial weed infestations. Differences in tillage, planting dates, length of growing season, available labeled herbicides, and other cultural factors for different crops can disrupt weed life cycles.

➤ Manage all production factors, especially seeding rates and row spacing, to establish a healthy crop population that competes with weeds.

➤ Select, if possible, fields free of weeds difficult to control in the upcoming small grain crop.

➤ Select well-adapted varieties for establishing a competitive crop. Note: certain varieties, i.e., Yecora Rojo, a hard red spring wheat, do not tiller well which can lead to weed problems.

➤ Use higher seeding rates and closer row spacings, 6 to 7 inches, to compensate for reduced tillering and late plantings of certain varieties.

➤ Replant fields or areas of poor stands to limit weed population buildup in otherwise open ground.

☑ Biological

➤ Use natural enemies (i.e., insects, plant pathogens, etc.) to control selected weed species. Typically, biological controls are released on a regional basis. Most emphasis of biological control of weeds is directed at noxious weeds (i.e., *Ceutorhynthus litura* (weevil) to control Canada thistle).

☑ Mechanical

➤ Till soil before planting to control existing weeds. Grain seedlings that emerge before weeds are more competitive for moisture, nutrients and light.

➤ Maintain good soil tilth for vigorous crop growth.

Compacted soil limits crop growth and allows for new weed infestations.

☑ Chemical

➤ Anticipate potential weed infestations based on past records, field maps and experience to determine the necessity of herbicide use.
➤ Calibrate sprayer well in advance of herbicide application.
➤ Identify weed species accurately for optimal herbicide selection, application rate and timing of application.
➤ Select herbicides to achieve the best combination of the following factors: weed control, crop tolerance, soil residual activity, and leachability. Crop rotations can limit herbicide selection depending on the soil persistence or label requirements. Leachability influences the potential of a herbicide to impact water quality.
➤ Rotate herbicide selection to minimize development of resistant weed populations.
➤ Time herbicide application based on susceptible weed stages and tolerant crop growth stages, which can vary depending on the selected herbicide.
➤ Consider application of herbicides early in the season when weeds are small. Smaller weeds are more easily controlled and less competitive.
➤ Apply herbicides when crops and weeds are growing vigorously and not under stress.
➤ Manage the crop for quick canopy closure after herbicide application to reduce subsequent weed establishment or regrowth.
➤ Herbigate only with herbicides labeled to be applied through sprinkler application. A chemigation permit is needed before herbigating.

➤ Read the herbicide label before application. Note any particular restriction influencing herbicide performance or safety.

Pesticide Management for Water Quality

The majority of applied pesticides degrade to harmless products, like carbon dioxide (CO_2) before posing a serious environmental threat. However, small quantities of pesticide may reach groundwater if soil, site and pesticide characteristics favor movement.

When pesticide use is necessary, select the most appropriate product based on the chemical properties of a pesticide. The following properties significantly influence the potential of off-target environmental effects of pesticides:

- **degradation rate** - time necessary to break down a compound to harmless products, like carbon dioxide. The rate is measured as the half life, commonly referred to as **persistence**;
- **adsorptivity** - tendency of a pesticide to be adsorbed by a soil, measured by the adsorption coefficient;
- **solubility**- tendency of a chemical to dissolve in water, measured in parts per million (ppm);
- **volatility** - tendency of a chemical to become a gas, measured as vapor pressure.

Persistence, adsorptivity and solubility are important indicating factors of the potential of a pesticide to leach.

Pesticide properties only indicate the probability of leaching (or runoff); soil, site and management factors determine if the chemical actually moves offsite. Coarse textured soils, low-organic matter, shallow water tables, and excessive irrigation and precipitation events in the San Luis Valley increase the potential for pesticide leaching. However, in most cases, proper management will keep pesticides out of the groundwater.

Evaluate soil, site and pesticide properties to determine what relative hazards to water resources exist from pesticide application. By considering these factors, integrated pest management measures can be selected that are least likely to impact groundwater quality.

Weed Management Chart

WEEDS	TILLAGE			CROP ROTATION				HERBICIDES								
	Moldboard Plow	Chisel Disc	Spring Till w/ Delayed Planting	Alfalfa	Potato or Vegetable	Canola	Winter Wheat	Buctril (Bromoxynil)	Bronate (Bromoxynil + MCPA)	2,4-D	MCPA	Banvel (Dicamba)	Curtail (Clopyralid + 2,4-D)	Assert (Imazamethabenz-methyl)	Hoelon (Diclofop-methyl)	Fargo (Triallate)
Annual Broadleafs																
Kochia	✳	✳	✔	✔	✔	✔	✔	F	G	F	F	G	F	P	X	X
Lambsquarter	✳	✳	✔	✔	✔	✔	✔	G	G	E	G	G	E	X	X	X
Mustards	✳	✳	✔	✳	✳	X	✳	G	G	F	F	G	E	G	X	X
Nightshade	✳	✳	✳	✔	✔	✔	✔	G	G	G	G	G	G	G	X	X
Pigweed	✳	✳	✳	✔	✔	✔	✔	G	G	E	F	E	E	P	X	X
Redstem Filaree	✳	✳	✔	✔	✳	✳	✳	X	F	X	X	X	X	X	X	X
Russian Thistle	✳	✳	✔	✔	✔	✔	✔	G	G	G	F	G	G	P	X	X
Sunflower	✳	✳	✳	✔	✔	X	✔	E	G	E	F	E	E	X	X	X
Annual Grasses																
Green Foxtail	✔	X	X	✔	✔	✔	✳	X	X	X	X	X	X	P	G	X
Wild Oats	✳	X	✔	✔	✔	✔	✔	X	X	X	X	X	X	E	G	G
Witchgrass	✔	X	X	✔	✔	✔	✳	X	X	X	X	X	X	P	G	X
Perennials																
Field Bindweed	✳	X	X	✳	✳	X	✔	P	P	F	P	G	P	X	X	X
Canada Thistle	✳	X	X	✳	✳	✳	✔	P	P	F	P	F	G	X	X	X
Mouse-ear Povertyweed	✳	X	X	✳	✳	✳	✔	P	P	F	P	F	?	P	X	X
Quackgrass	✳	X	X	✳	✳	✳	✔	P	P	P	P	P	P	X	X	X
Russian Knapweed	✳	X	X	✳	✳	✳	✔	P	P	F	P	F	G	X	X	X
Tall Whitetop	✳	X	X	✳	✳	✳	✔	P	P	F	P	F	P	X	X	X
Water Quality Concerns																
Leachability	-	-	-	-	-	-	-	L	M	M	H	H	H	L	L	L
Persistence	-	-	-	-	-	-	-	L	L	L	L	L	M	M	L	M
Rotation Restrictions	-	-	-	-	-	-	-	N	N	N	N	Y	Y	Y	N	N

Excellent (90-100 percent control)	E	No control/not labeled	X	High	H
Good (75-90 percent control)	G	Inconsistent (varies)	✳	Medium	M
Fair (50-75 percent control)	F	Suitable	✔	Low	L
Poor (0-50 percent control)	P	Not applicable	-	No	N
Rating not documented	?			Yes	Y

Note: This chart is a guideline to selected weed management techniques. Good weed management is critical for success. For example, herbicide performance is dependent on proper use as indicated on the product label. Also, not all techniques are applicable to all conditions. For example, excessive tillage may result in high soil erosion. An integrated approach of varied techniques is the key to weed control.

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Colorado State University Cooperative Extension offices are local resources for additional fact sheets and publications in agriculture, natural resources, consumer and family education, 4H/youth education, and community resource development.