Category 1A: Agricultural Pest Control – Plants

Agricultural Pest Control – Plants Learning Objectives

After studying this section, you should be able to:

- Describe some of the most common insect pests of agricultural crops.
- Describe the different types of herbicides used to control weeds and the factors that can affect herbicide uptake in plants.
- Explain the different ways that herbicides move in plants.
- Describe basic types of plant diseases and list symptoms of each.
- Describe the most common diseases found on common Nevada crops.
- Describe the most common vertebrate pests that impact agricultural crops in Nevada and control strategies for each.

Category 1A, Agricultural Pest Control - Plants

Category 1A, Agricultural Pest Control – Plants, is the category that covers pesticide applications on crops. This includes fruit and vegetable crops, small grain crops, feed crops and forage crops. Agricultural crop production provides the ideal conditions for weeds to grow.

The growth of a single type of plant, also known as a monoculture, can provide an ideal setting for diseases and insect pests to develop and thrive. Pesticides are often needed to reduce pests to tolerable levels, but they can have serious consequences if applied improperly. Pesticides can harm non-target plants, beneficial insects, wildlife, pets, livestock and humans. Thoughtful planning and implementation are required to reduce pest pressure, minimize unintended damage, reduce costs and maximize profit.
Integrated Pest Management (IPM)

The principles of Integrated Pest Management (IPM) can be applied to controlling insect pests, weeds, diseases and vertebrate pests on agricultural crops.

- **Pests, their hosts and beneficial organisms must be positively identified.** The pest problem and associated plant species must be correctly identified. If you can’t identify the pest, collect samples and submit them to the University of Nevada Cooperative Extension or the Nevada Department of Agriculture for identification. Once the pest has been identified, determine its life cycle, growth cycle and reproductive habits. Pest managers should also be able to identify all life stages of beneficial organisms, such as the lady bird beetle, an insect predator.

- **Establish monitoring guidelines for each pest species.** Routine monitoring of both pests and natural enemies (beneficial species) is an essential part of IPM. Methods of monitoring include visual inspection, pheromone and sticky traps, and sweep nets. Document and track both pest and beneficial organism population numbers. The ratio of natural enemies (usually insects) to pests should be taken into account before a pesticide is applied.

- **Establish an action threshold for the pest.** A fundamental concept of IPM is that a certain number of individual pests can and should be tolerated. Will the pest cause unacceptable damage to the value the crop? **What will happen if no action is taken?** The action threshold in crop production is generally based on economics. The **economic threshold** is defined as the pest population level that produces damage equal to the cost of preventing damage by controlling the pest. The threshold is the pest density, or population level, at which a pesticide or other control method should be used.

- **Evaluate and implement control tactics.** Select tactics that will be most effective, most economical and have least impact on non-target species and the environment. Select controls that will harm beneficial organisms as little as possible while suppressing the pest. If a pesticide is one of the selected management tools, beneficial enemies (usually insects) will likely also be killed.

- **Monitor, evaluate and document the results.** This allows you to make adjustments to improve the effectiveness of future pest control strategies.

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**Principles of IPM:**

- Identify the pest.
- Monitor the pest population.
- Establish an action threshold.
- Evaluate control options.
- Implement control options.
- Monitor results.
**Worker Protection Standard (WPS)**

The Worker Protection Standard (WPS) is a regulation issued by the U.S. Environmental Protection Agency. It covers pesticides that are used in the production of agricultural plants on farms, forests, nurseries and greenhouses. The WPS requires you to take steps to reduce the risk of pesticide-related illness and injury if you (1) use pesticides or (2) employ workers or pesticide handlers who are exposed to pesticides. If you are an agricultural pesticide user and/or an employer of agricultural workers or pesticide handlers, the WPS requires you to provide the following to your employees and, in some cases, to yourself and to others:

**Information about exposure to pesticides:** To ensure that employees will be informed about exposure to pesticides, the WPS requires:

- Pesticide safety training for workers and pesticide handlers.
- A pesticide safety poster be displayed for workers and pesticide handlers.
- Access to pesticide labeling information for pesticide handlers and early-entry workers.
- Access to centrally-located information detailing pesticide applications that have occurred on the establishment.

**Protection against exposures to pesticides:** To ensure that employees will be protected from exposures to pesticides, the WPS requires employers to:

- Prohibit handlers from applying a pesticide in a way that will expose workers or other persons to pesticides.
- Exclude workers from areas being treated with pesticides.
- Exclude workers from areas that remain under a restricted-entry interval (REI), with narrow exceptions.
- Protect early-entry workers who are doing permitted tasks in treated areas during an REI, including providing special instructions related to the correct use of personal protective equipment (PPE).
- Notify workers about treated areas so they can avoid inadvertent exposures.
- Protect handlers during handling tasks, including monitoring while handling highly toxic pesticides and providing special instructions related to the correct use of PPE.

**Mitigation of pesticide exposures:** To mitigate pesticide exposures that employees receive, the WPS requires that:

- Decontamination supplies are available to all workers. Employers must provide pesticide handlers and workers with an ample supply of water, soap and towels for routine washing and emergency decontamination.

In 2015 the EPA revised the WPS. A synopsis of the 2015 changes can be found in the Pesticides and the Law chapter of this workbook.

For further information on the WPS, consult the U.S. EPA web publication “How to Comply With the 2015 Revised Worker Protection Standard for Agricultural Pesticides: What Owners and Employers Need To Know” at http://pesticideresources.com/wps/htc/htcmanual.pdf
Emergency assistance information is available to all workers. Employers must provide transportation to a medical care facility if an agricultural worker or handler may have been poisoned or injured by a pesticide and must provide information about the pesticide(s) to which the person may have been exposed.

**Insect Pests**

Basic insect identification information can be found in the General Knowledge: General Pest Problems section of this manual.

Insects can damage plants in the following ways. They may:

- Feed on leaves.
- Feed on and move into fruit, seeds and nuts.
- Feed on and tunnel into roots.
- Tunnel or bore into stems, stalks, branches and trunks.
- Suck sap or juices from leaves, stems, roots, fruits and flowers.
- Act as vectors, transmitting disease pathogens as they feed.

Insect outbreaks often result from one or more of the following factors:

- Large scale planting of a single crop (the basis of modern agriculture).
- Introduction of an insect pest into an area with no natural enemies.
- Favorable weather conditions that aid in rapid development and reproduction. These same weather conditions may be unfavorable to natural enemies.
- Use of insecticides that kill natural enemies or reduce competing species of pests.
- Cultural practices that encourage the pest infestation.
- Other factors that destroy the natural food chain that normally helps keep the pest insect population in check.

For a listing of insect control strategies, see General Pest Problems in the General Knowledge section of this manual.

**Specific Insect Pests in Agricultural Plants**

**Alfalfa weevil**: This is the most serious insect pest of alfalfa in Nevada. Adult alfalfa weevils overwinter in surrounding vegetation and field trash. In early spring, adult females deposit eggs in stems of alfalfa. The eggs hatch and larvae make their way to the growing tips and upper leaves, where they feed. Feeding damage results in a skeletonized appearance on the leaves. Severe damage can give the field a grayish to whitish cast, as if it had been frosted. Mature larvae make their way to the base of the plant and pupate.
On rare occasions, newly emerged adults may cause damage to the second crop. Alfalfa weevil damage is most commonly seen before the first cutting. Healthy plants are better able to tolerate insect feeding. Resistant cultivars are available. Early cutting can be an alternate to chemical applications, if economically feasible. Cutting will reduce numbers and interrupt the insect’s life cycle.

The best time for chemical control is in the larval stage. Compounds previously used for controlling adults have been canceled. Therefore, treat only for larvae. Proper timing is extremely important when applying insecticides to control alfalfa weevils.

**Mites:** Mites are not insects, but arachnids. They have eight legs. Mites often appear under dry conditions prior to the first irrigation. Often the first irrigation will reduce their populations by knocking them off the plants and interrupting their life cycle. Mites cause damage by sucking plant juices. Damage first appears as stippling (small yellow areas) on leaves. Severe damage causes leaves to dry and then drop from the plant. The mites are found on the undersides of the leaves and the infestation usually starts on the lower, older leaves and moves upwards. Minimizing plant stress through improved cultural practices, such as proper irrigation and fertilization, can aid plants in withstanding an infestation. They can be controlled with acaracides (pesticides that kill mites).

**Aphids:** Almost every plant has its own type or types of aphid pests. Aphids are soft-bodied insects with piercing mouthparts that are used to suck out plant fluids. Some species inject toxins into plants, resulting in distortion of the leaves. Heavy infestations can reduce plant vigor, causing stunting in plants and causing leaves to wilt, curl, yellow or become mottled. It is extremely important to identify the specific aphid species that is attacking the crop since thresholds and the effectiveness of chemicals may vary from species to species.

The typical aphid overwinters as either a sexually produced egg or adult aphid. This may occur on a summer host or on an alternate winter host. In the spring, eggs hatch, producing winged adults, or the overwintering adults move to the summer host. The females mature and begin producing offspring without being mated. This is referred to as asexual reproduction. This may be repeated (adult to adult) in the summertime as often as once a week.

Cultural practices that promote vigorous growth can help plants tolerate aphid feeding. Resistant cultivars are available. Early harvesting may help to reduce numbers. Biological control by lady bird beetles, lacewing larvae,
syrphid fly larvae, damsel bugs, big-eyed bugs, minute pirate bugs and parasitoids can keep numbers below action thresholds. Chemical controls should be applied thoughtfully to minimize injury to these beneficial insects.

**Lygus bugs:** This is primarily a pest on alfalfa seed but can cause some damage on hay. Lygus bugs damage plants by puncturing plant tissues with their piercing mouthparts and feed by sucking sap. In addition to the physical injury they cause by feeding, females also damage plants when they lay eggs directly into plant tissues using their piercing ovipositors. This is usually a problem on other crops grown for seed. Lygus bugs preferentially target growing points (buds, flowers, seed pods) and can significantly reduce seed set, plant maturation and seed yield. Control is difficult and the best success is achieved with pesticide applications aimed at the smaller nymphs. Monitor for lygus bugs prior to first bloom, so treatment decisions can be made prior to pollinator release. Apply chemical controls in the late evening or early morning, when pollinators are not active.

**Cutworms:** Cutworms are an occasional problem in all agricultural crops. Early detection is very important. Symptoms often show up as “late spots” in alfalfa fields. In row crops young seedlings will be severed at ground level. If populations are high enough (about 1/square ft) controls are warranted. Baits can be applied but often bait acceptance is a major problem. It is important to know which cutworm or armyworm you are dealing with since many are nocturnal and for these species you must spray in the late afternoon or evening to get adequate control. Tillage and flood irrigation can reduce cutworm populations.

**Grasshoppers:** Large grasshopper populations generally develop on non-cultivated land or on land that has been left fallow or abandoned. These grasshopper populations or “bands” then move to agricultural lands and feed on crops. Controls must be aimed at the entire band of grasshoppers. Treating only a portion of the band will often result in rapid re-infestation of the treated area. Treatment must also occur before grasshoppers begin laying eggs.

If properly treated, grasshoppers can be controlled in an area for up to five years. Control measures include a number of chemical controls. Remember to make sure the crop or site is specified on the product’s label. *Nosema locustae* is a disease of grasshoppers. This biological control can be used effectively against grasshoppers if the proper conditions exist. Success is most dependent on the grasshopper species present, the life stage of the grasshopper, and the habitat conditions.

**Mormon Crickets:** Mormon crickets are not true crickets. They are shield-backed, short-winged katydids. They resemble fat grasshoppers and cannot
fly. Similar to grasshoppers, they have cyclic population increases. Mormon crickets form bands that feed on almost any plant material, but they prefer succulent forbs. They damage rangeland forbs, grasses and shrubs. They can also damage small grains, alfalfa and most other crops. Their presence can also cause losses to forage crops they don’t eat; hay quality significantly drops if the hay is full of Mormon crickets and their droppings.

Control of Mormon crickets is an ongoing battle in Nevada. Physical or mechanical control by creating a barrier is usually impossible over large land areas. Biological controls include wild birds and poultry. A black wasp (Palmodes laeviventris) has been reported to be a Mormon cricket predator. A parasite (Varimorphan sp.) occurs naturally in populations of Mormon crickets and can be devastating in the early nymph stages. Unfortunately, this parasite is not commercially available. Several different chemical controls are available, with different mechanisms of action. Pesticide baits are available. Since Mormon crickets cannibalize their dead, the bait that kills one Mormon cricket may kill and second or third with subsequent feeding within the band. If you are using chickens as a biological control, you may not want to use these baits or many of the other chemical controls. Other chemical controls include growth regulators. The choice of growth regulator is based on a number of factors, including the age of the cricket population, forage conditions, labeled sites for use with each growth regulator, weather, and environmental impacts. Check with your local pesticide dealer for the most up-to-date chemical control products available for your site and situation.

**Thrips:** These are important pests of onions and garlic. On these crops the economic threshold is considered to be about 10 per leaf. Thrips on other crops can cause cupped or silvered leaves, deformed flowers and problems in pollination resulting from their rasping style of feeding.

Thrips are very difficult to control. Consider crop rotation, sanitation near crops, such as removing alternate host plants, planting trap crops, and chemical applications.

**Pollinator Protection:** When growing crops for seed or adjacent to areas of seed production it is vitally important to be aware of the effect that an application of pesticides will have on the pollinators of the crop. The three most important pollinators in Nevada are the alfalfa leafcutter bee, the alkali bee and the honey bee. If an application of pesticide is to be made near hives or domiciles, the owner of the bees should be notified so protective measures can be taken. For information on Nevada’s Managed Pollinator Protection Plan go to [http://agri.nv.gov/uploadedFiles/agrinygov/Content/Plant/Entomology/nevada_pollinator_protection_plan_final.pdf](http://agri.nv.gov/uploadedFiles/agrinygov/Content/Plant/Entomology/nevada_pollinator_protection_plan_final.pdf).
Weeds Pests in Agricultural Plants

General information on weeds is covered in the General Knowledge: General Pest Problems section of this manual. Please refer to that chapter for discussion on the stages of plant development and the different plant life cycles.

It is impossible to describe and discuss every weed you may encounter in Nevada in this publication. However, it is imperative to identify the weed, its lifecycle and its stage of growth in order to formulate a weed management plan. There are many resources available to help you identify weeds. The Nevada Department of Agriculture and the University of Nevada Cooperative Extension can help in identification. Many books contain pictures and descriptions of weeds. There is a limit to the amount of information they contain, so it is best to consult sources specific to your geographic area.

There is great variability in Nevada’s climate. Weeds found in southern Nevada can be much different than those in northern Nevada. Not all weeds that occur in the Las Vegas area occur at Lake Tahoe, and vice-versa. There is a wealth of information available on weed identification on the Internet, but use caution and only trust information from reputable sources.

It is important to understand some of the living dynamics of plant growth to understand how herbicides work and the different ways they may affect plants. Plants consist of roots, stems or trunks, and leaves. Water movement in most plants is from the roots upward through the trunk or stem and into the leaves, where transpiration occurs. Plants produce their own food or carbohydrates through photosynthesis. Movement of the food is from the leaves downward through the trunk or stem to the roots.

Weed control strategies

Most effective weed management plans include two or more control strategies. Weed control can be split into five separate categories.

- **Prevention:** Prevention includes such factors as using certified weed-free seed, hay, transplants, amendments and mulches. Cleaning equipment to prevent the spread of weed seed and weed plant parts from one area to another is another prevention tactic. Prevention also includes removing weeds before they can form seed heads or spread by other methods. It is more difficult to prevent weed seeds from blowing in from an adjoining property.

- **Cultural controls:** Cultural controls are management practices that reduce the incidence of weed infestations. Cultural controls include using proper planting times and planting rates, planting companion
crops, managing fertilization and irrigation to favor desired plants rather than weeds, rotating crops and planting cover crops.

- **Mechanical/Physical controls:** These controls include tillage, hoeing, mowing, flooding, burning, hand-pulling, etc.
- **Biological controls:** This method uses a living organism to control a pest. Success depends upon selectivity, reproduction, adaptation, and ability of the organism to reach a high level of effectiveness.
- **Chemical controls:** Chemical control is the use of pesticides, in this case, herbicides, against a target pest (weeds). Many herbicides are available. In order to be effective, an herbicide:
  - Must come into contact with plant parts (leaves, stems, trunks, roots, etc.).
  - Must remain on the plant surface long enough to penetrate or be absorbed.
  - Must reach a living site to disrupt a vital process or structure.
  - Must be able to kill the target weed.

**Herbicide effectiveness** is dependent on a number of factors:

- **Herbicide uptake rate and quantity:** Herbicides are applied either to the soil, where they interact with the roots, or applied to the foliage of the plant (the above-ground stems, leaves, etc.).
  - **Soil-applied materials**, such as preemergence herbicides, generally dissolve in the soil water and enter the plant via the plant’s roots. Absorption of the herbicide takes place across the cell walls of the root hairs. The plant must be actively growing, so non-germinating seeds are not affected by these herbicides. To remain effective, the herbicide barrier formed in the soil must not be disturbed.
  - **Foliar-applied herbicides** are sometimes difficult to get into the plant through the shoots and leaves. The major barrier to herbicide uptake is the cuticle. The cuticle is the waxy covering found on all leaves. The thickness of this waxy coating varies for each plant species and can be thicker within the same species on plants growing in dry, hot climates. Many plants have leaf hairs, which may hold the herbicide spray droplets above the leave surface where they are not readily absorbed. Both the leaf cuticle and leaf hairs can cause herbicides to bead up and run off or evaporate. The addition of wetting agents or oils can help spread out herbicide solution, cover the foliage and penetrate the cuticle, but they are an added expense. Often the wetting agents or oils are included in the product. If they are not included, follow label instructions to add them.
  - **Spray volume** can affect the effectiveness of an herbicide application. Adjust the spray volume to minimize spray runoff or
spray drift but maximize coverage and penetrate the crop canopy.

- The amount of foliage or shoot growth can affect the effectiveness of an herbicide application. There must be enough foliage to intercept the spray application. For grasses, this generally means waiting until there are three to five blades. For broadleaf plants, it means waiting until the leaves are one-half inch to one inch in diameter.

- In general, the retention time of water-soluble herbicides on plants must be six to 12 hours to maximize absorption. Oil-soluble herbicides require less time, often as little as one hour. Do not apply herbicides during rain, when rain is expected, or when irrigation will occur before the required retention time has passed.

- **Herbicide movement in the plant:** To be effective, herbicides must reach a living site to disrupt a vital process or structure. Herbicides are subdivided based on how they move in plants.
  - **Selective herbicides:** Chemicals that kill specific types of plants.
  - **Nonselective herbicides:** Chemicals that kill all types of plants.
  - **Contact herbicides:** Herbicides with little to no movement in plants are called contact herbicides. They kill immediately after penetration, usually within hours. They require thorough coverage. They kill only the plant parts they touch, so they will kill the leaves and stems, but not necessarily the roots. For this reason, they are more effective against annual weeds to kill plants and prevent seed production and not very effective against biennial or perennial weeds whose roots remain and produce more above-ground plant parts at a later date.
  - **Systemic herbicides:** Chemicals that are absorbed through the leaves or roots and move freely throughout the plant. Application to part of the plant will kill the entire plant. Systemic herbicides are effective against most plants and are recommended for perennials. They take time to be effective and may be soil- or foliage-applied. These types of herbicides can move through the plant tissues in two basic ways: through the water-conducting tissues or through the food conducting tissues.
    - Herbicides that move through the water-conducting tissues, called apoplastic movement: Water movement in most plants is upward only. Water generally is not absorbed by the leaves and transmitted down to the roots, but it moves from the roots up to the leaves. These herbicides are generally soil applied. If they are foliar applied, the herbicide will act as a contact herbicide, only killing the plant parts they touch. The older leaves are affected first.
• Herbicide movement through the food conducting tissues, called symplastic movement: These types of herbicides move through the plant to the points of active growth. They are generally applied to the leaves and move through the plant to the roots. A few are soil applied. They are very effective at killing the roots and can be used on annual, biennial and perennial weeds.

• **Herbicide mechanism of action** is the way the herbicide affects a vital metabolic plant process. There are a number of mechanisms of action and they occur at the tissue or cellular level in the plant. Using the same herbicide over and over can result in resistance to that herbicide. In order to prevent herbicide resistance it is important to alternate herbicides with different mechanisms of action.
  
  o **Synthetic auxins** interfere with cell division and cell enlargement. The symptoms of these types of herbicides are downward twisting and curving stems, puckered, twisted or curling leaves, called epinasty. The plant dies as growth stops and mature tissues undergo cell division, choking the vascular tissues. While the symptoms may appear within hours, the plant dies slowly, usually in three to four weeks. Synthetic auxins are translocated through the plant and are usually applied to the foliage. Control occurs at low volumes of spray. Drift is a concern with these herbicides, as very low volumes can cause damage. Synthetic auxins are more effective at controlling broadleaf weeds and trees than grasses. Some are persistent in the soil.
  
  o **Photosynthesis inhibitors** cause the plant leaves and stems to stop producing food. The plant turns white and dies. They may be applied to the soil or directly onto foliage. They do not appear to affect the roots. Photosynthesis inhibitors can persist in the soil, depending on the formulation.
  
  o **Cell membrane disruptors** cause the cell contacts to leak. Plants wilt, dry, yellow and eventually die. Most of these herbicides are nonselective contact herbicides. Good coverage is required for control. Injury can be visible in few hours to a few days, depending on the formulation.
  
  o **Cell division disruptors** inhibit new cell formation. This causes the plant to stop growing and prevents the development of a seed head, which prevents reproduction. These herbicides do not readily translocate from the leaves on which they are applied. They are not persistent in soils.
  
  o **Root and shoot inhibitors** prevent the growth of roots and shoots or germinating seeds and small seedlings by disrupting cell division. These herbicides have a very limited ability to translocate in plants.

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If more than one application of herbicide is required to control a weed infestation, it is imperative to use herbicides with different mechanisms of action to reduce the possibility of the weed developing herbicide resistance.
so they do not control established weeds. They are generally soil applied and have limited mobility in the soil. They require precipitation or irrigation water to activate in the soil.

- **Bud development inhibitors** prevent bud development when applied to woody plants late in the growing season, but before leaves start changing colors. The effects are not seen until the following spring, when the woody plants fail to resume growth. These herbicides move only from the leaves to the buds, so they do not translocate in the plants. They have no soil activity and do not injure grasses at normal application rates.

- **General metabolic inhibitors** are those herbicides that interfere with enzyme production or activity. The enzymes normally help in amino acid production, which form proteins in the plants. The elimination of protein production eventually eliminates the plant. Symptoms show up slowly in the targeted plants, sometimes taking a week or more to manifest. Some of these types of herbicides have residual soil activity and some are not active in the soil at all.

- **Pigment inhibitors** cause the destruction of chlorophyll in the plants. Plants die because the leaves can no longer produce food. These herbicides are sometimes applied as preemergence herbicides and have limited soil mobility. They are considered nonselective herbicides, but may not control deep-rooted, established plants due to limited soil mobility.

**Herbicide fate in the environment** plays an important role in herbicide effectiveness. Herbicides are applied either to foliage or to the soil. They are absorbed into plant tissues or adsorbed (attached) onto soil particles. They then may combine with plant tissues and disrupt plant functions. As the plants die, the herbicides may break down or they may remain viable in the plant residues or the soil. The breakdown is also referred to as degradation.

Sometimes degradation is desirable. For example, herbicides that do not remain in the plant residues or soil allow replanting to occur. Other times, degradation is not desirable, as the herbicide may not last long enough to be effective. Degradation is measured as “half-life,” which is defined as the time it takes for half the applied herbicide to break down.

**Pesticide degradation** occurs in three ways:

- **Microbial action**: Chemical breakdown or degradation of pesticides by soil microorganisms, such as fungi, bacteria, etc.
- **Chemical degradation**: Breakdown of pesticide chemical components by inorganic methods, often hydrolysis (not by living organisms).
Photodegradation: Breakdown of pesticide chemical components by reaction with sunlight. This is why many pesticide application instructions require incorporation of the pesticide in the soil, away from direct sunlight.

The major concern is that herbicides that become residues on plants, in animals, or in the soil can contaminate air, surface water or groundwater. Herbicides that do not degrade to harmless chemicals are generally dropped from consideration during the development process or they are only approved for use in non-crop or non-forage applications.

Problems with herbicide applications can be avoided by:

- Reading, understanding and following herbicide label directions.
- Calibrating equipment properly.
- Evaluating site conditions and making appropriate adjustments to reduce the possibility of drift.
- Using the right herbicide for the target site and pest.
- Making the application during the right time in the pest's life cycle.

Nevada’s Noxious Weeds

A noxious weed is a plant that has been defined as a pest by law or regulation. This designation requires that land owners or occupiers control noxious weeds growing on their property. If a plant is found to be detrimental or destructive and difficult to control or eradicate, the Nevada Department of Agriculture can recommend to the state board of agriculture that the plant be designated as noxious. Nevada’s noxious weed list can be found at http://agri.nv.gov/Plant/Noxious_Weeds/Noxious_Weed_List/.


Plant Diseases in Agricultural Plants

There are six major principles of plant disease management:

- Exclusion
- Eradication
- Protection
Most plant disease management plans combine two or more control methods.

A disease is defined as any impairment of plant health or a condition of abnormal functioning.

Canker, rusts and smuts are all diseases caused by fungi.

- Resistance
- Therapy
- Avoidance

These six principles are discussed in detail in the General Knowledge: General Pest Problems section of this manual.

Successful plant disease management considers all of the potential control methods:

- Prevention
- Cultural controls
- Physical or mechanical controls
- Biological controls
- Chemical controls

Most plant disease management plans combine two or more control methods. Chemical control in agricultural plants can be achieved through seed treatments, soil treatments and/or treatment of growing plants.

Plant diseases manifest in a number of ways. A disease is defined as any impairment of plant health or a condition of abnormal functioning.

- **Rot** is decay or disintegration of plant tissue. It can be caused by hundreds of different bacteria or fungi.
- **Blight** is any plant disease that results in withering and killing of leaves, flowers and shoots.
- **Canker** is a disease of woody plants that causes localized damage to the bark of the plant. It can be caused by fungi or bacteria.
- **Gall** is an abnormal outgrowth of plant tissues. This disease can be caused by fungal or bacterial infection or insects.
- **Wilts** are plant diseases characterized by drooping and shriveling, usually caused by vascular pathogens, such as Fusarium.
- **Rusts** are plant diseases that produce reddish-brown pustules on leaves and stems. Rusts are caused by various rust fungi.
- **Smuts** are destructive diseases of plants, especially cereal grains, that produce black, powdery masses of spores. Smuts are caused by fungi.

Nevada cropland exceeds 600,000 acres. Crops include:

- Alfalfa hay and alfalfa seed
- Potatoes
- Small grains
- Onions and garlic
- Fruits and vegetables
Specific diseases related to each of these crops are discussed below.

**Alfalfa Hay and Alfalfa Seed**: Disease management in alfalfa hay production is largely based on cultural practices to reduce loss, such as variety selection and the use of certified weed-free seed. Many of the diseases mentioned below are favored when soils are heavy and poorly drained. Excessive soil moisture can allow soil-borne fungal or bacterial diseases to develop. Additionally, dodder and nematodes can cause damage to plants and may create entry sites for diseases. Some seed is treated with fungicides to control damping-off disease during seed germination and plant establishment. In many cases, adapted resistant alfalfa varieties are available to combat many of the major alfalfa plant diseases.

Alfalfa seed production is also complicated by dodder. Dodder seeds are similar in size and shape to alfalfa seeds, so producing weed-free seed can be difficult if dodder is present in the field.

**Alfalfa root diseases include:**

- **Phytophthora root rot**: The fungus causing this disease is present in the soil. The disease can build up in the soil. It occurs most often in soils with poor drainage or where water stands for an extended amount of time. It is common at the tail end of flood-irrigated fields, where water collects. Symptoms include stunting and yellowing of the above-ground portions of the alfalfa plants. The plants may wilt due to inadequate water uptake resulting from root damage. The roots may be brownish or dead. **Control**: Manage irrigation properly, level fields, rotate crops and plant resistant varieties.

- **Fusarium root and crown rot**: The disease occurs in most soils. Infection can become more severe in the presence of nematodes, which cause injury to the plant and provide an open wound for the infection to enter the plant via the roots. Mechanical injury by surface traffic can cause injury to the crowns, allowing the disease to enter. **Control**: Plant resistant varieties, maintain favorable growing conditions for the plants to reduce stress, reduce surface injury and control nematodes.

- **Bacterial wilt**: This bacterial disease occurs in most soil types, but is more common in cold climates. It can be severe in the presence of nematodes or other root-feeding insects that create entry sites for the disease. Symptoms are stunting of the plants and yellowish to brown discoloration inside the root. **Control**: Plant resistant varieties. Cultural practices that limit damage and maintain favorable growing conditions can limit the infestation. Control nematodes or other root-feeding insects.
- **Damping-off of seedlings**: Caused by several soil-borne fungi. This disease causes seedlings to rot at the soil surface. Seedlings that survive are stunted and yellowish. The fungi causing this disease can be transported by water, contaminated equipment and movement of infected plant materials. Disease is favored in cool temperatures, excessive moisture, low light or improper fertilization. **Control**: Plant during conditions that favor rapid germination and seedling growth. Control irrigation and fertilization. Use seed treated with fungicide to protect seedlings from damping off. As these diseases have a wide range of hosts, crop rotation is not an effective cultural control.

- **Nematodes**: These microscopic roundworms live in the soil and feed on alfalfa roots. They cause stunting of plants and/or galls on the roots. Infestation can be localized to a small area of the field or extensive throughout the field. Infestation by nematodes can increase the incidence of other diseases, as their feeding causes root damage, providing an entry point for disease. **Control**: Planting resistant varieties and rotating crops can aid in control. Pre-plant soil fumigation can be effective but is expensive. There are no non-fumigant nematicides currently registered for use on alfalfa.

**Alfalfa foliage diseases include:**

- **Common leafspot**: As the name implies, this fungal disease causes numerous small (1-3 mm), brown to black spots on infected leaves. The spots are roughly circular and the margins of the spots can be toothed or smooth. As the disease progresses, the leaves eventually become yellow and die. Infection of established plants is seldom fatal, but the disease can be fatal to seedlings. The disease is favored in cool to moderate temperatures and wet conditions. It can be a problem in the first and second cuttings. The pathogen overwinters in undecayed plant residue and germinates when moisture is present. The windblown spores can infect the lower leaves of the plants directly through the leaf cuticle. **Control**: Harvest the first cutting early to reduce the severity of the disease in the field over time. Some cultivars may be more resistant than others. Crop rotation and good sanitation can reduce the amount of fungal inoculum.

- **Spring blackstem**: This fungal disease affects both leaves and stems of alfalfa plants. It is a cool-season disease that overwinters in plant debris and is spread by water or infected plant materials. Symptoms are small black to brown spots on leaves and stems. The spots are irregular to triangular in shape. The affected leaves turn yellow and wither before falling off. The affected stems turn black near the base of the plant. Most damage occurs before the first cutting. **Control**: Plant resistant cultivars,
plant pathogen-free seed, cut early to reduce leaf loss. Good sanitation and crop rotation can reduce the amount of fungal inoculum.

- **Stemphylium leafspot**: This fungal disease is a cool-season foliar disease. Moist conditions favor infection and disease spread. Symptoms include irregularly shaped lesions on leaves that have tan centers with a darker border. Defoliation can occur, but generally only under very heavy disease pressure. The disease is spread by spores via water or wind. This disease is usually found in the first and second cuttings. **Control**: Early harvest is an option with severe infestations. Some cultivars may have more resistance than others, but seed companies do not commonly report resistance to this disease.

- **Downy mildew**: This is another fungal disease that favors cool, wet climate conditions. The upper surface of the leaves become lighter in color. Entire buds and leaves may become infected, becoming distorted and yellowing. Infected leaves can fall off the plant, reducing quality and quantity of the alfalfa. This disease is usually only a problem in the spring. Spring planted fields can be severely affected, as this is when the disease is most common and the field is in the seedling stage. Stand survival is usually not affected. **Control**: Early harvests can be used to reduce losses. Resistant cultivars are available.

- **Dodder**: Dodder is a parasitic plant that attaches to and eventually kills its host plant. The plant appears as a yellow, stringy mass on infected plants. In alfalfa fields it can be a real nuisance, since the seeds can remain viable in the soil for many years, sprouting and causing new infestations during multiple growing seasons when conditions are right. **Control**: Dodder reproduces from seed, so it is essential to prevent production of seed. Remove infested plants. For existing stands, preemergence herbicides may help control germinating dodder. Dodder seed can be spread by equipment and livestock. Use certified weed-free seed. Crop rotation using non-host plants, such as grasses, can interrupt the infestation cycle.

**Potatoes**: Potatoes are another important crop in Nevada. Potato varieties are generally chosen for agronomic characteristics, not disease resistance. All diseases discussed below can be managed by destroying cull piles as the final sanitation practice in the fall. This will reduce the source of spring inoculum of many potato diseases.

**Foliage diseases of potatoes**

- **Late Blight** is a fungal disease that is most severe during cool, clear weather. It occurs in fields with sprinkler irrigation systems where moisture levels are high. It first appears as small light to dark green water-soaked spots, often with a yellowed halo. Lesions enlarge
Destroying all cull piles as the final sanitation practice in the fall will help to control all the potato diseases discussed here.

- **Early Blight** is a fungal disease that occurs during high humidity conditions. Although it appears early in the season, it spreads later in the growing season and is a problem late in the growing season. Early blight also produces lesions on the leaves. The lesions form on the lower, oldest leaves first and have a bulls-eye or target pattern. As the lesions grow and coalesce, they are restricted by large leaf veins and may appear more angular. The disease appears to increase on plants that are stressed from poor nutrition, so higher rates of nitrogen may help control the disease. Irrigation in cool, cloudy periods or late in the evening when foliage may remain wet for extended periods should be avoided. **Control:** Some cultivars are more resistant than others. Foliar fungicide applications can be used to manage the disease.

- **Black Leg** is a bacterial disease that occurs on the stem and on the potato tubers. Stems infected with black leg usually have a black decay that begins at the underground seed piece. Leaves of infected plants often roll upwards, yellow and wilt. Plants are stunted and appear stiff before wilting and dying. Mechanical injury of plants by cultivation increases the incidence and severity of the disease. **Control:** Certified seed will significantly reduce the incidence of Black Leg. Seed treatment may also be required. Remove infected plants to limit the spread of the disease. Avoid injury during harvest and storage. No chemical control measures are available to date.

- **Calico Virus** in potatoes is caused by the same virus that causes alfalfa mosaic disease. Leaves may roll up and appear yellowed. Plants may appear stunted. **Control:** Aphids are vectors of this virus, so controlling aphids will help control the disease. Use certified seed, remove all infected plants immediately, control volunteer plants and destroy all cull piles. Avoid planting potatoes near alfalfa.

**Root and Tuber Diseases of Potatoes**

- **Verticillium Wilt** is a fungal disease that plugs the water-conducting tissues, causing premature yellowing and death of the foliage. Tan discoloration of the vascular tissues in cut stems of infected plants is common. This fungus invades through the root system, through root hairs and wounds. The wound can be the result of mechanical injury or rapidly and turn brown. The lesions are not restricted by leaf veins. **Control:** Some cultivars are more resistant than others. Crop rotation can reduce the incidence of the disease. Foliar fungicide applications can be used to manage the disease.
may be caused by insect or nematode injury. **Control:** Crop rotation (4-6 year cycle), planting resistant cultivars, controlling insects and nematodes and good sanitation will help control this disease. Soil fumigants can be used in infected fields.

- **Scab** is a fungal disease that results in corky lesions on the tuber that may be superficial or may cause deep pits. The scab disease can survive on decaying plant debris and can be spread by water or contaminated soil on equipment. The lesions are usually circular, but can coalesce in the later stages to form irregular shapes. A soil pH of 5.5 to 7.5 is most favorable to scab. Scab is most severe when tubers develop under warm, dry soil conditions, so avoid moisture stress during the 2 to 6 weeks following tuber formation. **Control:** Rotate crops, plant certified seed, treat seed, plant resistant cultivars and practice good sanitation.

- **Root Knot Nematode** causes stunted plants and rough, pebbly-appearing tubers. Additionally, the injuries these worms create provide a pathway for other diseases. **Control:** Certified seed, crop rotation, seed treatment and good sanitation will help control nematodes. At present, there are no nematode-resistant potato varieties available.

**Small Grains (wheat, barley, oats, sorghum, etc.):** Smuts are the major disease problem for small grains. Smuts are fungal diseases that are carried in the seed. Smut does not show up until the seed heads form. Diseased plants have darkened, discolored seed heads and are commonly stunted. **Control:** Certified seed, planting resistant cultivars and seed treatment will help control smuts.

**Onions and Garlic:** Onions and garlic are important crops produced in Nevada. The major disease problems are fungal diseases. Insects, nematodes and other pests that feed on onions and garlic can cause wounds that provide entry for the fungal diseases.

- **Botrytis neck rot** is a common fungal disease of onions and, to a lesser extent, garlic. The fungus causes considerable losses during field curing periods and during storage. White globe varieties of onions are very susceptible to the disease. The fungus persists on dead onion and garlic plant tissues for long periods and germinates in moist, cool weather. **Control:** Cultural practices will help limit the incidence of infection. Do not fertilize with excessive amounts of nitrogen, as this will delay maturity. Limit irrigation late in the season. Always allow time for adequate and proper curing. Store properly, ensuring low temperatures and humidity and good air circulation.
• **Pink Root** is a fungal disease that affects onions. As the name implies, the most striking symptom of this disease is pink roots. Roots eventually shrivel, turn black and die. The fungus is very common in the soil and can penetrate roots directly. No wound is necessary for an infection to occur. Stressed plants are more susceptible. The fungus can remain viable in the soil for long periods (10 years or more) and can be spread by water and by dirty equipment. Control: Prevention and control include use of resistant varieties, good soil tilth and fertility, control of other diseases and insects that will stress plants, good sanitation and cleaning equipment between fields. Crop rotation will reduce the incidence of infection, but will not eliminate it entirely. Pre-plant soil fumigation is effective for control.

• **White Rot** is a fungal disease that affects both onions and garlic. The leaves of infected plants start to decay at the base, yellowing, wilting and toppling over. The older leaves are affected first. The roots rot and plants are easily pulled from the soil. A fluffy white growth, the fungal mycelium, may be present on the remaining roots and the base of the bulbs. This fungus can remain viable in the soil for 20 years or more. The disease can be spread from field to field by flood water, on equipment or on plant material. Control: Avoidance and good sanitation are effective controls. Once a field is infected, chemical treatments are necessary to produce onion and garlic crops. Soil fumigation provides good control.

**Fruits and Vegetables:** Nevada grows fruit and vegetable crops, such as grapes, apples, pears, cantaloupe, tomatoes, squash and herbs.

• **Powdery Mildew** is a common problem on grapes. Symptoms are a powdery mycelium and spores on all foliage. Control: This fungal disease is best controlled with various copper and/or sulfur formulations.

• **Fire Blight** is a common problem in apple and pear production. It is a bacterial disease that is spread by pollinators and rain splash. It first appears in the blossom clusters as wilting and collapse of the cluster. Diseased tissue produces brownish, sticky exudates. The tips of the infected, young succulent growth shoots curve into a characteristic shepherd’s hook and appear to have been burnt. Warm, wet spring weather is ideal for disease development. Control: Remove diseased plant parts and prune to healthy wood. Dispose of infected plant materials. Use streptomycin or copper spray formulation during bloom to help prevent infestation.

• **Fusarium Wilt** is a fungal disease that can affect cantaloupe. It causes root rot and wilt as the plant develops, generally after fruit set. Plants
may develop a yellow runner on one side of the plant followed by rapid wilting of the infected runner. Other runners begin showing symptoms and the whole plant can collapse. In soils where the inoculum is high, seedlings may wilt. The disease is long-lived in soil and can remain viable for 20 years or more. Control: Good sanitation, planting resistant varieties and cleaning equipment between fields can help reduce the infestation. Seed treatment can also be effective for control.

- **Curly Top Virus** is a disease that affects tomatoes in Nevada. This disease is transmitted by leaf hoppers, which carry the disease for life. Leaf hoppers have a wide range of hosts. Plants with curly top stop growing and become stunted. The plants turn yellow or bronze in color and leaves may have a purple tinge. The plants become stiff and soon die. Leaf hoppers tend to feed on the plants that border bare soil areas, so the edges of the field are most susceptible. Control: Dusting transplants as soon as they are set out and as new foliage appears, until fruit set, will discourage leaf hoppers. Talc, diatomaceous earth or finely ground pumice are equally effective. There are no curly top resistant varieties of tomato to date.

**Vertebrate Pests in Agricultural Plants**

Vertebrate pests are those pest animals that have backbones. Specific control measures vary for different species and are discussed in the sections for individual species.

**Common vertebrate pest control practices**

- **Exclusion:** Keep the pest out or away from crops by using barriers, such as fencing and row covers.

- **Sanitation:** Eliminate food and water sources. Store food and animal feeds, grain and seed in rodent-proof containers. Repair leaky pipes.

- **Trapping:** There are several types of kill traps and live traps available for most vertebrate pest species. Choosing the proper trap and learning the correct way to use it is critically important. **Live trapping and releasing is not acceptable or legal.** Individuals who release live trapped animals are moving the pest problem and sometimes diseases like rabies, distemper or plague along with them. Live trapping followed by an approved method of euthanasia is recommended. The American Veterinary Medical Association has specific guidelines for euthanasia.

- **Repellents:** Repellents may be applied to valuable vegetation or can be used in areas where pests are known to frequent. They often don’t work the way people expect them to work. Sunshine can break down the
repellent, and sprinklers and rain can wash away the product. New growth on plants must be retreated and animals may simply get used to the repellent.

- **Rodenticide Baits:** Baits like seeds, grains and vegetation treated with rodenticides are used to control several types of vertebrate pests. Most baits must be applied in bait stations or underground within animal burrows to lessen the risk of killing of non-target species. Pesticide labels describe methods for applying the bait. Pesticides used include strychnine, zinc phosphide and various anticoagulants. **Strychnine may only be applied underground.**

- **Fumigants:** Smoke bombs and internal combustion engines produce poison gases, including carbon monoxide, that can be used as fumigants. To be effective, all burrow entrances must be blocked. When using smoke bombs, avoid areas near structures, hay stacks, etc.

  Aluminum phosphide fumigants are available either as tablets or pellets. When applied in rodent burrows, they produce phosphine gas, which is deadly. Applied improperly, aluminum phosphide has resulted in numerous human deaths. To purchase, apply or supervise the use of this pesticide, applicators must successfully pass the state rodent burrow fumigation certification category.

**Specific Vertebrate Pests**

- **Ground Squirrels:** Four species cause problems to crops and ornamental plants in Nevada: Richardson’s, Belding’s, Townsend’s and California ground squirrels. They may also damage irrigation lines by chewing them or damage landscapes and buildings by burrowing. The best time for control is after they emerge from hibernation in early spring. At this time of year, there is little green vegetation, so the ground squirrels are more likely to accept rodenticide baits. Additionally, at this time of year, they have not yet mated and given birth. If control is postponed until later in the spring, there is green vegetation available and the ground squirrels are less likely to accept rodenticide baits. Advanced planning and preparation are essential. Attempting to control squirrels after they have reproduced can be frustrating, expensive and practically impossible. In order to eliminate exposure to non-target species, product labels for some rodenticide baits require application in bait boxes. Live trapping and subsequent euthanasia are also used to control ground squirrels. Check traps often and use caution to prevent unintended injury or death to non-target species. Strychnine cabbage bait, a restricted use pesticide, is well accepted but it must be used underground to protect non-target species. When applying grain baits, pesticide labels advise users to pre-
bait. This is the process of applying untreated grain and monitoring to see if the animal takes it. If the animal isn’t taking the untreated bait, it won’t take the treated bait. As these animals can be carriers of bubonic plague, use care in handling sick or dead animals.

- **Moles**: Moles are insectivorous and are not a serious problem in Nevada. They eat soil-dwelling insects as well as other invertebrates like worms. Often found in urban areas, moles cause damage by building shallow surface tunnels that dislodge plants or push up turf. Trapping controls moles. Soil insecticides may be used to reduce the mole’s food supply. This may encourage them to move off a property.

- **Pocket Gophers**: Pocket gophers live underground and damage crops and ornamental plants by feeding on roots and sometimes foliage. Their burrows also cause damage to farm equipment and sprinkler systems. Gopher activity is determined by fresh mounds that are typically horseshoe-shaped. Burrows are four to 10 inches underground. Strychnine grain bait, a restricted use pesticide, is most effectively applied in fall or early spring. The bait must be applied below ground. Hand-apply or use in a burrow builder for large areas. Synchronize application with neighbors for best results. Anticoagulant and zinc phosphide baits are also available. Trapping with kill traps is another commonly used control method for pocket gophers.

- **Mice and rats**: These rodents eat and contaminate food and animal feed. They will both defecate and urinate on food and feed. They feed on alfalfa crowns and damage forage, seed and ornamental plants by girdling. They also cause structural damage by chewing both wood and wiring. They carry diseases contagious to humans, such as Rickettsial pox, bubonic plague and leptospirosis. **No control method will be successful without excluding subsequent mice and rats from entering the site.** Seal any opening over ¼-inch. Use good sanitation practices to remove any food supply that may attract these rodents, including seed for planting. Use rodent-proof containers to store all food and animal feed to prevent attracting and feeding these pests. Anticoagulant baits are most commonly used. Use care in placing these anticoagulant baits. Pesticide baits must be applied in approved bait stations. Snap traps can be effective, provided exclusion measures are also put in place. Baits for trapping include peanut butter plus oatmeal, bacon, gumdrops (for mice), nutmeats and dried fruit. Rat and mouse urine fluoresces under UV light. This can be used to locate their trails and commonly frequented areas. Bait and trap in these areas. Check traps daily and use care handling dead rodents.
- **Voles**: Voles are also referred to as meadow mice or field mice. They eat a wide variety of plants including grasses, forbs and seeds. When populations are high, voles will damage cropland through construction of tunnels and surface runways. They eat bark, primarily in the fall and winter. This can cause severe damage to trees and shrubs by girdling them. Voles breed throughout the year and may have five or more litters of young annually. Populations fluctuate and may reach extremely high densities. Habitat modification and toxicants are the primary means of vole management. Remove ground cover, weeds and litter around croplands to reduce populations. Zinc phosphide is the most common rodenticide used for vole control and is available on grain bait. Pesticide labels require that zinc phosphide baits be applied in the burrows and runways. Some product labels require the use of bait stations.

- **Blacktailed Jackrabbits**: Jackrabbits cause damage by feeding on crops and ornamental plants. A 45-degree angle cut to stems or branches is typical of rabbit damage. Jackrabbits don’t hibernate, so they are active all year long. They have cyclic populations. They will travel long distances for food. The best control is exclusion. Jackrabbits are not easily trapped. Since they generally come in from surrounding rangeland, trapping and removing one simply allows another to take its place. Exclusion fences are recommended around haystags, small areas, ornamentals and gardens. Shooting is an option as blacktailed jackrabbits are not protected, but it must be done only where it is safe and legal to do so. Repellents can be effective, but must be reapplied on a regular basis and especially after rain or irrigation water wash them away. There are no registered poisons or fumigants for use on rabbits in Nevada. Strychnine (a restricted use pesticide) is no longer registered for jackrabbit control.

- **Cottontail rabbits and whitetailed jackrabbits**: Cottontail rabbits and whitetailed jackrabbits are usually considered pests in the landscape. Control is similar to that for blacktailed jackrabbits. Exclusion is the best control option. While they can be trapped, trapping is not the best control method, and there are no toxicants registered in Nevada for control of either of these rabbits. The information provided for jackrabbits applies to both of these rabbits as well, with one exception: cottontail rabbits and whitetailed jackrabbits are game species in Nevada. Since they are designated game species, they can be shot only during cottontail rabbit and/or whitetailed jackrabbit hunting season, and you must have a hunting license.
• **Birds:** Droppings, disease and consumption of crops and livestock feeds all make pests of certain birds. Caution must be used when dealing with bird pests, as many birds are protected under the Migratory Bird Treaty Act (MBTA). As with all other pests, you must first identify the pest causing your problems. The following common bird pests are not protected by the MBTA:

  o **Pigeons (Rock doves):** Pigeons were introduced to the U.S. as domesticated birds and are now found throughout the country. They depend on human activities to provide them with food and shelter and have become serious pests in agricultural and urban areas. Pigeons feed on grains, seeds and garbage, and food is regularly provided intentionally by humans. Other damage results from pigeon fecal material and filth in areas where they nest, roost and loaf. Pigeons assemble sticks and twigs to form crude nests that are built in or on buildings and other structures such as billboards. Breeding occurs year-round but peak reproduction is in the spring and fall.

  o **House Sparrows:** House sparrows were introduced to New England in 1850 and spread throughout the North American continent. They prefer human habitats, especially urban and farm areas. House sparrows feed mainly on grains and seeds but garbage and other refuse contribute significantly to their diet. Breeding can occur any time but March through August is most common. Problems are caused by feeding activities and fecal contamination in feed storage areas as well as inside and outside of other buildings.

  o **European Starlings:** These birds were introduced to North America in the late 1800’s. Starlings cause problems at livestock facilities and in urban areas by consuming fruits and livestock feed. Holes or cavities in trees and structures serve as nesting sites and large roosts in buildings and trees cause health concerns and other problems due to filth, noise, and odor.

**Bird Management:** Exclude birds from nesting sites by closing openings that are larger than ¾ inch. Eliminate access to nesting and roosting sites by installing barriers, such as metal, netting or needle strips (porcupine wire). Roosting sites, such as ledges, can be eliminated by changing the angle to 45° or more. To discourage birds, use tactile repellents such as sticky bird glue on ledges and roosting areas. Recreational bird feeding attracts pest species. Limit the availability of food by storing livestock and other food in bird-proof facilities and containers. Prevent access to water sources.

Pesticides used for bird control are called avicides. These products are applied on baits and are classified as restricted use pesticides. Bait material
may include small grains and whole kernel corn, depending on the bird species. The process of pre-baiting is recommended on avicide labels.

Conclusion

Category 1A, Agricultural Pest Control – Plants, is the category that covers pesticide applications on crops. This includes fruit and vegetable crops, small grain crops, feed crops and forage crops.

The growth of a single type of plant, also known as a monoculture, can provide an ideal setting for diseases, weeds and animal pests to develop and thrive. Pesticides are often needed to reduce pests to tolerable levels, but they can have serious consequences if applied improperly. Pesticides can harm non-target plants, beneficial insects, wildlife, pets, livestock and humans. Thoughtful planning and implementation are required to reduce pest pressure, minimize unintended damage, reduce costs and maximize profit.

The first step in pest control is to correctly identify the pest. It is imperative to determine that the damage you see was actually caused by a pest.

Consider all control options for managing the pest. Keep records of your management efforts and their success.

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