EC301
April 2019

# Bee Aware

*Protecting Pollinators from Pesticides*

**Erin C. Bauer, Entomology Lecturer**
**Clyde L. Ogg, Extension Pesticide Educator**
**Frederick P. Baxendale, Emeritus Extension Entomologist**
**Jan R. Hygnstrom, Project Manager**

Honey bees (*Apis mellifera*) and other bee species such as bumblebees, orchard mason bees, and leafcutter bees are very important to the pollination of flowers and crops, and can be found foraging on numerous plants in the spring through late summer and early fall. In addition to bees, important pollinators can include butterflies, moths, flies, hummingbirds, and some bats.

Approximately 3,500 species of bees live in North America. Bees are valuable pollinators of 95 crops grown in the United States. Crops pollinated by bees have a farm value of nearly $20 billion annually in the U.S. Honey bee colonies also contribute to our agricultural economy by producing over $200 million in honey annually.

This publication focuses on the honey bee, the most important pollinator in the Midwest, because it can:

- be managed by beekeepers,
- be transported,
- be managed for income from both honey production and pollination,
- be maintained in large populations throughout the growing season, and
- visit and pollinate many plant species.

Honey bees (*Figure 1*) are hairy, yellow, and black or brown banded social insects that are about 1/2 inch long on average and live in hives. Each individual has distinct duties, either as a worker (serving as a nursemaid, housekeeper, or forager) or a reproductive bee (drone or queen).

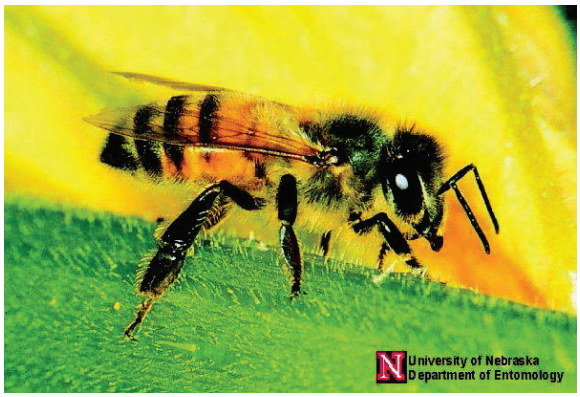


Figure 1. Honeybee

Maintenance of the hive relies on the distributed work within the colony. For example, foragers (usually older worker bees) search for food resources (pollen and nectar) and communicate this to the colony. Because the health of the hive and successful crop pollination rely on the foraging activities of worker honey bees, it is essential to protect these insects from potentially harmful pesticide exposure.

Protecting pollinators is an important consideration when applying pesticides to control crop pests. Pesticides such as insecticides, fungicides, and miticides may be toxic to bees. Insecticides are formulated to kill insects, fungicides kill fungi that cause some plant diseases, and miticides kill mites. Pesticide labels may carry specific statements to protect bees and should be read carefully prior to pesticide application. In 2013, the Environmental Protection Agency

(EPA) introduced the Bee Advisory Box (*Figure 2*) on labels of pesticides, such as neonicotinoids, that pose a high risk to bees. The goal is to provide clearer and more precise directions to protect bees. The loss of native pollinators due to habitat reduction, and the decline in honey bee colonies due to parasitic bee mites, diseases, and other factors reinforce the need to protect these insects through good pesticide stewardship. While this publication focuses on protecting honey bees, many of the recommendations serve to protect other bee and pollinator species as well.

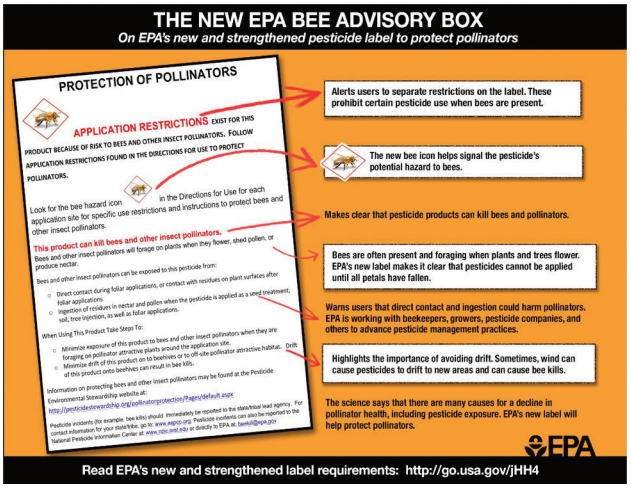


Figure 2. EPA developed the Bee Advisory Box for pesticide labels with a high risk to pollinators to provide clearer information on safer applications.

## Considerations for Pollinator Protection

### *Plant Growth Stage*

Most honey bee poisonings happen when pesticides are applied to flowering crops (e.g., apples, melons, soybeans) or are allowed to drift onto flowering plants (e.g., weeds and wildflowers) during periods when bees are actively foraging. If applications are permitted by the label, growers and applicators need to communicate with beekeepers and exercise all reasonable measures to minimize the risks to bees.

### *Relative Toxicity of the Chemical*

Pesticides vary in their toxicity to honey bees. Most fungicides and herbicides (pesticides that kill weeds) have relatively low toxicities to honey bees and can be used without endangering them. In addition, certain insecticides and miticides are not hazardous to bees and can be applied with little risk of bee injury. For example, *Bacillus thuringiensis* (*Bt*), a biological insecticide derived from a soil-dwelling bacterium, is not toxic to bees. However, insecticides such as pyrethroids that are more toxic to bees can only be applied when bees are not actively foraging; bees exposed during the application may be killed. Pesticides that are highly toxic to honey bees cannot be applied to flowering crops when bees are present without causing serious injury or death. Bee toxicity data for selected pesticides are listed in *Table 1*. Lethal dose ($LD_{50}$, the amount of a substance that will kill 50% of a population) and relative toxicity ratings are provided for each active ingredient (AI). Use the table to compare toxicities within and between broad pesticide types (i.e. fungicides, insecticides, herbicides, miticides), but understand that these pesticide types can vary in their toxicity to bees. Also, recognize that toxicity does not indicate the exposure a bee is likely to receive, but rather how much of an AI it takes to kill a bee. Realize that toxicity is only one factor when considering hazards to bees. Exposure time and dosage, application rate, and formulation all contribute toward overall risk or hazard of using an active ingredient. A good way to think about risk is with the risk formula:

RISK = TOXICITY x EXPOSURE

Always read and follow the label for the product you are using. It will provide guidance about toxicity to bees and how you can reduce the risk of exposure during application.

### *Choice of Formulation*

Different formulations of the same pesticide often vary considerably in their toxicity to bees. Granular (G) pesticides are generally less hazardous to honey bees than other formulations. Dust (D) formulations, though uncommon, are usually more hazardous than emulsifiable concentrates (EC) because they adhere to the bee's body hairs and are carried back to the beehive. Wettable powder (WP) and flowable (F) formulations dry after application to a dustlike material that can be transferred to foraging pollinators. Likewise, microencapsulated (M) formulations also can be transferred to bees along with pollen and brought back to the colony. Since bees are highly social and hives can be crowded, substances picked up in the field can be spread within a hive. Exposure to pesticide formulations can cause significant losses of both foraging bees and bees in the hive. In severe cases, pesticides may remain active in the hive for several months and prevent colonies from recovering.

### *Using Treated Seed*

Pesticides added as a protective coating to seeds can become dislodged during handling and/or planting. Graphite and talc used to lubricate seeds during planting can carry these residues to nontarget locations. Before handling or planting treated seed, take precautions to reduce the risk of pesticide residues or planter talcs drifting or moving offsite

**Table 1. Selected representative trade names, pesticide AIs, bee toxicities, toxicity ratings, and pesticide types.[1]**

| Representative Trade Names | Pesticide Active Ingredient (AI) | Bee Toxicity ($LD_{50}$ as µg/bee) | Toxicity Rating | Pesticide Type |
|---|---|---|---|---|
| **Gaucho** | Imidacloprid | 0.0039 | Highly toxic | I |
| **Cruiser Platinum** | Thiamethoxam | 0.005 | Highly toxic | F |
| **Lorsban Vulcan Nufos 4E** | Chlorpyrifos | 0.01 | Highly toxic | I |
| **Brigade Capture** | Bifenthrin | 0.0146 | Highly toxic | I |
| **Ambush Pounce** | Permethrin | 0.024 | Highly toxic | I |
| **Aztec** | Cyfluthrin | 0.037 | Highly toxic | I |
| **Dimethoate** | Dimethoate | 0.056 | Highly toxic | I |
| **Avid Zoro** | Abamectin | 0.41 | Highly toxic | M |
| **Carbaryl Sevin** | Carbaryl | 1 | Highly toxic | I |
| **Acramite** | Bifenazate | 7.8 | Moderately toxic | M |
| **Captan** | Captan | 10 | Moderately toxic | F |
| **Javelin Dipel** | *Bacillus thuringiensis* | 23.2 | Relatively nontoxic | I |
| **Tilt Bumper Fitness** | Propiconazole | 25 | Relatively nontoxic | F |
| **Quilt** | Propiconazole + Azoxystrobin | 25<br>200 | Relatively nontoxic | F |
| **Atrazine AAtrex** | Atrazine | 97 | Relatively nontoxic | H |
| **Headline** | Pyraclostrobin | 100 | Relatively nontoxic | F |
| **Kanemite Shuttle** | Acequinocyl | 100 | Relatively nontoxic | M |
| **2,4-D Ester** | 2,4D 2EHE | 100 | Relatively nontoxic | H |
| **Roundup** | Glyphosate | 100 | Relatively nontoxic | H |
| **Parallel Stalwart** | Metolachlor | 110 | Relatively nontoxic | H |
| **Stratego** | Trifloxystrobin + Propiconazole | 200<br>25 | Relatively nontoxic | F |
| **Quadris Dynasty** | Azoxystrobin | 200 | Relatively nontoxic | F |

[1]The USDA Windows Pesticide Screening Tool (Win-PST) is an environmental risk screening tool that includes bee toxicity data available for each active ingredient in the database. The tool is available for download from http://go.usa.gov/Kok.

onto flowering plants where bees may be foraging. For example, if you intend to plant treated corn seed with a pneumatic planter, a burndown herbicide should be used to eliminate henbit from the site prior to planting. This will prevent planter talc from settling on the henbit, which is usually blooming at corn planting time and may be visited by bees.

## *Residual Action*

Residual activity of a pesticide is an important factor in determining its safety to pollinators. Pesticides that degrade within a few hours usually can be applied with minimal risk during times when bees are not actively foraging. Some pesticides have extended residual activity, longer than eight hours after application. So, even if bees aren't actively foraging, they still may be injured if they visit the crop during the period of residual activity. Pesticides with extended residual activity require extra precaution to prevent bee exposure. Look for clues about the residual activity of an individual pesticide on the product label. For example, restricted entry intervals greater than 12 hours indicate extended residual activity.

To help applicators choose pesticides that are safer for honeybees, EPA developed a table using data on the residual time that results in 25% honey bee mortality ($RT_{25}$). This is the time it takes for a specific pesticide residue on foliage to cause 25% of a sample honey bee population to die after exposure. If the $RT_{25}$ is 8 hours, it means that 8 hours after application, residue on foliage will cause 25% bee mortality; for this pesticide, bees exposed less than 8 hours after the application will have a higher mortality. As more time passes, the mortality percentage decreases, meaning the residue is less toxic. Information in the table was compiled from registrant-submitted data based on the study *Honeybee Toxicity of Residues on Foliage*. This looks at the length of time over which foliar residues remain toxic to honey bees in field conditions.

An applicator can use the $RT_{25}$ table to compare effects of different active ingredients at various concentrations on

bees. When possible, select an active ingredient that is less harmful to bees (a lower $RT_{25}$ value). Know that $RT_{25}$ values are based on numerous factors, including application rate, physical-chemical properties, dissipation, crop, and pesticide formulation. $RT_{25}$ values may vary within a single formulation, between formulations, between crops, and across application rates. EPA plans to update this table as more data become available: *https://www.epa.gov/pollinator-protection/residual-time-25-bee-mortality-rt25-data*

### *Drift*

Bees may forage in areas adjacent to the target crop. Pesticides that drift from the target crop onto nearby flowering plants can cause significant bee poisoning. In general, sprays should not be applied if wind speed exceeds 10 mph or is blowing toward adjacent flowering plants. When evaluating potential drift hazards, focus on reducing the risk of drift to nearby flowering plants.

### *Temperature*

Temperature affects the activity of cold-blooded animals, such as bees; it also has an effect on pesticides, and can affect when or how bees are exposed to pesticides. Bees are most actively foraging during periods of high temperature and sunlight. Also realize that some pesticides vaporize during these times, thereby increasing potential for bee injury. Making pesticide applications during periods of cooler temperatures and low light or overcast conditions will minimize exposure to bees. Always be aware of temperature fluctuations and use common sense before applying pesticides that are toxic to bees.

### *Distance from Treated Areas*

Honey bee mortality due to pesticides usually decreases the farther away colonies are from treated areas (i.e., crops, turf, etc.). Most foraging activity occurs within one to two miles of the hive. However, during periods of nectar or pollen shortage, honey bees forage at greater distances, and colonies up to five miles from the treated area can be injured.

### *Time of Application*

Application timing is related to all the previously mentioned factors, but the most critical one is to control pests either prior to crop flowering or after flowering is complete. This will greatly reduce the risk of pollinators being exposed to pesticides. If pesticides must be applied to flowering plants, use pesticides with short residuals in the evening when the temperatures are below 60°F. This can greatly reduce the potential for honey bee injury.

### *Communication and Cooperation*

Reducing pesticide injury to honey bees requires communication and cooperation among beekeepers, growers, and pesticide applicators. Beekeepers should understand the cropping and pest management practices that growers use near their apiaries. Likewise, pesticide applicators should be aware of apiary locations, have a basic under standing of honey bee behavior, and know which materials and application practices are the most hazardous to bees. It is unlikely that all bee poisonings can be avoided, but in most cases, bee losses can be reduced by under standing the hazards and maintaining effective communication.

## How Growers and Applicators Can Reduce Risks of Honey Bee Injury

**Understand the risks.** Many crop pests can be controlled without endangering bees. Attend crop pest management training sessions to learn the latest about crop pests and control measures used by growers and applicators.

**Do not treat flowering plants**. Be especially careful when treating crops such as alfalfa, sunflowers, and canola, which are highly attractive to bees. Pesticide labels carry warning statements and sometimes prohibit application during bloom. Always read and follow the label.

**Examine fields before spraying to determine if bees are foraging on flowering weeds.** Milkweed, smartweed, henbit, and dandelion are examples of weeds that are highly attractive to honey bees. Milkweed is the only food source for monarch butterfly larvae, which are declining in numbers.

Figure 3. Partridge pea planted in an uncultivated area serves as bee forage.

Consider leaving milkweed alone. For other flowering weeds and where feasible, consider eliminating them by mowing or cultivating prior to pesticide application or planting.

While bright and colorful flowers are highly attractive to bees, some plants with inconspicuous blossoms such as dock, lambsquarter, and ragweed are also visited. Therefore, when you examine areas for flowering plants, consider all plants that have flowers. Be aware that many plants only produce pollen and nectar for a few hours each day. Fields should be scouted for honey bees at the same time of day as the anticipated pesticide application.

**Maintain forage areas for bees.** Intensive agriculture often increases bee dependence on cultivated crops for forage. Establishing plants in wild or uncultivated areas for honey bees to forage will reduce bee dependence on crop plants that may require pesticide treatments. Plants recommended for uncultivated areas include sweet clover, white Dutch clover, alfalfa, purple vetch, birdsfoot trefoil, and partridge pea (*Figure 3*). Many trees and shrubs are beneficial to bees as well. The most attractive species include linden, black locust, honey locust, Russian olive, wild plum, elderberry, red maple, willow, and honeysuckle. However, when establishing foraging areas with trees and shrubs, avoid planting honey locust, Russian olive, or honeysuckle. Although attractive to honey bees, these species can become invasive and outcompete native plant species. Soil conservation, natural resources, and game managers usually are eager to help establish plantings that benefit honey bees because these areas also conserve soil and provide valuable habitat for plant and wildlife conservation programs. These individuals can be a good resource for selecting trees that are both attractive to bees and healthy for the environment.

**Avoid spray drift.** Give careful attention to the location of flowering crops and weeds relative to wind speed and direction. Changing spray nozzles or reducing pressure as allowed by the label can increase droplet size and reduce spray drift.

**Apply pesticides when bees are not foraging.** In general, bees are foraging more actively during the sunniest and warmest times of the day. Therefore, some pesticides can be applied in late evening or early morning (i.e. from 8 p.m. to 6 a.m.) with relative safety. Be aware that temperature inversions may occur during these times, however. In addition, the species of plant that is blooming may guide you in the best time to apply pesticides. For example, with the partridge pea, bees work heavily on it in the morning, but by early afternoon the field will go quiet because the nectar stops flowing about that time of day.

Although bees don't prefer corn pollen and it has limited nutritive value, they may collect pollen from tassels in the early morning but are not present in the afternoon or evening. Short-residual materials applied from late afternoon

Figure 4. Notify beekeepers when you will be applying a product that is toxic to bees.

until midnight pose less bee hazard in corn fields if flowering weeds are not present.

**Adjust spray programs in relation to weather conditions.** Reconsider the timing of a pesticide application if unusually low temperatures are expected. Cool temperatures can delay pesticide degradation and cause residues to remain toxic to bees the following day. Stop applications when temperatures rise and when bees re-enter the area in early morning. Similarly, do not apply during evening hours if temperatures are unusually high and bees are still foraging.

**Contact local beekeepers and obtain locations of**

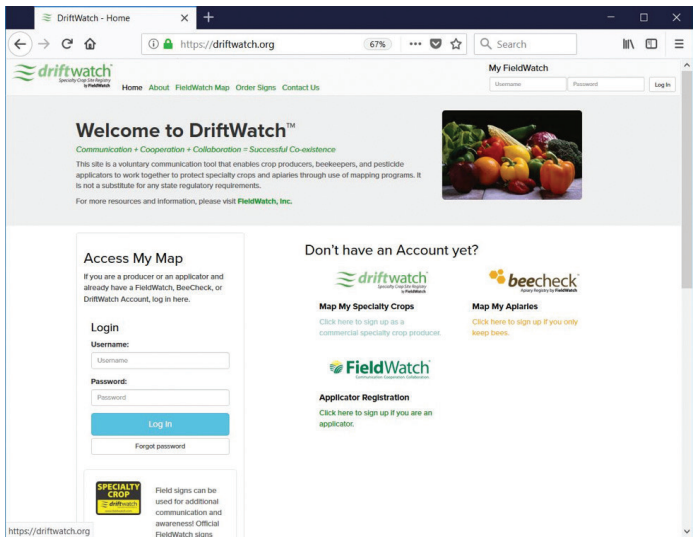


Figure 5. DriftWatch and BeeCheck encourage commercial producers to register locations of beehives.

**beehives.** If colonies are present in an area where you will be applying a product that is toxic to bees, you should contact beekeepers (*Figure 4*) within 48 hours so they have time to protect or move the colonies. Many pesticide applications

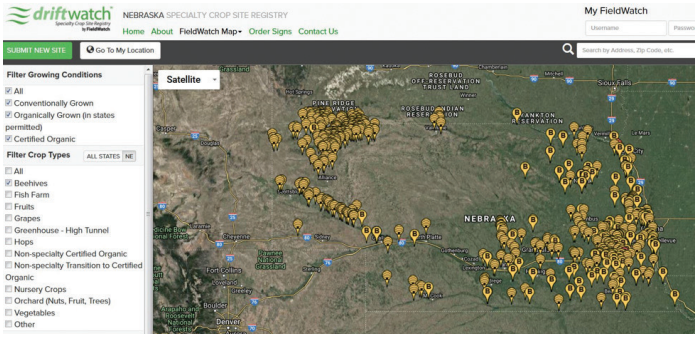


Figure 6. Locations of registered hives along with contact information are available through DriftWatch.

pose minimal risk to bees, and beekeepers may choose to accept some risk rather than move colonies. Notify beekeepers as far in advance as possible.

**Use DriftWatch.** The Nebraska Department of Agriculture (NDA) subscribes to a web-based locator for sensitive commercial crops and beehives (*Figure 5*). The site consists of three programs: DriftWatch, for those who raise sensitive crops (organic, grapes, bees, etc.); BeeCheck, where beekeepers can register just hives; and FieldWatch, where pesticide applicators register to receive notification of new crops as they are registered in BeeCheck and DriftWatch. These three programs all fall under the name of DriftWatch, the original program. The site is not intended for homeowners or sites less than 1/2 acre. This site can be accessed at *http://www.driftwatch.org*. Beekeepers are encouraged to register the locations of their hives, and pesticide applicators are encouraged to use this website to determine if any beehives are located near a planned pesticide application site (*Figure 6*). Many beekeepers have provided their contact information on DriftWatch, making personal communication much easier. If beehives are present, pesticide application procedures, including timing and/or application methods, should be adjusted accordingly.

Beekeepers, crop producers, and applicators are encouraged to access DriftWatch and document known beehive locations in application records, or print a map from the website and incorporate it into application records. It is also good practice to scout the area prior to a planned pesticide application to become familiar with the landscape. Because listings on DriftWatch are voluntary, not all apiary locations may be included. DriftWatch is only as effective as the information provided by beekeepers and the action taken by applicators. New or updated information should be submitted as soon as possible. Good communication is the key to avoiding pesticide injury to honey bees. To view video segments about DriftWatch and bees/pollinators, visit the Nebraska Extension PSEP YouTube channel, listed in the Resources section of this publication.

**Read the pesticide label.** Carefully follow listed restrictions and/or precautions with regard to bee safety.

Figure 7. Hives shouldn't be placed near crops likely to be sprayed with pesticides.

## Steps Beekeepers Can Take to Protect Their Colonies

**Choose low-hazard apiary locations**. Do not place beehives adjacent to crops likely to be sprayed with a pesticide (*Figure 7*).

**Know the risks.** Many crop pests can be controlled without endangering bees. Attend crop pest management training sessions to learn the latest about crop pests and control measures used by growers and applicators. These sessions also provide an opportunity to establish communication links with growers and pesticide applicators.

**Maintain positive working relationships with applicators.** Risk management decisions can best be made when both parties understand each other's needs. Establish a communication link prior to the spray season rather than during peak activity periods when all parties are busy.

**Use DriftWatch.** As mentioned earlier, register the location of your hives on DriftWatch or BeeCheck. Applicators will be able to search for such locations and communicate with you before applying pesticides near your beehives.

**Be prepared to protect colonies if necessary.** If pest control measures that carry unacceptable risks are necessary, know the options for protecting your colonies and be prepared to implement them. Options for protecting bees include:

1. When products with short residual activity are to be applied, briefly confine bees to their hive with wet burlap. This measure is only feasible if a small number of colonies are involved and if the confinement period is brief and early in the morning. *Caution! This measure can result in the colony overheating and should be used with care. Fine mesh moving nets are also available and can be purchased by beekeepers if the need arises.*
2. Temporarily reduce forage activity by removing colony covers and offsetting boxes. Most honey bees will remain in the hive to protect their supply and to maintain temperature and humidity in the exposed hive. After a few hours to one day, colonies will adjust to the change and resume foraging. This approach is safer than confining colonies but is not recommended if bees are located in or adjacent to areas that will be treated.
3. When highly toxic products with extended residual activity are applied to flowering crops, move honey bees to another location at least four miles from the treated area. Moving populous colonies during hot weather can result in considerable bee mortality and should be avoided if possible. Moves should be made early in the morning or evening when temperatures are cool and the bees are the least active. In general, moving colonies isn't practical for most beekeepers. It requires that hives be kept on pallets and moved using a forklift. Migratory beekeepers may be some of the few with such equipment.

**Report colony injury.** Beekeepers are often reluctant to report bee injury incidents for a number of reasons, one of which is because they may be relying on the landowner/applicator to provide a place to put their hives. However, EPA cannot adequately evaluate product use and risk assessment without bee injury incident information. The best way for EPA to collect this necessary information is through an incident reporting form, available at *http://pi.ace.orst.edu/erep/*.

## Final Thoughts

Many ways are available to reduce bee poisoning. Often, severe losses can be avoided by relatively simple modifications of pest control programs. Talk with other growers and applicators about how to reduce bee injury and consult reference materials, such as this publication, on protecting honey bees.

With good environmental stewardship, you can help protect the bees that are essential pollinators for Nebraska crops. Applicators and beekeepers should work together to ensure successful pest control while reducing the risks to honey bees. This includes registering beehives on DriftWatch or BeeCheck, having a good communication network, using pesticides that are least toxic to bees, and timing applications when bees are not actively foraging. Bees are a valuable agricultural resource that are worthy of our respect and protection.

## Resources

DriftWatch: *http://www.driftwatch.org*

Nebraska Extension PSEP YouTube Channel: *http://www.youtube.com/user/UNLExtensionPSEP*

## Disclaimer

Reference to commercial products or trade names is made with the understanding that no discrimination is intended of those not mentioned and no endorsement by Nebraska Extension is implied for those mentioned.

This publication has been peer reviewed.
Nebraska Extension publications are available online at http://extension.unl.edu/publications.

Extension is a Division of the Institute of Agriculture and Natural Resources at the University of Nebraska–Lincoln cooperating with the Counties and the United States Department of Agriculture.

Nebraska Extension educational programs abide with the nondiscrimination policies of the University of Nebraska–Lincoln and the United States Department of Agriculture.