

# **Integrated Pest Management**

## **PRACTICAL WEED SCIENCE FOR THE FIELD SCOUT Corn and Soybean**

Plant Protection Programs  
*College of Agriculture, Food  
and Natural Resources*

This publication is part of a series of IPM Manuals prepared by the Plant Protection Programs of the University of Missouri. Topics covered in the series include an introduction to scouting, weed identification and management, plant diseases, and insects of field and horticultural crops. These IPM Manuals are available from MU Extension at the following address:

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**1-800-292-0969**

### Authors

Kevin W. Bradley  
Division of Plant Sciences  
University of Missouri-Columbia

Bill Johnson  
Department of Botany and Plant Pathology  
Purdue University

Reid Smeda  
Division of Plant Sciences  
University of Missouri-Columbia

Chris Boerboom  
Department of Agronomy  
University of Wisconsin

### On the cover

Common waterhemp seedling; common waterhemp in cornfield

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Dale Langford, editor  
Dennis Murphy, designer and illustrator

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This publication is intended to serve as a practical reference and educational tool to be used in scouting corn and soybean fields for the presence of weeds, identifying whether a rescue treatment is necessary, and determining crop response to herbicide activity. This publication consists of two main sections. The first section includes information on weed identification, scouting and mapping procedures, and a discussion of economic thresholds for weeds. An identification key and color photographs of weeds common to Missouri are also included. The second section includes information on diagnosing herbicide injury. It discusses the various causes and conditions contributing to herbicide injury. It also includes a key to help determine which herbicide family might have caused the injury symptoms, and color photos of herbicide injury caused by various herbicide families.

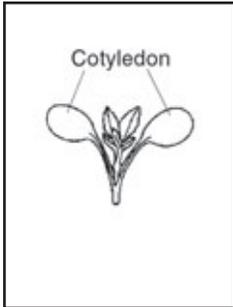


Figure 1. Cotyledons.

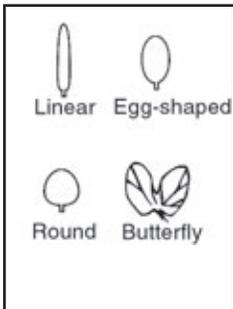


Figure 2. Variations of cotyledon shape.

## PRINCIPLES of WEED IDENTIFICATION

Weeds can be classified into three primary categories: broadleaves (dicots), grasses (monocots), and sedges. To identify broadleaf seedlings, it is common to look first at the cotyledons or seed leaves. The cotyledons are the first pair of leaves that open after emergence (Figure 1). Cotyledons have various shapes and sizes; they may be linear-, egg-, round- or butterfly-shaped or have variations of each (Figure 2). Look at other features of the weed,

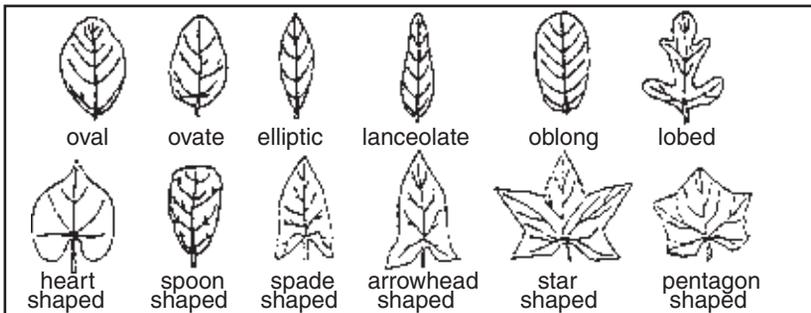


Figure 3. Characteristic leaf shapes.

such as the true leaves (leaves emerging after cotyledons) and stems. Leaf shape can vary dramatically and is a consistent key to plant identification (Figure 3). The leaves may be alternately or oppositely arranged along the stem (Figure 4). Some leaves may be attached to a short stem, known as the petiole, while others may lack a petiole (Figure 5). Check the leaf surfaces for the presence of hair and the amount of waxiness. Stems can also assist in identifying a weed; they have various shapes and amounts of hair, if any. Finally, dig or carefully remove the roots from the soil and look for the presence of rhizomes (Figure 6), creeping roots, or other structures such as tubers. Rhizomes are underground vegetative stems from which new plants are generated. The presence of these vegetative structures will indicate that the weed's life cycle is perennial.

Grasses are usually more difficult to identify than broadleaf weeds. It is especially useful to have a hand or pocket lens with 10x magnification power because grasses possess subtle characteristics that distinguish them from one another. Most of these identifying features are contained in the collar region. The collar region can be seen by carefully pulling the leaf blade back from the stem. When the blade is pulled back, look for the ligule (Figure 7). The ligule is a projection at the base of the leaf blade. If a ligule is present, it will appear as a ring of hair or it may be membranous (thin and almost transparent). It can be relatively large or small, and its tip can be jagged or smooth. Some grassy weeds will have auricles; these are small fingerlike structures that appear to clasp around the stem at the collar (Figure 8). Like broadleaf weeds, grasses may be hairy on either the top or bottom leaf surface, or both. Grass stems can be a key feature; most are rounded,

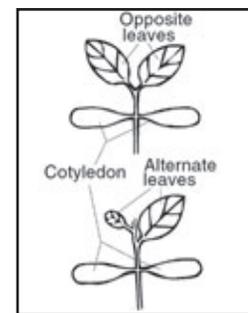


Figure 4. Opposite and alternate leaves.

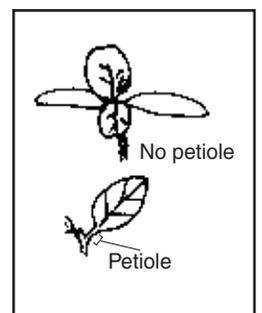


Figure 5. Petiole.

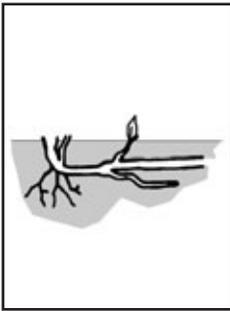


Figure 6. Rhizome.

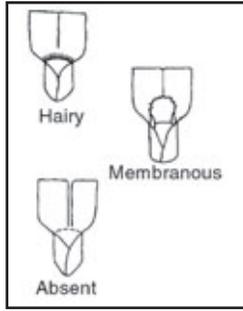


Figure 7. Ligule.

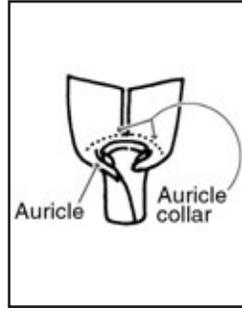


Figure 8. Auricle.

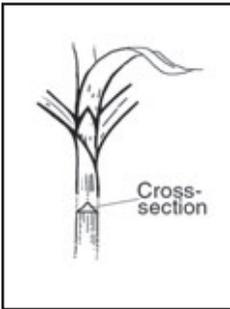


Figure 9. Sedges have 3-sided stems.

while others are flattened. A few grassy weeds will also have hair on their stems.

Sedges can be relatively easy to distinguish from grasses and broadleaf weeds. From a distance, they appear grasslike; however, upon closer inspection, the stems are triangular in shape (Figure 9). The leaves on sedges usually appear very glossy or shiny in texture and the leaves are hairless and occur in sets of three.

See the weed identification section of this publication (pages 66–69) for a vegetative key and for photographs to assist in identifying some of the most common weeds in the Midwest.

## WEED SCOUTING AND MAPPING PROCEDURES

Information on weed populations in a field is needed within two weeks after crop emergence to determine performance of preplant and preemergence herbicides as well as the need for supplemental postemergence strategies. With increased adoption of total postemergence programs, it becomes increasingly important to recognize the weed management issues soon after crop emergence. In fields using only postemergence weed management strategies, the competitive load represented by weeds on the crop is greater early in the season than it is with programs using preplant or preemergence herbicides. Although preplant or preemergence herbicides may occasionally provide an unacceptable level of weed control, they will still thin the emerging weed population and reduce the competitive load on the crop early

in the season.

To identify the location of weeds in a field, sample areas representing no more than 5 to 7 acres should be recorded on a map of the field (see Figure 10). This map will provide information on location of weed problems and be useful for monitoring changes in weed infestations from year to year. When drawing the map, outline the boundaries of the field and indicate points of reference, such as waterways, terraces, terrace inlets, buildings, fences, or timber. A map can also be generated using global positioning satellite (GPS) equipment. Identify and record (including height and growth stage) all species found, and determine the severity of the infestation either by counting or by estimating the number of weeds in 100 square feet (10 ft × 10 ft) or by categorizing the infestation into one of seven categories (none, very low, low, moderate, intermediate, high, very high). Tables 1 and 2 show the approximate yield loss caused by several annual species at different

**Scouting Report**

Producer: <u>JIM WHIT</u>	Scout: <u>ERIC KILEY</u>	Date: <u>6/10/07</u>			
Field ID: <u>BROADFORD 1</u>	County: <u>BOONE</u>	Time: <u>9:00 AM</u>			
Acres: <u>50</u>	Crop: <u>SOYBEANS</u>	Hybrid: <u>ADVANTAGE</u>			
Row width = <u>30"</u>		Total Average			
Plant Count (ft. row or hoop)					
Plants per Acre					
Insect	Sampling Unit	At each survey stop, number of pests or damaged plants	Total	Average	%
<u>BEANLEAF BEETLE</u>	<u>#/ft. of row</u>	<u>3 1 10 9 13 4 1 3 10 10</u>	<u>64</u>	<u>6.4</u>	
"	<u>% DEFOLIATION</u>	<u>10 5 25 25 30 15 5 10 25 30</u>			<u>18</u>
"	<u># DEAD PLANTS PER 10' x 10' ROW</u>	<u>0 0 0 0 0 0 0 0 0 0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Weed		At each survey stop, enter either: N (none), VL (very low), L (low), M (moderate), I (intermediate), H (high), or VH (very high) or density per 100 sq ft. for each weed	Average ht. and # of leaves		
<u>GIANT FOXTAIL</u>	<u>N VL H VL VH</u>	<u>N VL VH</u>	<u>N VL VH</u>	<u>N VL VH</u>	<u>2" 3</u>
<u>SPATTERCANE</u>	<u>N VL N N N VL VL VL VL N</u>				<u>6" 3</u>
<u>WATERHEMP</u>	<u>H N VH M I VL H H N</u>				<u>1" 2</u>
<u>COCKLEBUR</u>	<u>N L N L N N L H VL</u>				<u>4" 4</u>
<u>MORNINGGLORY</u>	<u>L N VL N M I H L N VL</u>				<u>1" curly stems</u>
Disease	Sampling Unit	At each survey stop, enter % infection	Average		
<u>PHYTOPTHORA</u>	<u>15 PLANTS</u>				
Growth stage: <u>V1</u>	Crop height: <u>3"</u>				
Soil Conditions: <u>wet (trap)</u>	<u>dry loose light crust hard crust</u>				
Weather: <u>70 °F partly sunny cloudy rainy calm light wind strong wind</u>					
Comments:	Draw field map (with numbered survey stops)				
<u>* STOPS 6 &amp; 9 APPEAR TO BE WHERE 1 SPRAYER RAN OUT OF HERBICIDE OR SKIPPED.</u>					
<u>* HEAVY FOXTAIL &amp; COCKLEBUR PRESSURE AT STOPS 6 &amp; 9.</u>					
<u>* POOR SOYBEAN STAND AT STOP 5 (&lt;50,000/A). AREA IS WET &amp; PHYTOPTHORA PRESENT.</u>					

Figure 10. This sample scouting report includes a map of the field being sampled.

**Table 1. Approximate yield loss with various densities of annual weeds in corn 0–5 inches tall with a 150 bu/acre yield potential.**

Weed density category (yield loss potential)	Giant foxtail (2–4" tall)	Shattercane (<6" tall)	Common waterhemp (2–4" tall)	Velvetleaf (2–4" tall)	Morningglory (0–2" tall)	Common cocklebur (2–4" tall)	Approximate yield loss by a single species (bu/acre)	Approximate yield loss by all species (bu/acre)
	Weed density per 100 square feet						(bu/acre)	(bu/acre)
None	0	0	0	0	0	0	0	0
Very low (0–1%)	10	3	3	2	2	1.5	2	12
Low (1–2.5%)	20	7	8	5	4	4	5	23
Moderate (2.5–5%)	40	14	16	10	9	7	9	37
Intermediate (5–10%)	85	30	35	20	19	15	18	54
High (10–20%)	220	78	85	52	50	40	35	71
Very high (20–30%)	430	150	175	103	100	78	50	80

**Table 2. Approximate yield loss with various densities of annual weeds in soybeans in the unifoliolate stage with a 50 bu/acre yield potential.**

Weed density category (yield loss potential)	Giant foxtail (2–4" tall)	Shattercane (<6" tall)	Common waterhemp (2–4" tall)	Velvetleaf (2–4" tall)	Morningglory (0–2" tall)	Common cocklebur (2–4" tall)	Approximate yield loss by a single species (bu/acre)	Approximate yield loss by all species (bu/acre)
	Weed density per 100 square feet						(bu/acre)	(bu/acre)
None	0	0	0	0	0	0	0	0
Very low (0–1%)	2	1	1	1	1	0.5	1	6
Low (1–2.5%)	5	2	2	1.5	1.5	1	2	11
Moderate (2.5–5%)	10	3	4	2	2	2	3	17
Intermediate (5–10%)	20	7	8	4	4	4	6	25
High (10–20%)	40	15	16	10	10	8	13	32
Very high (20–30%)	60	22	25	15	14	11	18	34

densities. The estimates shown in Tables 1 and 2 assume that scouting takes place when the corn is less than 5 inches tall (a yield goal of 150 bu/A) or when soybean plants are in the unifoliolate growth stage (a 50 bu/acre yield goal). Yield loss information on additional weeds at different weed and crop growth stages is available through the use of the WeedSOFT™ yield loss calculator (<http://weedsoft.unl.edu> then click "tools").

When making weed scouting maps, include notes on locations of perennial weeds and severe infestations of annual weeds. These areas will most likely require annual management tactics. Record early-season soil moisture conditions, because adequate soil moisture is needed for effective weed control with soil-applied herbicides. Inadequate moisture can mean that there is not enough water for herbicide activation and

absorption by weed seedlings. Excessive rainfall will cause dilution of the herbicide by moving it deeper (leaching) into the soil profile or from one area of the field to another (surface runoff).

A late-season weed survey should also be done in August to determine the effectiveness of the strategies employed on a given field and assess late-season weed emergence and potential issues for the following growing season. Ideally one wants as much detail in the map generated in this survey as in the map for the early-season survey. However, less detail (10-acre grids) would usually be sufficient in the late-season survey to assess overall effectiveness of a weed management program. This will help the grower plan the cropping system and management strategy for the next season.

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## ECONOMIC THRESHOLDS FOR WEEDS

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The economic threshold for weeds may be defined as the density of a weed population at which control is economically justified. Control may be economically justified if there is potential for yield loss, crop quality loss, harvesting difficulties, aesthetic issues or future weed management difficulties due to weed seed production. Economic thresholds developed for both insects and weeds assume that crop yield loss can be predicted by an accurate estimate of pest density, if crop market price, expected yield, control costs, and effectiveness of the control are known. However, economic thresholds developed for weeds should also include time of weed emergence relative to crop emergence, duration of weed interference in the crop, and herbicide effectiveness on large weeds. Regardless of whether one uses a threshold concept or not, decisions to control weeds must be made in a timely manner so that postemergence herbicide treatments are both efficacious and cost-effective. Herbicide applications on smaller weeds allow for the use of lower application rates, which can reduce expenses and the chemical load into the environment. Delaying applications can allow weeds to be controlled with a single postemergence application, but rates will need to be higher and some competition with the crop can occur. Additionally, timely detection of weed escapes allows producers and custom applicators to base late-season control decisions on the threshold concept to determine whether it is economical to control the weed.

It is important to understand that each field has a specific amount of resources available for growth and development of plants. The amount varies from field to field and from year to year with environmental conditions. If a weed-free crop is grown, the crop has all of the resources available for its own use. If weeds are allowed to grow with the crop, they will use a portion of the resources and may cause crop losses severe

enough to justify control measures. In general, removing an infestation of insects or disease from a crop does not necessarily lead to an infestation by more of these pests. However, if a weed species is removed from an area, other species may invade unless the crop is sufficiently competitive to prevent it.

How long can a grower allow weeds to grow with the crop before yields are compromised? This length of time is often termed the *critical period* for early-season competition. This period determines how long a grower can wait before initiating a postemergence herbicide application or tillage operation to reduce weed pressure. Weed species prevalence and density are strongly correlated with the critical period; fields infested with cocklebur, sunflower, and giant ragweed have shorter critical periods than do those fields with giant foxtail and common waterhemp. Fields with high densities of broadleaf weeds have shorter critical periods than fields with low densities or grass weeds. Environmental factors, especially the availability of soil moisture early in the season, may at times override the impact of weed density on the critical period. The crop row width, or time required for the crop to develop a canopy sufficient to shade weeds, would also affect the recommended weed-free period. In general, a narrow-row soybean field (less than 15-inch rows) may develop a canopy as much as 10 days earlier than a field with wider rows. Finally, late-emerging weeds that escape control may reduce harvesting efficiency or produce viable weed seed, lowering not only crop yield but also crop quality.

Some general assumptions about weed interference can help the crop consultant make an appropriate management decision. Weed competition studies at the University of Missouri and in other states indicate that crop yield losses are unlikely if weeds are allowed to emerge and grow with the crop for no more than four or five weeks after crop emergence, and the crop thereafter is kept free of weeds until harvest. Alternatively, if weeds are kept out of the field for six to eight weeks after crop emergence, any weeds that emerge later will not cause significant yield reductions, although they may produce seeds, cause harvesting problems, or reduce crop quality.

An economic threshold may be important when considering whether a postemergence weed management decision is needed. Examples 1 and 2 are predictions from WeedSOFT™ yield loss calculator and based solely on the effect of various weed densities on crop yield. To use the calculator, some assumptions are made regarding the relative weed-free yield of the crop and either the count (number of weeds per 100 square feet) or categorization of the yield loss potential by each weed species present. The categories of yield loss potential for the weeds are designated as none, very low, low, moderate, intermediate, high, and very high. Approximate densities of several weeds that define these yield loss categories are shown in Tables 1 and 2. If a particular weed is not listed, you can use WeedSOFT™ or compare the unlisted weed and a weed in Tables 1 or 2 with similar leaf size and plant height characteristics to get a rough estimate of yield loss potential. It is important to remember that weed species differ in their competitiveness based largely on their growth rate, size (shoot and root mass), canopy shape, and emergence date. *Competitive index* (CI) is a term used to describe the relative competitiveness of a weed species and is expressed in a range from 1 to 10 (Table 3).

A plant with a CI of 1 is 1/10 as competitive as a plant with a CI of 10. Figures 11 and 12 show yield loss due to season-long competition of several densities of weeds commonly found in the Midwest and also shows differential competitiveness of individual weed species. *Competitive load* is a term used to describe the total competitive effect of a weed population on crop yield, and is a summation of the number of individual weeds multiplied by the CI of each weed. As seen in Figures 11 and 12, competitive load approaches 100 percent yield loss asymptotically, based on the fact that at high weed densities, weeds begin to interfere with one another and have progressively less effect on crop yield.

Based on information gathered in scouting and an understanding of treatment expenses, expected crop prices, and relative competitiveness of weeds present, a decision to treat can then be made based on the expected gain from various weed removal tactics. These expectations vary from year to year depending on environmental factors.

There are a few items to consider whether one uses a software package or common sense to make control decisions. First, weed infestations that can cause a 10 percent or greater yield loss will usually justify treatment if they are within size limits for maximum herbicide effectiveness. Second, failure to obtain 100 percent weed con-

**Example 1:** A preemergence grass herbicide was applied to a cornfield. Two weeks after crop emergence, a scout determined that the corn was 5 inches tall, that grass weeds were under control, and that densities of broadleaf weeds (per 100 square feet) were as follows:

Common cocklebur (2–4 inches) = 30 = high yield loss potential  
 Velvetleaf (2–4 inches) = 3 = low yield loss potential  
 Ivyleaf morningglory (0–2 inches) = 10 = intermediate yield loss potential

Based on an expected weed-free yield of 150 bu/acre, a yield loss model calculated a yield loss of 26.3 bu/acre due to cocklebur, 2.4 bu/acre due to velvetleaf, and 7 bu/acre due to morningglory, for a total yield loss of 35.7 bu/acre. Corn and weeds are still small enough to be treated with post-emergence herbicides for effective weed control. To make a decision on whether or not to spray, one needs to make a few assumptions:

The expected weed-free yield will be 150 bu/acre.  
 Expected crop price will be \$2.50/bu.  
 Treatment cost, including custom application fee, will be \$16.00/acre.

If the expected loss is 35.7 bu/acre = \$2.50/bu = \$89.25/acre and the treatment cost is \$16.00/acre, then treatment is economically justified because the net gain of the treatment is \$89.25 = \$16 = \$73.25/acre.

**Example 2:** A preemergence atrazine-premix herbicide was applied to a cornfield on the same day corn was planted. Rain began at two weeks after crop emergence, and the wet weather persisted for four weeks. At six weeks after emergence it was finally dry enough to scout and spray if necessary and a scout determined that the corn was 37 inches tall and the following weeds were present at these densities (per 100 square feet):

Giant foxtail (4–8 inches) = 30 = very low  
 Shattercane (12–24 inches) = 9 = very low  
 Common waterhemp (4–8 inches) = 3 = very low or none  
 Common cocklebur (>8 inches) = 1 = very low or none  
 Velvetleaf (4–8 inches) = 1 = very low or none

Based on an expected weed-free yield of 120 bu/acre, a yield loss model calculated the yield loss of 1.2 bu/acre due to giant foxtail, 1.3 bu/acre due to shattercane, 0.3 bu/acre due to common waterhemp, 0.3 bu/acre due to common cocklebur, and 0.2 bu/acre due to velvetleaf, for a total yield loss of 3.3 bu/acre. Corn and weeds are relatively large and there are few effective legal options (according to the herbicide label directions). To make a decision on whether or not to spray, one needs to make a few assumptions:

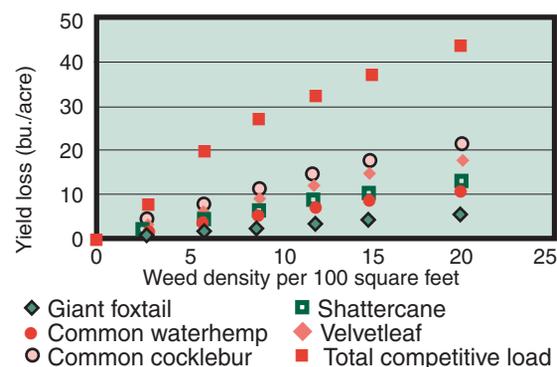
The expected weed-free yield will be 120 bu/acre.  
 Expected crop price will be \$2.50/bu.  
 Treatment cost, including custom application fee, will be \$16.00/acre.

If the expected loss is 3.3 bu/acre = \$2.50/bu = \$8.25/acre and the treatment cost is \$16.00/acre, then treatment is not economically justified because the net gain of the treatment is \$8.25 = \$16 = -\$7.75/acre.

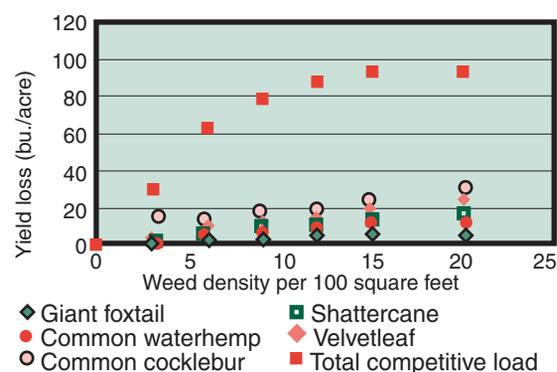
**Table 3. Competitive indices of weed species commonly found in Missouri.**

Weed	Competitive index
Common cocklebur	5.5
Hemp dogbane	1.0
Giant foxtail	3.0
Ivyleaf and pitted morningglory	5.5
Fall panicum	1.5
Common ragweed	1.5
Giant ragweed	8.0
Shattercane	3.5
Common sunflower	10.0
Velvetleaf	4.2
Common waterhemp	2.5

trol must be considered. This becomes increasingly important if treated weeds are stressed from drought or cool weather or larger than specified on the herbicide manufacturer's label. And finally, grain quality, harvesting difficulties, aesthetics (landlord pressure), and weed seed production are not considered in the examples above. Therefore, common sense should always be combined with other decision aids in any weed management decision.



**Figure 11. Predicted yield loss with season-long competition of various weed densities in soybeans, assuming a 50 bu/acre yield goal.**



**Figure 12. Predicted yield loss with season-long competition of various densities of selected weeds in corn, assuming a 150 bu/acre yield goal.**

## HERBICIDE INJURY

Correct diagnosis of crop injury from any source requires an accurate investigation of the symptoms and as much information as possible about the history of the area where symptoms are present. Herbicides are sometimes blamed for crop injury caused by fungal, bacterial, or viral pathogens, nematodes, nutrient deficiencies or excesses, insect damage, or adverse weather conditions (e.g., excess soil moisture) that cause similar symptoms. Therefore it is helpful for the person diagnosing the injury to have detailed information on each injury situation as well as plant and soil samples for evaluation before attempting to identify the cause of injury.

Herbicide injury frequently occurs in distinct

patterns within a field and can be caused by misapplication of the herbicide or by faulty equipment. Signs indicating faulty application of herbicides include streaks of injury resulting from improper incorporation, overlapping of the spray pattern, improper nozzle size and spacing, altered nozzle pattern (worn nozzle), or improper boom height. Injury occurring at the field ends may result from failure to shut off the sprayer when making turns or decreased sprayer speed. Injury symptoms may follow lines of water movement or appear where changes occur in soil type, organic matter content, pH, or field topography. Look for spray or drift patterns and compare adjacent, untreated fields with the areas showing injury symptoms. Also, compare the response of susceptible weed species and watch for symptoms caused by insects, disease, mechanical damage, wind, drought, and other environmental conditions.

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## Factors contributing to herbicide injury

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**Limited selectivity.** *Selective* herbicides kill some plants but not others (i.e., control several weeds but do not kill the crop). Most herbicides have at least a 4x margin of selectivity on labeled crops. This means that the crop can tolerate at least four times the amount of herbicide needed to control the target weeds. However, the margin of selectivity on some crops is often narrow with specific herbicides. This means that under conditions that stress the crop (environmental conditions, soil compaction, or presence of other pests), or if inaccuracies occur in application, herbicide injury can occur. Margins of selectivity can be improved by using proper application rates for a soil type, carefully choosing spray adjuvants, and avoiding applications to stressed crops (growth stages) or where crop sizes exceed labeled limits.

**Faulty application.** Herbicides are expensive and margins of selectivity can be narrow. This is why it is important to inspect and calibrate application equipment carefully to ensure accurate application rates. Inspections should occur every year before the equipment is used and more often if large acreages are treated several times. To avoid faulty applications, (1) be sure all nozzles are the same size and type and that spray patterns are uniform, (2) be sure the herbicide is properly mixed and preslurried if required on the label, (3) be sure the mixture is properly agitated, (4) use a marking system to avoid skips and overlaps, (5) use incorporation equipment that will give uniform distribution of the herbicide (two passes are usually required), (6) with post-directed sprays, minimize contact of the herbicide with the crop, (7) shut off the boom when turning on field ends to avoid overlap, and be sure the spray tank is not contaminated with herbicides that can injure the crop.

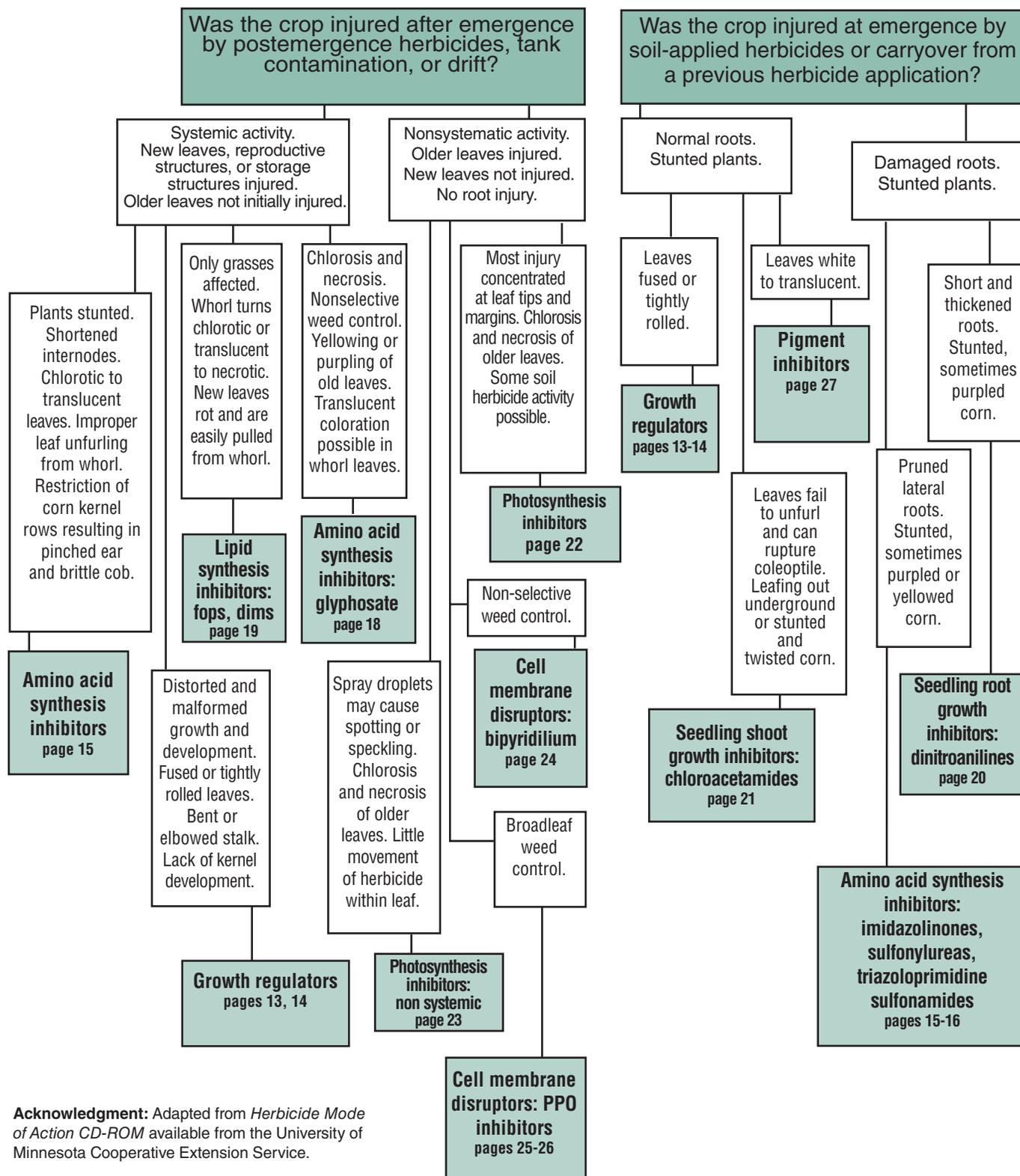
**Environmental conditions.** Weather conditions favorable for rapid crop emergence and growth minimize the risk of herbicide injury and maximize herbicide activity on target weeds. Planting crops too deep results in the emerging shoot or growing point of the crop being in con-

tact with the soil herbicide longer. On the other hand, planting crops too shallow (especially corn) will also increase the risk of injury. Planting crops too shallow may result in the seed sprouting in herbicide-treated soil. Under cool, wet conditions, the metabolism of the plant is reduced. This means that the crop grows more slowly and the herbicide is detoxified more slowly, resulting in greater injury. Conversely, under warm, humid conditions, herbicide uptake can occur rapidly and injury may result. Hot, dry conditions can also magnify the effect of the herbicide on the plant since the plant is under stress. Additional secondary stresses such as diseases, insects, and poor soil conditions can all reduce the vigor of the crop and magnify the effect of herbicide injury on the crop.

**Genetic susceptibility.** Crops with different genetic backgrounds may also have different margins of selectivity to certain herbicides. Many seed companies have begun to make this information available to growers. Differences in susceptibility could be due to morphological (leaf angle or pubescence) or physiological (ability to detoxify the herbicide) differences.

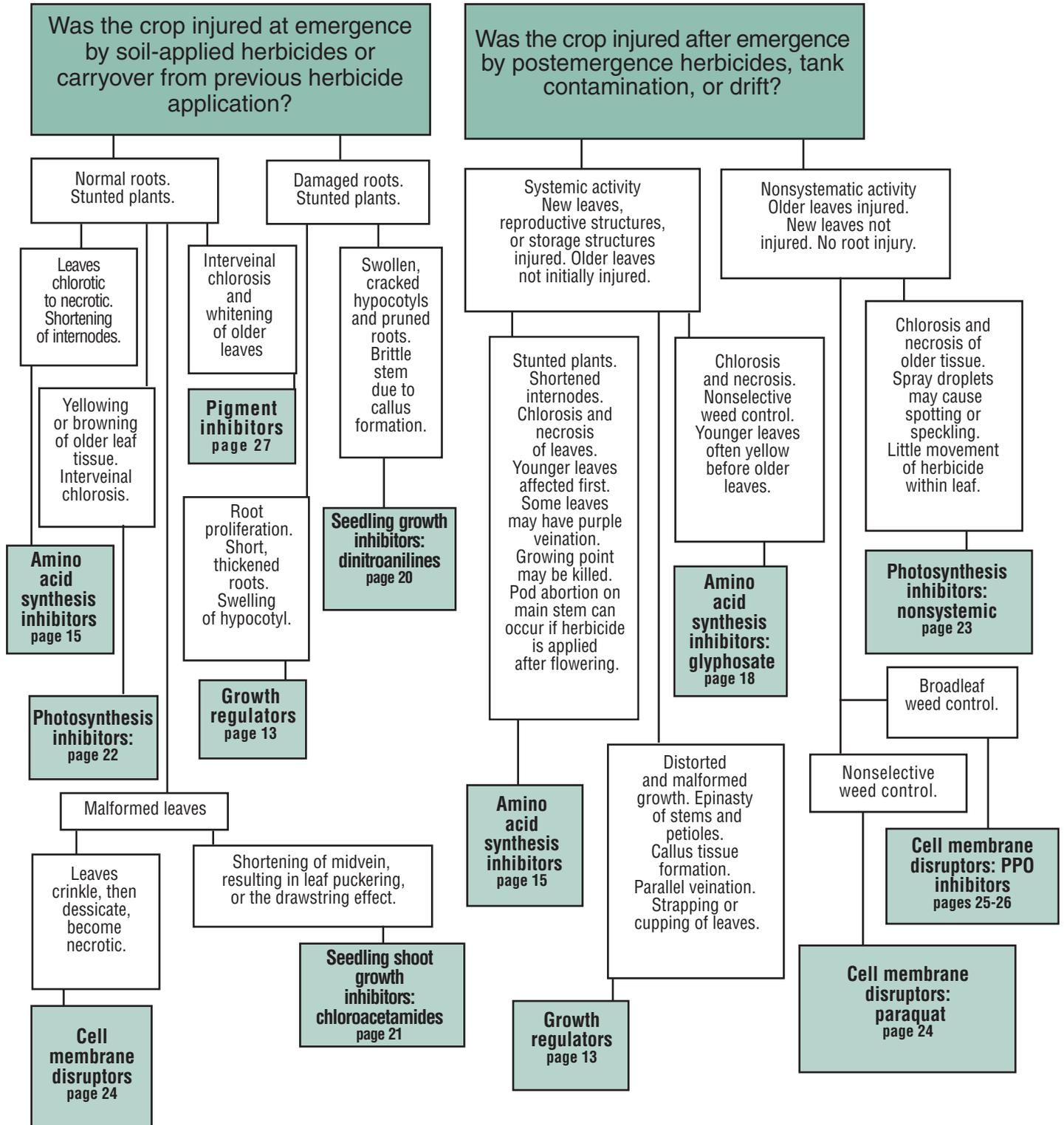
**Herbicide drift.** Off-site movement of herbicides is called drift. Particle drift is movement of spray particles from the application equipment while the application is being made. These particles never reach the intended target area. Vapor drift is the movement of herbicide vapors. Vapor drift can occur at application and up to several days after application. Particle drift can be minimized by using spray application parameters that minimize production of small spray particles (using a larger orifice or changing the angle at which the droplet leaves the nozzle) and not spraying in windy conditions. In some situations, drift retardent agents can be added to the spray solution to increase viscosity and hence reduce drift. Vapor drift can be minimized by using less volatile formulations of the herbicide and not spraying when air temperatures exceed 85 degrees F. For additional information, refer to University of Missouri publication G1886, *Controlling Drift of Crop Protection Materials*, and University of Wisconsin publication I-6-2004-5M, *Dicamba Injury to Soybeans*.

# DIAGNOSING HERBICIDE INJURY: CORN



**Acknowledgment:** Adapted from *Herbicide Mode of Action CD-ROM* available from the University of Minnesota Cooperative Extension Service.

# DIAGNOSING HERBICIDE INJURY: SOYBEANS



# HERBICIDE MODE OF ACTION FAMILIES

The purpose of this section is to assist diagnosis of herbicide injury and to categorize injury according to herbicide mode of action. There are many causes of abnormal crop response (injury), including weather, soil conditions (e.g., compaction), and other pests (diseases, nematodes, insects). It is important to recognize that symptoms typically associated with herbicide damage can also be confused with injury from other factors. Injury from herbicides can also increase when crops are under stress from other factors listed above. This section outlines crop damage due solely to herbicides and does not

include damage due to other causes. Use the keys on pages 10 and 11 to identify the symptoms you observe in the field, and narrow down the choice to a specific mode of action family. Then compare the results you obtain by searching the key with the written descriptions and photographs shown in the following section. If in doubt about the cause of injury, your local MU Extension specialists have access to digital technology and the services of the Extension Plant Diagnostic Clinic (phone 573-882-3019; on the Web at [soilplantlab.missouri.edu/plant](http://soilplantlab.missouri.edu/plant)) to assist with diagnosis.

There are many herbicide injury publications available to help with diagnosis of herbicide injury and categorizing the injury into a herbicide mode of action family. In addition, the following information provides some detail on symptoms associated with damage from specific herbicides. The herbicides have been classified by their broad mode of action families universally accepted by the Weed Science Society of America (*Weed Technology* 11:383-393 (1997)).

## ❑ Growth regulators

Benzoic acids (Banvel, Clarity, Status)  
Phenoxy acetic acids (2,4-D, 2,4-DB)  
Pyridines (Stinger, Garlon, Starane, Milestone)

## ❑ Amino acid synthesis inhibitors

Imidazolinones (Scepter, Pursuit, Raptor)  
Sulfonylureas (Beacon, Peak, Accent, Classic, Permit, Harmony SG, Spirit/Exceed)  
Triazolopyrimidine sulfonanilides (Python, FirstRate)  
Amino acid derivatives

- Glufosinate (Ignite)
- Glyphosate (Roundup and others)

## ❑ Lipid synthesis inhibitors

Aryloxyphenoxypropionates (fops) (Fusilade, Fusion, Assure, Hoelon)  
Cyclohexanediones (dims) (Poast, Poast Plus, Select Max)

## ❑ Seedling growth inhibitors

Dinitroanilines (Treflan, Prowl)  
Acetanilides, chloroacetamides, oxyacetamides (Dual, IntRRo/Microtech, Harness/Outlook/Surpass/Topnotch)

## ❑ Photosynthesis inhibitors

Triazines (Aatrex, Princep, Sencor)  
Phenylureas (Lorox, Spike)  
Benzothiadiazoles (Basagran)  
Nitriles (Buctril)

## ❑ Cell membrane disruptors

Bipyridiliums (Gramoxone Inteon)  
PPO inhibitors

- Diphenylethers (Ultra Blazer, Cobra, Reflex/Flexstar)
- N-phenylthalimides (Resource, Valor)
- Aryl Triazolinones (Spartan, Aim)
- Pyrimidinediones (Sharpen)

## ❑ Pigment inhibitors

Isoxazolidinones (Command)  
Isoxazoles (Balance)  
Triketones (Callisto, Impact, Laudis)

## Growth regulators

**Chemical group:** benzoic acids and pyridines  
**Herbicides:** dicamba (Banvel, Clarity, Distinct, Status, in Marksman) on corn, sorghum, wheat, pastures and turf; clopyralid (Stinger, in Hornet) on corn, pastures, and turf; triclopyr (Garlon/Rely) on grass forages/rangeland, and rice; fluroxypyr (Starane) on wheat; aminopyralid (Milestone) on pastures

**Mode of action and characteristics of activity:** Hormone type. Primarily annual and perennial broadleaf weed control, translocates upward in xylem and to growing points and roots in phloem, mobile in soil, some soil persistence; dicamba has vapor drift potential.

**General symptoms:** In broadleaf plants, necrosis (browning) of terminal meristematic areas, stem twisting and epinasty, early petioles turned down, and leaves cupped upward. Broadleaf plants may exhibit more cupping than strapping (veins in leaf becoming parallel) of leaf tissue. Corn may be onion-leaved (leaves do not unroll) and have brace root damage as well as missing kernels on cob.



Leaf cupping caused by dicamba drift or dicamba-contaminated spray tank. Sometimes the mottled appearance can be confused with certain viruses of soybean.



Green snap caused by high winds shortly after dicamba applications (left). Stalk twisting and leaning after dicamba (center and right).



Injury from dicamba can cause stems to form callus tissue (snap bean shown).



Dicamba and dicamba-containing products can also cause brace root fusion in corn with late postemergence applications.



Postemergence applications of dicamba can sometimes cause corn leaf rolling and mimic drought stress.



Early applications of dicamba + atrazine with a sulfonyleurea herbicide and methylated seed oil resulted in this severe case of onion-leaving on corn.



"Draw-stringed" leaves can also occur when proper rotational intervals are not followed with dicamba or clopyralid (Stinger, Hornet).



Injury from 2,4-D on soybeans appears as strapped leaves, irregular bending in the stems, and formation of callus tissue on the stem.



Injury from Harness + 2,4-D tankmixes on spike-stage corn. See also page 21.



Soybean injury can also occur when proper intervals are not followed after burndown with 2,4-D.

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## Growth regulators *(continued)*

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**Chemical group:** phenoxy acetic acid

**Herbicides:** 2,4-DB (Butyrac – soybean, alfalfa), 2,4-D (corn, grain sorghum, rice, small grains, grass forages)

**Mode of action and characteristics of activity:**

Hormone type. Annual and some perennial broadleaf weed control; translocates upward in xylem and to growing points and roots in phloem; short soil persistence; some vapor drift potential.

**General symptoms:** Abnormal growth responses

— In broadleaf plants, youngest leaves are strapped, cupped upward and twisted; may be brittle, branched, or callus tissue may develop on stems. Corn plants exhibit onion-leaving, fused brace roots, stalk bending, brittleness, and missing kernels on cob.



2,4-D injury on corn appears as brittle stems, rolled up leaves (onion-leaving) and fused brace roots.

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## Amino acid synthesis inhibitors

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**Chemical group:** imidazolinones

**Herbicides:** imazaquin (Scepter – soybean), imazethapyr (Pursuit – soybean, alfalfa and IT/IR/cleanfield corn), imazethapyr + imazapyr (Lightning – IT/IR/cleanfield corn), imazamox (Raptor – soybean, alfalfa)

**Mode of action and characteristics of activity:** Inhibition of ALS (acetolactate synthase) or AHAS (acetohydroxyacid synthase) enzyme. Controls annual broadleaves and some annual grasses; woody brush species with imazapyr, translocates upward in xylem and to growing points and roots in phloem, both soil and foliar activity, medium to long soil persistence.

**General symptoms:** Broadleaf plants die slowly; loss of apical dominance; chlorosis (yellowing) of tissue, and shortening of internodes. Grass plants may be stunted with chlorosis or purpling. Corn plants may be stunted and show symptoms of root inhibition such as pruning of lateral roots (bottlebrush). Leaves emerging from the corn whorl may not unfurl properly and be yellow to translucent in appearance. IT/IR corn tolerates residues better than regular corn. Soybean injury can range from stunting to death of the terminal growing point. Soybean leaves may be yellow in appearance and leaf venation may appear red or purple in color. Soybean plants may also appear to be potassium deficient or affected by soybean cyst nematode. Injury is more noted when plants are under stress.



Drift from imidazolinone herbicides like imazethapyr and imazamox can cause stunting and plants to exhibit more purple color than normal.



Maize dwarf mosaic virus can also cause reddening symptoms that are often confused with imidazolinone herbicide injury.



Injury from imidazolinone herbicides like imazamox on soybeans appears as stunting and chlorosis of the newest trifoliolate.



Severe injury may result in interveinal chlorosis and eventually death in emerging corn seedlings.



Carryover injury from imidazolinone herbicides like imazaquin is characterized by short, stunted plants, interveinal chlorosis, purpling, and pruning of lateral roots. In the three bottom photos, the healthy plant is on the right, injured plant on the left.



Injury from unlabeled sulfonylurea herbicides on soybeans is characterized by severe stunting, death of the newest trifoliates and red or black veins on the underside of the leaf.



< Sulfonylurea damage on soybeans is characterized primarily by irregular chlorosis and red or black veins on the underside of the leaf. Imidazolinone herbicides can cause similar symptoms.

> Soil activity of sulfonylurea herbicides like chlorimuron or carryover injury from unlabeled herbicides can cause short, stunted plants and chlorosis of the newest growing point. Left, treated soybean plant; right, untreated.



(Above and right) In corn, injury from sulfonylurea herbicides will appear as "yellow flash." This is most often characterized by chlorosis in the whorl and lower part of the leaf and a crinkled leaf edge near the chlorotic tissue.



## Amino acid synthesis inhibitors

(continued)

**Chemical group:** sulfonylureas and triazolopyrimidine sulfonamides

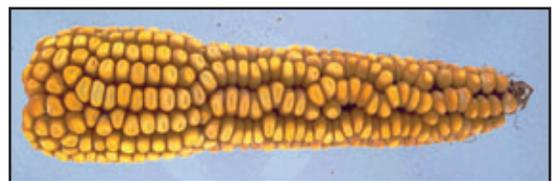
**Herbicides:** chlorimuron (Classic – soybean), thifensulfuron (Harmony GT – soybean), primisulfuron (Beacon – corn), nicosulfuron (Accent – corn), nicosulfuron + rimsulfuron (Steadfast – corn), rimsulfuron (Resolve – corn), foramsulfuron (Equip – corn), pro-sulfuron (Peak – corn, grain sorghum, small grains), halosulfuron (Permit – corn, grain sorghum), flumetsulam (Python, in Hornet – corn and soybean), cloransulam (FirstRate – soybean)

**Mode of action and characteristics of activity:**

Inhibition of ALS or AHAS enzyme. Control of annual broadleaf weeds and some grasses, soil and foliar activity, translocation upward in xylem and to growing points and roots in phloem, active at low rates, short to long soil persistence.

**General symptoms:** Stunted plant growth, lack of apical dominance, and black or red veins in soybean; same as imidazolinones.

> Pruning of lateral roots, or "bottle-brushed" roots as a result of cool, wet conditions and sandy soils after a flumetsulam application.



Late applications of sulfonylurea herbicides like nicosulfuron and nicosulfuron + rimsulfuron can cause ear "pinching" and severe yield reductions.

> Injury from sulfonylurea herbicides like foramsulfuron can also appear as stunting and internode stacking in corn.



**Chemical group:** amino acid derivatives

**Herbicides:** glufosinate (Liberty)

**Mode of action and characteristics of activity:** Inhibition of glutamine synthetase. Nonselective weed control unless used in Liberty Link crops. Limited translocation in xylem and phloem; no soil activity.

**General symptoms:** Glufosinate causes new growth to turn chlorotic, then necrotic. Activity is faster in hot weather. Glufosinate symptoms appear more quickly than those of glyphosate in cool weather and typically include more yellowish green strips or patches followed by necrosis.



Injury to non-Liberty Link corn plants. In photo at right, Liberty Link corn plant stands between two non-Liberty Link corn plants.



Glufosinate symptoms soon after application will appear as small spots or lesions, indicative of the faster, more contact-nature of glufosinate than glyphosate.



Glufosinate injury on non-Liberty Link soybeans will progress fairly rapidly from chlorosis to necrotic areas throughout.



< Glufosinate injury to non-Liberty Link corn hybrids will appear as chlorosis of new growth, whereas older leaves and leaf tips will become necrotic first. Glufosinate injury on corn is somewhat similar in appearance to frost damage.



Glyphosate injury on non-Roundup Ready corn hybrids can appear as tight, rolled leaves in the whorl, known as "onion leafing."



Glyphosate drift or tank contamination can also cause whitening in the whorl and onion leafing.



Significant injury can occur to conventional corn from as little as 0.01 lb/acre of glyphosate as a tank contaminant, as shown here.



## Amino acid synthesis inhibitors

(continued)

**Chemical group:** amino acid derivatives

**Herbicides:** glyphosate (Roundup and others)

**Mode of action and characteristics of activity:**

Inhibition of EPSP synthase. Nonselective weed control unless used in Roundup Ready crops. Translocates upward in xylem and to growing points and roots in phloem; no soil activity.

**General symptoms:** Glyphosate causes new growth to turn chlorotic, then necrotic; plants usually die in 7 to 14 days. Activity is faster in hot weather.



Glyphosate injury on non-Roundup Ready corn hybrids is perhaps most often characterized by the distinctive chlorotic bands that form on the leaves around the plant. These injured leaves developed after the exposure, which indicates when the glyphosate drift or contamination occurred.

> Glyphosate can also injure Roundup Ready soybean plants, especially when applied later in the season or when overlaps occur. Newest trifoliates are most often affected and are usually chlorotic.



Glyphosate injury on non-Roundup Ready soybean plants will progress as general stunting and chlorosis of the newest trifoliates first, followed by eventual chlorosis and necrosis of the entire plant.

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## Lipid synthesis inhibitors

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**Chemical group:** aryloxyphenoxypropionates and cyclohexanediones

**Herbicides:** fluazifop (Fusilade, in Fusion), quizalofop (Assure), fenoxaprop (Whip, in Fusion), diclofop (Hoelon); sethoxydim (Poast, Poast Plus) and clethodim (Select Max)

**Mode of action and characteristics of activity:**

Inhibition of acetyl CoA carboxylase (ACCase) enzyme. Postemergence control of annual and perennial grasses, foliar activity, translocates upward in xylem and to growing points and roots in phloem; very short soil residual; no activity on broadleaf weeds.

**General symptoms:** Reddening of leaves and stems, necrotic at nodes. Injury is seen in grasses only. Newer leaf tissue will be chlorotic or necrotic and the leaves in the whorl can be easily separated from the rest of the plant. Symptoms appear 3–7 days after application.



Postemergence lipid synthesis-inhibiting herbicide like sethoxydim, clethodim and quizalofop causes chlorosis and purpling of corn leaves and will cause the meristem of the newest leaf to rot.



Injury from post-selective grass herbicide. Notice the dead, necrotic meristem of the plant when the whorl is removed.



Quizalofop can cause chlorosis near leaf veins of soybeans. This injury will eventually progress into necrosis like that shown in the picture at the right.

^ Low doses of ACCase inhibitors such as sethoxydim and clethodim as drift or tank contamination can cause corn to whiten leaves in the whorl.



Trifluralin injury. Notice the purple color, rolled up leaves as if drought stressed, and short, thick lateral root system.



Short swollen stem caused by trifluralin (left) and pendimethalin (right).



Pendimethalin cannot be used in preplant incorporated applications in corn because of the potential for severe root injury. Planting corn too shallow and followed by preemergence pendimethalin can also cause root clubbing and injury, as in the photo on the right.

## Seedling growth inhibitors

**Chemical group:** dinitroanilines

**Herbicides:** trifluralin (Treflan and others), pendimethalin (Prowl and others)

**Mode of action and characteristics of activity:**

Mitotic disruptor. Inhibits cell division and inhibits lateral root formation through inhibition of tubulin protein involved with cell division. Annual grass and small-seeded broadleaf weed control; soil activity; little translocation; intermediate to long soil persistence.

**General symptoms:** Stunted plants that do not fully emerge from the soil and have short, thick lateral roots. Grass shoots are short and thick and may appear red or purple in color. They may also appear to be drought stressed. Broadleaf plants may have swollen hypocotyls (stem emerging from soil). Following preemergence treatments, callus tissue may appear at the base of soybean stems. Inhibits main and lateral root growth, causes swollen root tips, swollen hypocotyls at ground line, and delayed emergence.

**Chemical group:** chloroacetamides, oxyacetamides

**Herbicides:** alachlor (Intro or Microtech – soybean, corn, grain sorghum), metolachlor (Dual II Magnum, others – soybean, corn, grain sorghum), dimethenamid (Outlook – soybean, corn, grain sorghum), acetochlor (Harness, Surpass, Topnotch – corn), flufenacet (Define – soybean, corn)

**Mode of action and characteristics of activity:** Seedling root and shoot inhibitor. Specific sites unknown, but inhibits very long chain fatty acids. Annual grass and small-seeded broadleaf weed control; soil activity; translocates upward in xylem; short to medium soil persistence.

**General symptoms:** Terminal tissue inhibition. In broadleaf plants, heart-shaped leaves due to midvein inhibition; rough, crinkled leaves with some cupping possible for broadleaves, and grasses will show stunted or malformed shoot and may be onion-leafed. Stunting of shoots that result in abnormal seedlings that do not emerge from soil. Grasses may leaf out underground and leaves may not properly unfurl.



Injury from acetanilides/chloroacetamides and oxyacetamides on corn appears as "buggy whipping" or improper leaf unfurling.



Injury from preemergence applications of chloroacetamide/acetanilide and oxyacetamide herbicides appears as heart-shaped leaves or irregular crinkling and cupping of leaves.



Injury from postemergence applications of chloroacetamide/acetanilide and oxyacetamide herbicides also appears as irregular cupping and sometimes strapping of soybean leaves. Injury is more likely with late applications.



Atrazine injury on soybeans appears first at the tips and margins of older leaves.

> Drift from postemergence applications of atrazine on soybeans or other plants such as ivyleaf morningglory will appear as interveinal chlorosis and necrosis of older leaves first.



Metribuzin damage in corn. Note the necrotic leaf edges.



Soybeans injured from a preemergence application of metribuzin. Note the interveinal necrosis that has occurred on the unifoliate leaves.



Injury from metribuzin on corn appears as chlorosis and necrosis along the leaf edges.



## Photosynthesis inhibitors

**Chemical group:** triazines

**Herbicides:** atrazine (Aatrex and others – corn, grain sorghum), simazine (Princep – corn), metribuzin, (Sencor and others – soybean, corn)

**Mode of action and characteristics of activity:**

Binding to D1 quinone protein of photosynthetic electron transport. Controls many grass and broadleaf weeds, soil and foliar activity; translocates upward in xylem; activity and persistence affected by soil texture, pH and organic matter; injury and persistence greater on high pH soils.

**General symptoms:** Chlorosis and necrosis at leaf tips and margins on older leaves first (lower leaves) followed by interveinal chlorosis and lower leaf drop. Photosynthesis inhibitors do not prevent seedlings from germinating or emerging. Injury symptoms occur only after the cotyledons and first leaves emerge. Initial injury symptoms include chlorosis of the leaf margins or tips. In broadleaf plants, chlorosis between leaf veins may occur. Older and larger leaves will be affected first because they take up more of the herbicide from the water solution and they are the primary photosynthetic tissue of the plant. Injured leaf tissue will eventually turn necrotic. Because of the chemical nature of the herbicide-soil relationship, injury symptoms are likely to increase as soil pH increases (above 7.2).

**Chemical group:** phenylureas

**Herbicides:** linuron, (Lorox – corn, soybean), tebuthiuron (Spike – pastures, noncropland), fluometuron (Cotoran – cotton)

**Mode of action and characteristics of activity:**

Binding to D1 quinone protein of photosynthetic electron transport. Control of some annual grasses and broadleaf weeds; primarily soil applied but have foliar activity; translocates upward in xylem; short to long soil persistence.

**General symptoms:** Very similar to triazines.

**Chemical group:** benzothiadiazoles, benzonitriles and pyridazines

**Herbicides:** bentazon, (Basagran – corn, grain sorghum and soybean); bromoxynil (Buctril – corn, grain sorghum, alfalfa, small grains)

**Mode of action and characteristics of activity:** Binding to D1 quinone protein of photosynthetic electron transport. Postemergence control of annual broadleaves; little translocation and soil activity.

**General symptoms:** Occasionally brown midveins. Plant injury is confined to foliage that has come into contact with the herbicide. Affected leaves will become yellow or bronze in color and eventually turn necrotic. Injury symptoms can look similar to cell membrane disruptors. Crop oil concentrates (COC), other additives, or warm weather may increase weed control and crop injury symptoms.



Injury from bromoxynil on soybeans and corn. Notice the necrotic tissue, mostly along the edges of the leaf.



Injury from bentazon on soybeans appears as chlorosis, then necrosis of leaf tissue. Injury on corn appears as necrotic spots and streaks across the upper half of the leaf.



Paraquat injury symptoms on soybeans will also progress from water-soaked lesions soon after application (left) to necrotic lesions with red rings several days after application (right).

> Within only a few hours of application, water-soaked lesions can be seen on corn that has been damaged with paraquat.



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## Cell membrane disruptors

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**Chemical group:** bipyridilium

**Herbicides:** paraquat (Gramoxone Inteon)

**Mode of action and characteristics of activity:**

Disrupts cell permeability (membranes) by producing free radicals, activated by sunlight. Nonselective weed control; very little translocation; foliar activity; inactivated by soil.

**General symptoms:** Activated by light and causes foliar burn at site of droplet deposition. Plant leaves will have a limp, water-soaked appearance, which is followed by necrosis of contacted tissue. Drift injury will appear as speckling on leaf tissue. Necrotic lesions will eventually have red rings around the perimeter.



Paraquat injury on other plants such as (from left to right) pumpkin, snap beans and squash and is similar in appearance to injury that occurs on soybean plants.



Paraquat drift symptoms on corn will progress as necrotic lesions that will eventually be surrounded by brown or red rings. Paraquat injury will be confined to the foliage that comes in direct contact with the herbicide.

**Chemical group:** N-phenylphthalimides, diphenyl ether and pyrimidinediones.

**Herbicides:** acifluorfen (Ultra Blazer – soybean), lactofen (Cobra/Phoenix – soybean), fomesafen (Reflex/Flexstar – soybean), flumiclorac (Resource – corn and soybean), flumioxazin (Valor), saflufenacil (Sharpen – corn, grain sorghum and soybean; Integrity – corn, grain sorghum; Optill – soybean), fluthiacet (Cadet – corn and soybean)

**Mode of action and characteristics of activity:** Inhibition of protoporphyrinogen oxidase (PPO). Foliarly applied, often referred to as contact herbicides; little translocation in plants. Fomesafen also has soil activity.

**General symptoms:** Plant leaves will yellow and then turn chlorotic, then necrotic. Reddish brown spotting on the leaf surface may appear shortly after the herbicide is applied. Plants that do not die may be stunted for a week or more. COC and other additives, as well as extremely cool or warm temperatures, may increase plant injury.



Acifluorfen injury will appear as speckling followed by chlorosis, then necrosis of tissue contacted by the herbicide.



Fomesafen carryover on corn appears as a clearing of the midvein and veins. This is referred to as veinal chlorosis.



Injury from fomesafen can also appear as speckling, chlorosis and necrosis but more often causes leaf crinkling and distortion. New growth is not affected.



Flumiclorac causes crinkling of leaves that were expanding when treated.



Flumiclorac injury on corn.



< Injury from flumioxazin drift on corn will appear as necrotic lesions and is often confused with paraquat.



Injury from carfentrazone on soybeans will appear as speckling, chlorosis and necrosis of contacted foliage. Note the absence of red rings surrounding the necrotic lesions as with paraquat.



Carfentrazone injury on corn.



Sulfentrazone injury on soybeans. Note the small leaflets, bent cotyledons and purple spots from sulfentrazone "splash" in wet conditions.



Sulfentrazone-damaged soybean hypocotyls when cold, wet conditions occurred at emergence.



Injury from sulfentrazone drift on corn will also appear as necrotic lesions and is often confused with paraquat damage.



Severe carfentrazone injury on corn as a result of rain washing the herbicide into the whorl.

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## Cell membrane disruptors

(continued)

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**Chemical group:** aryl triazolinones

**Herbicides:** sulfentrazone (Spartan – soybean and tobacco), carfentrazone (Aim – corn, soybean, wheat)

**Mode of action and characteristics of activity:**

Inhibition of protoporphyrinogen oxidase. Control of annual broadleaf weeds; very little translocation; soil and foliar activity; short to intermediate soil persistence.

**General symptoms:** Necrosis of leaf tissue. Plant leaves will yellow and then turn brown and die. Reddish brown spotting on the leaf surface may appear shortly after the herbicide is applied. Plants that do not die may be stunted for a week or more. Sensitive soybean varieties and extremely cool temperatures or wet soils may increase plant injury appearing as necrosis on the cotyledons and hypocotyl.

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## Pigment inhibitors

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**Chemical group:** isoxazolidinones

**Herbicides:** clomazone (Command – soybean, rice)

**Mode of action and characteristics of activity:**

Specific sites unknown. Control of annual grass and broadleaf weeds; primarily soil active; medium soil persistence; volatile, be aware of drift potential.

**General symptoms:** Leaf and stem tissue turns white after becoming translucent at the leaf tips, then chlorotic and necrotic. In corn, if more than 75 percent of the plant is white, it will probably die.



Injury from clomazone on soybeans and corn. Soybeans are generally tolerant; damage to soybeans is unlikely except at high application rates.

**Chemical group:** isoxazoles

**Herbicides:** isoxaflutole (Balance – corn)

**Mode of action and characteristics of activity:**

Inhibition of p-hydroxy phenyl pyruvate dioxygenase. Control of annual grass and broadleaf weeds; primarily soil active; medium soil persistence.

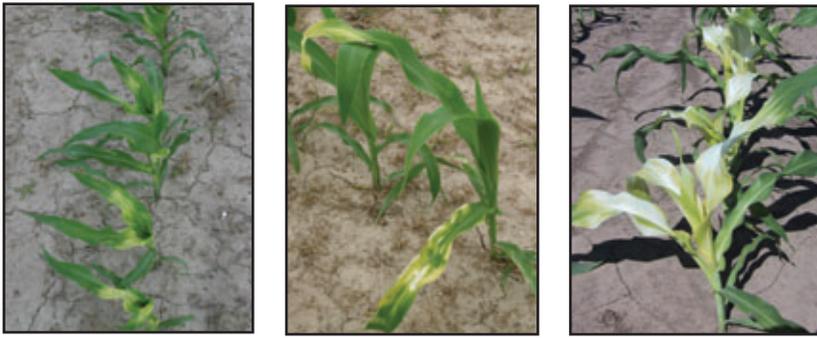
**General symptoms:** Plant tissue turns white, chlorotic, and then necrotic. Subsequent rainfall events will result in plants taking up more herbicide and showing injury symptoms in newly developed tissue. Injury can be severe in sandy soils, in high-pH soils, in combination with high application rates of atrazine, and under cool, wet-weather conditions.



Injury from isoxaflutole on soybeans appears to be similar to atrazine injury except that isoxaflutole causes more chlorosis and some bleaching should eventually be seen.



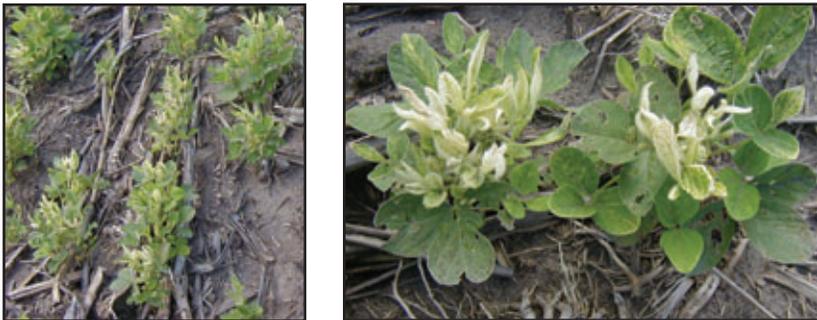
Injury from isoxaflutole on corn. Note the chlorosis on leaf tips and ends.



Injury from postemergence applications of triketone herbicides like mesotrione will appear as irregular chlorosis and bleaching of the lower leaves and whorls. Some sweet corn hybrids (picture at right) are highly sensitive to postemergence triketone herbicides.



Injury from residual activity of triketone herbicides like mesotrione will also appear similar to isoxaflutole and atrazine injury with initial chlorosis of the first true leaves and trifoliates, but some signs of bleaching should eventually appear.



> Soybean injury can occur as a result of mesotrione or topramezone carryover. This will appear as partially bleached trifoliates with some degree of leaf strapping.



## Pigment inhibitors

(continued)

**Chemical group:** triketones

**Herbicides:** mesotrione (Callisto – corn), topramezone (Impact – corn), tembotrione (Laudis - corn)

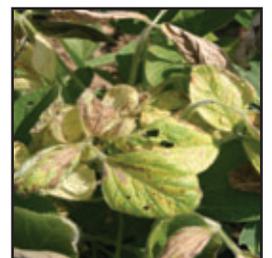
**Mode of action and characteristics of activity:**

Inhibition of p-hydroxy phenyl pyruvate dioxygenase. Control of annual broadleaf and some grass weeds; soil and foliar activity; medium soil persistence.

**General symptoms:** Plant tissue turns white (bleaching) then necrotic within three to five days. Translocates in xylem and phloem. Injury can be worse under cool, wet weather conditions.



Mesotrione injury on other vegetable plants will also appear as bleaching, especially toward the outer leaf edges.



> Injury from drift of triketone herbicides like mesotrione on soybean plants ranges from slight bleaching of the leaf margins to severe chlorosis and bleaching of the newest trifoliates, depending on the severity of drift or contact with the foliage.



# WEED IDENTIFICATION

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## Amaranth, Palmer (*Amaranthus palmeri*) also called Palmer pigweed

An erect summer annual pigweed that may reach 6½ feet in height. Seedlings have cotyledons that are narrow and green to reddish in color. First true leaves are alternate, ovate in shape, and slightly notched at the tip of the leaf. Mature leaves are alternate, without hairs, and lance shaped or egg shaped in outline. Leaves are 2 to 8 inches long and ½ to 2½ inches wide and occur on petioles that are usually longer than the leaves. Stems are without hairs. Seedheads are terminal panicles that reach ½ to 1½ feet in length. Smaller lateral inflorescences also occur between the stem and the leaf petioles.



## Summer annual broadleaf

## Anoda, spurred (*Anoda cristata*)

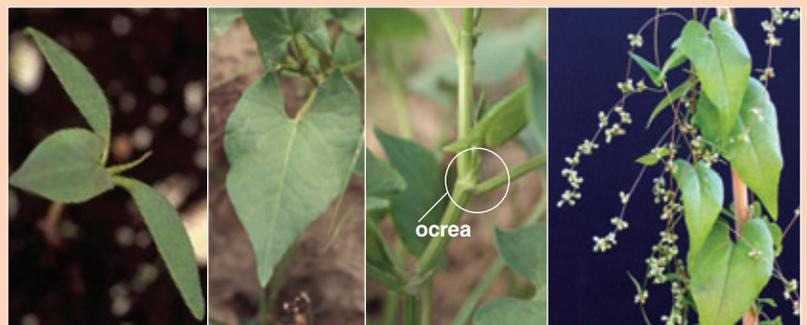
Erect annual with alternate, triangular leaves that are coarsely toothed. Spurred anoda is freely branching from the base and may reach 3½ feet in height. Seedlings generally have one round and one heart-shaped cotyledon with hairs along the margins. Velvetleaf cotyledons are similar, but the first true leaves are not toothed like those of spurred anoda. First true leaves are alternate, triangular, and hairy along the margins and on both leaf surfaces. Leaf petioles often have stipules at the base. Solitary flowers arise from the leaf axils and are 7 to 12 mm wide with petals that are light blue to lavender in color.



## Summer annual broadleaf

## Buckwheat, wild (*Polygonum convolvulus*)

An annual twining or trailing vine that may reach as much as 3½ feet in length. Seedlings have cotyledons that are linear and without hairs. Stems are erect at first, then become twining or creeping and branched at the base. A membranous sheath (ocrea) surrounds the stem at the base of each leaf petiole, which helps to distinguish this weed from almost all other vining species that have a similar leaf shape. Leaves are alternate and triangular to heart shaped with a pointed tip. Basal lobes point inward toward the petiole. Flowers are inconspicuous and greenish white in color.



## Summer annual broadleaf

**Burcucumber** (*Sicyos angulatus*)

A summer annual climbing vine that closely resembles cucumber plants, especially during the early stages of growth. Vining stems are hairy especially at the leaf nodes, longitudinally ridged, and climb by way of branched tendrils. Cotyledons closely resemble those of ordinary cucumber cotyledons and are thick and oblong, with many spreading hairs on the top and bottom. Mature leaves are alternate, 2 to 8 inches long, 2 to 8 inches wide and hairy, with five pointed lobes and a toothed margin. Flowers are whitish to green and inconspicuous. Fruit is produced in clusters of 3 to 20 and resembles small cucumbers covered with long bristles.



**Summer annual broadleaf**

**Carpetweed** (*Mollugo verticillata*)

A late-germinating, much-branched summer annual forming circular mats several feet in diameter. Carpetweed is primarily a weed of cultivated agronomic and horticultural crops. Leaves are smooth, without petioles, widest above the middle and taper to the base, and occur in whorls of three to eight at each node. Small white flowers are produced in clusters of two to five with slender flower stalks 5 to 15 mm long.



**Summer annual broadleaf**

**Cocklebur** (*Xanthium strumarium*)

A summer annual that produces a conspicuous prickly "cocklebur" fruit and ranges from ½ to 6½ feet in height. Common cocklebur is found throughout the United States and is primarily a weed of agronomic and horticultural crops, nurseries and occasionally pastures. Seedlings have cotyledons that are linear to oblong in outline, waxy, smooth, fleshy and thick. The first true leaves are opposite, while all subsequent leaves are alternate. Mature leaves are triangular to ovate in outline, have stiff hairs, and are 2 to 6 inches long. Leaves are irregularly lobed and occur on long petioles. Flowers are inconspicuous and greenish in color.



**Summer annual broadleaf**

**Copperleaf, hophornbeam** (*Acalypha ostryifolia*)

A summer annual that may grow to 40 inches in height with distinctly toothed leaves. Hophornbeam copperleaf is primarily a weed of agronomic crops but can also occur along fencerows, in landscapes and in nursery crops. Seedlings have two round cotyledons that are slightly hairy. Mature plants have leaves that are alternate, egg- or diamond-shaped, with finely toothed margins. Flowers are inconspicuous and occur on long axillary or terminal spikes. Hophornbeam copperleaf seedlings are often mistaken for prickly sida, but prickly sida has one round and one heart-shaped cotyledon.



**Summer annual broadleaf**

**Copperleaf, Virginia** (*Acalypha virginica*)

A summer annual with leaves that have a distinctive copper coloration. Seedlings have round, smooth cotyledons. Virginia copperleaf is a weed of cultivated agronomic, nursery, and horticultural crops, landscapes and roadsides. First true leaves are opposite, while all subsequent leaves are alternate. Leaves are lanceolate in outline,  $\frac{3}{4}$  to 3 inches long, and occur on petioles. Youngest leaves develop a distinct copper coloration. Many inconspicuous green flowers occur in clusters in the areas between the stem and leaf petioles.

**Summer annual broadleaf**



**Croton, tropic** (*Croton glandulosus* var. *septentrionalis*)

A summer annual that ranges from 4 to 20 inches in height with toothed leaves and white, disc-like glands that occur above and below the petiole at the point of attachment to the stem. Tropic croton is sometimes confused with eclipta. However, the leaves of eclipta are more linear in outline and arranged oppositely along the stem, unlike the alternate leaves of tropic croton. Prickly sida, or teaweed, also resembles tropic croton in growth habit and appearance. Prickly sida has linear stipules at the base of the petiole but lacks the glands that occur on tropic croton. The stems of tropic croton are also much hairier than those of prickly sida.

**Summer annual broadleaf**



**Galinsoga, hairy** (*Galinsoga ciliata*)

A summer annual with hairy leaves and stems, reaching 2 feet in height. Hairy galinsoga is primarily a weed of vegetable crops, but it may occur in any cultivated situation. Seedlings have cotyledons that are club shaped with a slightly indented tip. Leaves are opposite, oval to triangular and coarsely toothed. They occur on petioles and are densely covered with hairs on the upper surface. Lower leaf surfaces have hairs that primarily occur on the veins. Many flowers are produced on each plant. They consist of four to five white (less often pink), three-toothed ray flowers (outer flowers) and many yellow disk flowers (inner flowers).

**Summer annual broadleaf**



**Horseweed or Marestalk** (*Conyza canadensis*)

An erect winter or summer annual that may reach as much as 6½ feet in height. Seedlings have cotyledons that are small and oval, first true leaves are egg shaped with toothed margins, becoming hairy with age. Mature plants have leaves that are entirely without petioles, hairy, alternate, linear and usually toothed. Leaves become progressively smaller up the stem. Small white flower heads occur at the top of the central stem. Many small white bristles are attached to the achene, which facilitates aerial dispersal of the seed.

**Summer annual broadleaf**



**Jimsonweed (*Datura stramonium*)**

An erect summer annual with large white to purple flowers and a distinctive odor. Seedlings have cotyledons that are thick, hairless, long and linear in outline, and with a clearly evident midvein. The stem below the cotyledon (hypocotyl) is initially maroon in color toward the base, eventually becoming maroon throughout. Mature plants have leaves that occur on long stout petioles and are large (3 to 8 inches long, 6 inches wide), ovate, without hairs, and with a few large triangular teeth along the margin. The fruit is a large egg-shaped capsule covered with spines; it splits into four segments when mature.



**Summer annual broadleaf**

**Kochia (*Kochia scoparia*)**

An erect, much-branched summer annual weed of agronomic crops, pastures and roadsides. Seedlings have cotyledons that are narrow, essentially linear in outline, dull green in color and covered with hairs. Mature plants have leaves that occur alternately along the stem and are linear to lanceolate in outline, ranging from 1 to 2 inches in length and tapering to a point. Leaves do not occur on petioles and usually have hairs only along the leaf margins. Flowers are inconspicuous and occur in clusters at the ends of stems and in the leaf axils. Flowers have distinctive hairy bracts beneath, which tends to give the flowering stems a "prickly" appearance.



**Summer annual broadleaf**

**Lambsquarters, common (*Chenopodium album*)**

A summer annual weed primarily of cultivated agronomic and horticultural crops that may reach 3½ feet in height and produce thousands of seeds per plant. Seedlings have cotyledons that are elliptic to linear in outline and dull green on the upper surface and maroon on the underside. The first pair of true leaves are opposite, and all other leaves are alternate. Seedling leaves are triangular and have a mealy gray cast on the upper leaf surface. Stems are erect, hairless, grooved, branching and light green to red in color. Flowers are small and clustered into panicles at tips of branches and upper leaf axils.



**Summer annual broadleaf**

**Lettuce, prickly (*Lactuca serriola*)**

An annual or biennial weed of nurseries, orchards, roadsides and agronomic crops. Leaves are arranged alternately along the stem of mature plants and range from 2 to 14 inches in length. Most leaves are distinctly lobed and have leaf bases that clasp the stem. All leaves have prickles that occur along the leaf margins and along the midvein on the lower leaf surfaces. Leaves emit a milky sap when cut and become progressively smaller up the flowering stem. Stems are erect, hollow and branching in the upper portions of the plant. Many small yellow flowers with 5 to 12 toothed petals are produced in the upper portions of the plant.



**Summer annual broadleaf**

**Mallow, common** (*Malva neglecta*)

**Summer annual broadleaf**

A summer annual or occasionally a winter annual or biennial, freely branching at the base, with a prostrate growth habit. Seedlings have cotyledons that are heart shaped and occur on long petioles. Young plants have alternate leaves that are circular in outline with toothed margins and a crinkled appearance. Mature plants have leaves that are alternate, circular to kidney shaped and toothed, with five to nine shallow lobes. Short hairs are present on upper and lower leaf surfaces, margins and petioles. Flowers are white or tinged with pink or purple and occur singly or in clusters in leaf axils. The fruit is flattened, round and resembles a button.



**Mallow, Venice** (*Hibiscus trionum*)

**Summer annual broadleaf**

A summer annual weed of agronomic and horticultural crops. Seedlings have cotyledons that are round and occur on long, hairy petioles. First true leaves are alternate and irregularly shaped with toothed margins. All subsequent leaves are lobed at least three times and are arranged alternately along the stem. Flower stalks arise from the leaf axils and consist of five petals that are pale yellow to white in color with a purple base. The five sepals resemble a membranous bladder with distinctive dark green veins.



**Morningglory, entireleaf** (*Ipomoea hederacea* var. *integriuscula*)

**Summer annual broadleaf**

A summer annual twining or climbing vine with heart-shaped leaves that may reach as much as 10 feet in length. Cotyledons are moderately indented with rounded points and have hairs that stick straight out from the cotyledon surface. Mature leaves are alternate, broadly heart shaped, and also have hairs that stick straight out from the leaf surface. The funnel-shaped flowers are attractive and purple to pale blue or white in color. Entireleaf morningglory closely resembles tall morningglory. Tall morningglory has hairs that lie flat on the leaf surface, while the hairs on entireleaf morningglory stick straight out from the leaf.



**Morningglory, ivyleaf** (*Ipomoea hederacea*)

**Summer annual broadleaf**

A summer annual twining or climbing vine with distinctive three-lobed leaves and large, showy, funnel-shaped purple to blue or white flowers. Seedlings have cotyledons that are only shallowly or moderately indented, and with a slight flare outward. The cotyledons of ivyleaf morningglory most closely resemble those of entireleaf and tall morningglory. However, the cotyledons of tall morningglory are usually more square in outline than those of ivyleaf or entireleaf morningglory. The first true leaf is unlobed. Subsequent leaves are alternate, three-lobed or ivy shaped, with hairs that stick straight out from the leaf.



**Morningglory, palmleaf (*Ipomoea wrightii*)**

A trailing or climbing annual vine with lobed leaves and pink to light purple flowers that range from ¾ to 1 inch in length. Palmleaf morningglory is primarily a weed of agronomic crops found in the southeastern United States. Seedlings have cotyledons that are deeply indented, have pointed ends and are without hairs. The cotyledons of palmleaf morningglory closely resemble those of pitted morningglory. Mature plants have leaves that are distinctly lobed into three to seven segments, giving the overall appearance of fingers on a hand. Individual segments range from ¾ to 2½ inches long. All lobes arise from the same point.



**Summer annual broadleaf**

**Morningglory, pitted (*Ipomoea lacunosa*)**

A trailing or climbing annual vine with heart-shaped leaves that taper to a point and attractive funnel shaped, white flowers. Seedlings have cotyledons that are deeply indented and taper to a point (compare with tall, ivyleaf and entireleaf morningglory). Cotyledons are also without hairs (glabrous). Mature plants have leaves that occur on relatively long petioles and are arranged alternately along the stem. Leaves can be without hairs or only slightly hairy, but do not have the appressed hairs typical of tall morningglory. Leaves are heart shaped in outline but taper to a narrow tip, unlike those of tall morningglory.



**Summer annual broadleaf**

**Morningglory, smallflower (*Jacquemontia tamnifolia*)**

A trailing or climbing summer annual with light blue flowers that may reach 6½ feet in length. Smallflower morningglory is an isolated weed of agronomic crops, nurseries and landscapes. Cotyledons are rounded with slight indentations and resemble those of a mustard seedling. Mature plants have leaves that occur on petioles arranged alternately along the stem. Leaves are ovate in outline, approximately 1¼ to 4½ inches long by ¾ to 3 inches wide. Hairs occur on the leaf margins and only occasionally on the leaf surfaces.



**Summer annual broadleaf**

**Morningglory, tall (*Ipomoea purpurea*)**

A trailing or climbing annual vine with heart-shaped leaves and purple to white flowers. Seedlings have cotyledons that are only moderately indented as compared with either pitted or palmleaf morningglory. Cotyledon lobes are rounded and not pointed to any degree and cotyledons are also almost perfectly square in outline. The first true leaf is heart shaped as are all subsequent leaves, but the first true leaf often is without hairs unlike the subsequent leaves. Mature leaves are arranged alternately along the stem and have hairs that lie flat against the leaf surface, unlike entireleaf morningglory. Older leaves have rounded bases that often overlap.



**Summer annual broadleaf**

**Nightshade, eastern black (*Solanum ptycanthum*)**

An erect summer annual, reaching as much as 1½ feet in height. Seedlings have cotyledons that are green on the upper surface, but distinctly purple- or maroon-tinted on the lower surface. Young leaves also remain purple- or maroon-tinted on the undersurface. Mature plants have leaves that are simple, alternate and ovate in outline. Stems are branching, round or angular, smooth or only partially hairy, and become woody with age. Flowers are star shaped, white or purple-tinged, and occur in umbel-like clusters of five to seven. Berries develop that are 5 to 12 mm in diameter, green when immature, turning purplish black at maturity.



**Summer annual broadleaf**

**Pigweed, prostrate (*Amaranthus blitoides*)**

A low-growing prostrate annual weed of many cultivated horticultural and agricultural crops. Seedlings have cotyledons that are narrow and generally longer than most other pigweed species. Cotyledons are often maroon underneath. Mature plants have leaves that are somewhat shiny on the upper surface and often have a distinctly notched tip. Leaves are often crowded at the ends of branches. Stems are succulent, sometimes with a reddish tint. Flowers are inconspicuous and produced in the leaf axils.



**Summer annual broadleaf**

**Pigweed, redroot (*Amaranthus retroflexus*)**

An erect summer annual that may reach as much as 6½ feet in height. Cotyledons are narrow and have a reddish tint. First true leaves are alternate, ovate in shape, and are slightly notched at the tip of the leaf blade. Hairs may occur on the leaf margins and along veins, especially along the lower leaf surfaces. Stems also have short hairs especially near the upper portions of the plant. Mature plants have leaves that are alternate, ovate in outline, with petioles that reach ½ inch in length. Flowers are inconspicuous and produced in dense, compact terminal and axillary panicles that are prickly to the touch.



**Summer annual broadleaf**

**Pigweed, smooth (*Amaranthus hybridus*)**

An erect summer annual that may reach as much as 6½ feet in height. Cotyledons are narrow and have a reddish tint. First true leaves are alternate, ovate in shape, and slightly notched at the tip of the leaf blade. Hairs may occur on the leaf margins and along veins, especially along the lower leaf surfaces. Stems also have short hairs, more so than with redroot pigweed. Mature plants have leaves that are alternate, ovate in outline, and generally with less wavy margins than redroot pigweed. Flowers are inconspicuous and produced in dense, compact terminal and axillary panicles that are longer than those of redroot pigweed and not prickly to the touch.



**Summer annual broadleaf**

**Pimpernel, scarlet** (*Anagallis arvensis*)

A low-growing annual that resembles chickweed but with showy reddish-orange flowers. Seedlings have cotyledons that are triangular in outline, dark green in color, shiny and covered with small hairs. Mature plants have leaves that are opposite, oval in outline, and reach 1 inch in length. Leaves do not occur on petioles. Lower leaf surfaces have small dark purple spots. Leaves may have tiny hairs and sometimes may occur in whorls of three. Stems are square in cross section, branch at the base, and may reach 10 inches in length. Individual flowers have five petals that are orange to red in color and occur on long flower stalks.



**Summer annual broadleaf**

**Poinsettia, wild** (*Euphorbia heterophylla*)

An erect annual with leaves like those of a poinsettia that emit a milky sap when broken. Stems are erect, branch oppositely from the base, and are hairy. Broken stems also emit a milky sap. Leaves are lanceolate in outline, approximately ½ to 3 inches long, with toothed margins. Leaves are oppositely arranged, usually have hairs, and often have a dark red spot on the upper surface, especially with age. Lower leaves may sometimes be alternately arranged. Leaves at the ends of stems near the flowers often appear whorled. Flowers occur in clusters at the ends of branches. Flowers are relatively inconspicuous and have no petals.



**Summer annual broadleaf**

**Purslane, common** (*Portulaca oleracea*)

A prostrate, fleshy, succulent summer annual that is able to tolerate poor, compacted soils and drought. Seedlings have cotyledons that are oblong, succulent and without hairs. Young leaves are maroon on the lower surface, opposite with each succeeding pair 90 degrees from the preceding pair. Mature plants have leaves that are alternate or opposite, ¼ to 1¼ inches long, rounded at apex and narrowed to the base. Leaves are thick, succulent and fleshy, with smooth margins. Stems are succulent, smooth, prostrate, much-branched, purplish red or green and 4 to 20 inches long. Flowers are yellow with five petals that open only when sunny.



**Summer annual broadleaf**

**Ragweed, common** (*Ambrosia artemisiifolia*)

A common summer annual weed of agricultural crops, pastures and roadsides. Seedlings have round cotyledons that are often purple underneath. Young leaves are opposite; subsequent leaves become alternate with age, with a dense covering of hairs over the entire leaf surface. Leaves are egg shaped in outline but highly divided. Stems are erect, branched, and have long rough hairs. Flowers are green and inconspicuous and produced at the ends of branches. The fruit that encloses the seed is a woody achene with several projections that resemble a queen's crown.



**Summer annual broadleaf**

**Ragweed, giant** (*Ambrosia trifida*)

An erect summer annual that can reach as much as 15 feet in height and thrives in fertile agricultural soils. Seedlings have cotyledons that are large, round and thick, three to four times larger than those of common ragweed. The first pair of true leaves is unlobed and lance shaped with toothed margins. At this stage, the seedlings can be confused with common cocklebur. Subsequent leaves are large and distinctively three-lobed, or less often five-lobed. Leaves are opposite, hairy, and occur on long petioles. As with common ragweed, flowers are green and inconspicuous. Giant ragweed also produces a large, black, crown-shaped achene that encloses the seed.

**Summer annual broadleaf**



**Sicklepod** (*Cassia obtusifolia*)

A summer annual weed of cultivated agricultural crops that may reach as much as 6 feet in height. Seedlings have cotyledons that are rounded, much more so than the subsequent egg-shaped leaflets. Distinctive veins (3-5) also occur on the cotyledons. Stems are erect, branched, and without hairs. Mature plants have leaves that are arranged alternately along the stem, which consist of four to six leaflets that are arranged oppositely from one another. Individual leaflets are egg shaped, with the broadest end above the middle. Flowers are yellow and plants eventually produce long, slender curved seedpods that contain many brown, angular seeds.

**Summer annual broadleaf**



**Sida, prickly** (*Sida spinosa*)

A summer annual with yellow flowers and distinctly toothed leaves. Seedlings have two cotyledons that are generally heart shaped with a small indentation at the cotyledon apices. The cotyledons and the stems below the cotyledons (hypocotyls) are covered with short hairs. Mature plants have leaves that are arranged alternately along the stem, approximately 3/4 to 2 inches long, and inconspicuously hairy. Leaves are oval to lanceolate in outline with toothed margins. Leaves occur on petioles that are 1/2 to 1 1/4 inches long and have small spines (stipules) at the base of each leaf petiole.

**Summer annual broadleaf**



**Smartweed, Pennsylvania** (*Polygonum pensylvanicum*)

A summer annual of horticultural, agronomic, and nursery crops that may reach 3 1/2 feet in height. Seedlings have cotyledons that are lanceolate in outline, with hairs along the margins. Mature plants have leaves that are arranged alternately along the stem and are also lanceolate in outline. Older leaves are usually only slightly hairy and often, but not always, have a purple spot in the middle of the leaf. Stems are branched, often reddish in color and swollen at the nodes. A thin membranous sheath called an ocrea encircles the stem at the base of each leaf petiole. Pink or white flowers are clustered in terminal spikes at the ends of stems.

**Summer annual broadleaf**



**Spurge, spotted (*Chamaesyce maculata*)**

A prostrate summer annual that often forms dense mats that may reach 16 inches in diameter. All parts of the plant emit a milky sap when broken. Seedlings have cotyledons that are oval, green above and tinted maroon below. Mature plants have opposite leaves that are egg shaped in outline and usually without hairs but sometimes long hairs may occur. Leaves often have a maroon spot on the upper leaf surface. Leaves occur on short petioles and leaf margins may be finely toothed (often indistinguishable) near the leaf apex. Stems branch out from a central point and are densely hairy and pink to red in color.



**Summer annual broadleaf**

**Spurry, corn (*Spergula arvensis*)**

A summer annual with finely divided leaves that ranges from 6 to 18 inches in height. Leaves are bright green and threadlike, generally only ½ to 1 inch in length, occurring in whorls around the stem joints. Stems are hairy and sticky to the touch, much-branched. Flowers occur in terminal clusters at the ends of stems and are small with five white petals. Egg-shaped seedpods split open into five parts to release many black, flat, round seeds.



**Summer annual broadleaf**

**Sunflower, common (*Helianthus annuus*)**

A stout summer annual that may reach as much as 9 feet in height with large yellow flowers. Seedlings have cotyledons that are relatively large and oval in outline. First true leaves are lanceolate with toothed margins. Mature plants have leaves that are alternate, rough and hairy, with toothed margins. Lower leaves occur on long petioles. Flower heads are robust and can range from 1 to 5 inches in diameter. Many outer yellow petals enclose the reddish brown disk flowers inside.



**Summer annual broadleaf**

**Velvetleaf (*Abutilon theophrasti*)**

An erect summer annual with leaves and stems that are covered with short, soft hairs. Seedlings have one round and one heart-shaped cotyledon, similar to spurred anoda. The first true leaves and subsequent leaves are alternate, heart-shaped, and covered with hairs on both surfaces. Mature leaves are approximately 2 to 6 inches long and wide and have slightly toothed margins. Small (½ to 1 inch) orange to yellow flowers with five petals are produced on flower stalks that arise from the leaf axils. Velvetleaf may reach as much as 7 feet in height and is a common weed of agricultural production systems.



**Summer annual broadleaf**

## Summer annual broadleaf

### Waterhemp, common (*Amaranthus rudis*)

A summer annual pigweed of agricultural crops. Seedlings have egg-shaped cotyledons, much more so than other pigweeds. First true leaves are lance shaped, without hairs, and have a glossy appearance. Mature plants range from 4 inches to 12 feet in height and have long and narrow leaves (lance shaped) that are also waxy or glossy in appearance. Waterhemp stems are also hairless, similar to palmer amaranth but unlike redroot and smooth pigweed and Powell amaranth. Seedheads of male waterhemp are generally more compact than female waterhemp seedheads, which have a more open habit.



**Bittercress, smallflowered** (*Cardamine parviflora*)

A winter annual weed of nurseries, landscapes and agronomic crops. Plants form a rosette with divided leaves initially and then produce flowering stems with distinctive seedpods. Leaves consist of one to three pairs of alternate round to oblong leaflets. Plants usually have 4 to 10 stem leaves. Basal leaves are completely absent at maturity. Flowers occur in dense clusters at the ends of the flowering stems. Individual flowers are small (2 to 3 mm) and consist of four white petals. Seedpods are long, narrow capsules (siliques) that dehisce explosively and propel seed away from the plant.

**Winter annual broadleaf**



**Buttercup, bulbous** (*Ranunculus bulbosus*)

A low-growing perennial with divided leaves and flowers that have five to seven bright yellow petals. Bulbous buttercup is most easily identified by the thickened base of the plant, which is a structure known as a corm. Corms are not always as evident as that pictured; in younger plants a thickened base may be all that occurs. Seedlings have cotyledons that occur on petioles and are oval to elliptic in outline. Basal leaves occur on long petioles and are divided into three lobes. As the leaves mature, the central lobe occurs on its own stalk while the lateral lobes are attached directly to the main leaf petiole. Stem leaves are generally smaller than the basal leaves and are arranged alternately along the stem.

**Winter annual broadleaf**



**Buttercup, corn** (*Ranunculus arvensis*)

An erect winter annual with distinctive yellow buttercup flowers. Leaves consist of both basal and stem leaves (cauline). Basal leaves occur on long petioles, are spatulate in outline, and have toothed margins. Stem leaves are dissected into three-parted linear segments that are about 3 mm in length and 5 mm in width, and are without petioles. Stem leaves are usually without hairs but can also be sparsely hairy. Flowers are yellow with five sepals 3 to 5 mm long and five petals 4 to 6.5 mm long.

**Winter annual broadleaf**



**Chickweed, common** (*Stellaria media*)

Most often a winter annual that can sometimes become a perennial under certain environmental conditions. Common chickweed is primarily a weed of winter small grains but also forms dense mats of green vegetation prior to planting no-till corn or soybeans. Leaves are arranged oppositely and are elliptic in outline, 1/2 to 1 inch in length, and mostly hairless. Stems often root at the nodes and have hairs that occur in vertical rows. Small white flowers occur at the end of stems alone or in small clusters.

**Winter annual broadleaf**



**Chickweed, mouseear (*Cerastium fontanum* ssp. *vulgare*)**

A spreading, mat-forming perennial that thrives during the winter months. Mouseear chickweed is a weed of winter small grains, no-till cropping systems, landscapes and turfgrass. Leaves are opposite, dull-green, oval to elliptic in outline, lacking petioles, and are covered with hairs on the upper surface and the veins beneath. Flowers occur in clusters of three at the end of stems. Flowers consist of five white petals that are deeply lobed, giving the appearance of 10 petals. Mouseear chickweed is similar in growth habit and appearance to common chickweed, but has densely pubescent leaves and stems and roots at the nodes.



**Winter annual broadleaf**

**Cornflower (*Centaurea cyanus*)**

An erect winter annual with long white hairs and blue, white or pink flowers. Seedlings have cotyledons that are without hairs, but the first true leaves have hairs and a grayish appearance. Mature plants have leaves that are narrow, 2 to 6 inches long and less than 1 inch wide. Due to the leaf appearance, these plants are often confused for a grass. Leaves are alternate, linear in outline, and covered with long white hairs. Cornflower produces many solitary flower heads on long flower stalks. Individual flower heads are about 1 to 2 inches wide and blue to purple, white or pink in color.



**Winter annual broadleaf**

**Cress, mouse-ear (*Arabis thaliana*)**

A low-growing winter annual weed of fallow fields, no-till crops, pastures and roadsides. Basal rosette leaves occur on short petioles, are usually oblong or spatula shaped in outline with entire margins, and are covered in soft hairs above and below. Flowering stem leaves are alternate and without petioles, much smaller and more linear in outline. Flowers occur in clusters at the ends of the flowering stems. Individual flowers consist of four small white petals with a yellow center. The seedpods are small narrow capsules (siliques) about 1/2 inch in length.



**Winter annual broadleaf**

**Deadnettle, purple (*Lamium purpureum*)**

A winter annual weed with square stems and pink to purple flowers. Seedlings have cotyledons that are oval with a notch at the base of the cotyledon where it joins the petiole. Leaves are opposite, heart shaped to triangular in outline, sparsely hairy or without hairs. Leaf margins have a "scalloped" appearance and are toothed and often bristly hairy. Stems root at the lower nodes and are square in cross section. Flowers are pink to purple in color and are fused into a tube about 2/3 inch long. Unlike henbit, purple deadnettle has upper leaves that are triangular and occur on petioles.



**Winter annual broadleaf**

**Eveningprimrose, common** (*Oenothera biennis*)

Usually a biennial or a winter annual, but may also occur as a summer annual. Mature plants have leaves that are elliptic to lanceolate in outline, are relatively narrow, and have untoothed margins. Leaves have a distinctive white or pink midvein and may have wavy margins. Leaves along the erect, flowering stem are alternate and become progressively smaller up the stem. Stems are erect and may reach as much as 6½ feet in height. Flowers occur in the upper leaf axils and are ¾ to 2 inches in width and consist of four bright yellow petals. The fruit is an erect, hairy capsule, ½ to 1½ inches in length.



**Winter annual broadleaf**

**Eveningprimrose, cutleaf** (*Oenothera laciniata*)

Cutleaf evening-primrose is almost always a biennial or a winter annual unlike common eveningprimrose which is more often a summer annual. Cutleaf eveningprimrose has leaves with deeply toothed margins and produces many showy yellow or red flowers. Leaves initially develop as a basal rosette. Young leaves have margins that are untoothed, but subsequent leaves have toothed margins. Mature plants have leaves that are lanceolate in outline, are relatively narrow with a white midvein, and have deeply toothed margins. The fruit is a capsule that is about ¾ to 1½ inches long and often curved.



**Winter annual broadleaf**

**Filaree, redstem** (*Erodium cicutarium*)

A winter annual weed that has showy pink to purple flowers and ranges from 4 to 20 inches in height. Cotyledons and first true leaves are deeply lobed and occur on long, hairy petioles. Plants first develop as a basal rosette. Rosette leaves occur on petioles and are divided into three to nine individual leaflets that are arranged oppositely from one another. Individual leaflets are deeply lobed and do not have petioles. Flowers occur in clusters on long flower stalks. Individual flowers are about ½ inch wide and consist of five pink to purple petals. The fruit resembles a bird's beak and is about ½ to ¾ inch long.



**Winter annual broadleaf**

**Fleabane, annual** (*Erigeron annuus*)

A winter annual or sometimes biennial reaching 1 to 2 feet in height with prominent white and yellow flowers. Annual fleabane is primarily a weed of abandoned fields, pastures or no-till cropping systems and closely resembles horseweed or mare's tail. Basal rosette leaves are similar to but usually much wider than those of horseweed while upper leaves become more lanceolate in outline along the flowering stem. All leaves are toothed and contain hairs.



**Winter annual broadleaf**

**Geranium, Carolina** (*Geranium carolinianum*)

**Winter annual broadleaf**

A winter annual or more often a biennial, forming a basal rosette initially with subsequent stem elongation and branching as the plant matures. Seedlings have cotyledons that are hairy, kidney shaped, green above and pink below. Mature plants have stems that are usually pink to red in color and densely hairy. Leaves are alternate near the base, opposite above, and hairy on both surfaces. Leaves are rounded in appearance and deeply (palmately) divided into five to nine segments, each of which is also lobed or toothed. The fruit is an elongated beak that gives this structure the appearance of a crane's bill, which is also another common name of this weed.



**Geranium, dovefoot** (*Geranium molle*)

**Winter annual broadleaf**

also called dovesfoot cranesbill

A winter annual or biennial that closely resembles Carolina geranium but has smaller flowers and round leaves not as deeply divided as those of Carolina geranium. Leaves occur on long petioles that have hairs. Individual leaves are round in outline and divided into five to seven lobes. Leaves on the upper stems are much smaller with shorter petioles. Leaves have hairs on the upper and lower surfaces. Flowers consist of five petals that are dark pink to purple in color. Each petal is notched at the apex to about one-third of the total length.



**Groundsel, cressleaf** (*Packera glabella*)

**Winter annual broadleaf**

also called butterweed

A winter annual weed of agronomic crops, pastures or roadsides. Leaves initially form as a basal rosette. Stem leaves are arranged alternately along the stem, are without petioles, and become progressively smaller up the stem. Leaves are highly lobed with the terminal lobe being much larger and more rounded than any of the lateral lobes. Stems are erect, thick, succulent, often tinged with red or purple, and may reach 3 feet in height. Many bright yellow flowers are produced at the ends of the flowering stems. Individual flower heads consist of yellow petals with a yellow center.



**Henbit** (*Lamium amplexicaule*)

**Winter annual broadleaf**

A very common winter annual weed with square stems and pink to purple flowers found throughout the United States. Seedlings have cotyledons that are oval and the base of the cotyledon is notched where it joins the petiole. Leaves are opposite, circular to heart shaped, with hairs on the upper leaf surfaces and along the veins of the lower surface. Leaf margins have rounded teeth. Lower leaves occur on petioles, while the upper leaves are without petioles. Stems root at lower nodes, are square in cross section and are covered with downward-pointing hairs. Flowers are pink to purple in color and fused into a tube.



**Knawel (*Scleranthus annuus*)**

Usually a winter annual but occasionally a summer annual weed that forms dense, prostrate mats. Knawel is commonly mistaken for a grass and is primarily a weed of lawns, turfgrass and small grains. Seedlings have cotyledons that are linear in outline and less than 1 mm wide with a sharp tip. Mature plants also have the same kind of leaf structure. Leaves are arranged oppositely along the stem and joined by a thin, clear membrane. Stems grow prostrate along the ground, are branching, and form dense mats outward from a central plant. Flowers are inconspicuous, green and spiny.



**Winter annual broadleaf**

**Mousetail (*Myosurus minimus*)**

A low-growing winter annual weed primarily of fallow and no-tillage agronomic crops. Seedling leaves are small and linear in outline, leading most to believe this plant is a grass rather than a broadleaf weed. Mature plants also have leaves that are linear in outline, no more than 3 mm in width, shiny, and without hairs. Flowers are small and consist of five very small white to yellowish white petals. The plant derives its name from the cylindrical, compressed spike that contains more than 100 carpels and resembles a mouse's tail.



**Winter annual broadleaf**

**Mustard, hedge (*Sisymbrium officinale*)**

Usually a winter annual but can also occasionally occur as a summer annual or even a biennial. Mature plants have leaves that are alternate and deeply lobed, with individual leaf segments having wavy margins that are also toothed. Both the upper and lower leaf surfaces are covered with hairs. Stems are erect and covered with bristly hairs, reaching 3½ feet in height. Flowers are produced in clusters at the ends of stems. Individual flowers are small and consist of four yellow petals with four sepals. The seedpod is a narrow capsule that is pressed closely against the stems.



**Winter annual broadleaf**

**Pennycress, field (*Thlaspi arvense*)**

A winter annual weed of small grains, nurseries and horticultural crops throughout the United States. Seedlings have cotyledons that are oval to oblong in outline and occur on long (5–7 mm) petioles. Leaves that initially develop into a basal rosette are without hairs and are oval in outline, with a wavy margin. Leaves along the flowering stem are generally much different from those of the basal rosette. Stem leaves are more lanceolate in outline, lack petioles, usually have toothed margins, and have pointed lobes that clasp the stem at the base of the leaf. Individual white flowers are very small and occur in clusters at the ends of the “bottle-brush” stems.



**Winter annual broadleaf**

**Pennycress, thoroughwort** (*Microthlaspi perfoliatum*)

**Winter annual broadleaf**

A winter annual weed of roadsides, landscapes and occasionally no-tillage agronomic crops. Basal rosette leaves occur on petioles, are without hairs, and are elliptic to oblong in outline. Leaves on the flowering stem have rounded bases that clasp the stem and become progressively smaller toward the top. Flowers occur in the upper portions of the terminal inflorescence and are very small (3 mm long, 1 mm wide) and consist of four white petals with yellow anthers in the center. The fruit closely resembles that of shepherd's-purse, but is generally more heart shaped, less triangular in outline, and larger than that of shepherd's-purse.



**Pepperweed, field** (*Lepidium campestre*)

**Winter annual broadleaf**

A common winter annual found throughout the United States. Seedlings have cotyledons that occur on petioles, are hairless, 12 to 15 mm long, and oval. Rosette leaves and lower stem leaves are rounded but taper to the base. Margins may be lobed, toothed or entire. Upper stem leaves do not have petioles and are clasping at the base. All leaves are covered with short hairs. Individual flowers are 2 mm long, have four white or greenish white petals, and occur on stalks 4 to 8 mm long. Many fruits make up the distinctive "pepperweed" seedhead, which is ovate, 5 to 6 mm long and 4 mm wide, with a winged structure at the apex.



**Pepperweed, Virginia** (*Lepidium virginicum*)

**Winter annual broadleaf**

A winter annual weed that develops as a basal rosette, then produces flowering stems that have a "bottle-brush" appearance. Seedlings have cotyledons that are hairless, oval and occur on long petioles. Rosette leaves are without hairs, oval in outline, and lobed along both sides of the leaf. Rosette leaves do not usually persist once flowering stems are produced. Leaves that occur along the flowering stem are lanceolate or linear in outline and do not have petioles. Flowers are produced at the ends of stems in a dense "bottle-brush" inflorescence. Individual flowers consist of four white or greenish white petals and are small and relatively inconspicuous.



**Pineapple-weed** (*Matricaria discoidea*)

**Winter annual broadleaf**

A summer or winter annual with finely dissected leaves that emit a sweet "pineapple-like" odor when crushed. Individual leaves are arranged alternately along the stem and are from 1 to 5 cm in length. Each leaf is hairless and divided into many narrow segments, each 1 to 2 mm wide. Stems are smooth, hairless and branched. One or several flowers are produced at the ends of the stems on short flower stalks (peduncles). Individual flowers are cone shaped and ¼ to ½ inch in diameter. Flowers are greenish yellow in color.



**Radish, wild** (*Raphanus raphanistrum*)

Usually a winter annual or biennial weed of agronomic crops, forages, nurseries and horticultural crops found throughout the United States. Leaves initially develop as a basal rosette of highly lobed leaves. Basal leaves are elliptic in outline, about 8 inches long by 2 inches wide, and occur on petioles. Stem leaves are alternate, lanceolate in outline, without petioles and with toothed margins. All leaves are covered with stiff hairs. Individual flowers are about ½ to ¾ inch in diameter and consist of four light yellow petals. Plants have a large taproot with a distinctive radish odor and taste.



**Winter annual broadleaf**

**Rocket, yellow** (*Barbarea vulgaris*)

A winter annual or biennial with shiny green foliage and bright yellow flowers. Seedlings have cotyledons that are egg shaped and slightly notched at the tip. First true leaves are rounded, usually with wavy margins. Basal leaves are about 2 to 8 inches long and lobed with one large terminal lobe and one to four oppositely arranged lateral lobes. Terminal lobes have a heart-shaped base. Leaves become smaller and less lobed toward the top of the plant. All leaves are alternate and have margins that are wavy and toothed. Individual flowers are bright yellow in color and consist of four yellow petals.



**Winter annual broadleaf**

**Shepherd's-purse** (*Capsella bursa-pastoris*)

A winter annual with a low-growing basal rosette growth habit and distinctive triangular seedpods. Seedlings have cotyledons that are round and narrow to the base. First true leaves begin to form a basal rosette; however, young rosettes take some time before the distinctive lobes become noticeable. Basal rosette leaves are lobed into triangular segments. The leaves are covered with hairs on the upper surface, especially in younger plants. Flowers are barely noticeable, small and white to greenish white in color, produced at the ends of the flowering stems. The seedpods occur alternately along the stem and are heart shaped to triangular in outline.



**Winter annual broadleaf**

**Sowthistle, spiny** (*Sonchus asper*)

An annual weed that may reach as much as 6 feet in height with bluish green leaves and stems that emit a milky sap when cut. Young leaves form a basal rosette. Leaves are generally hairless, egg shaped in outline with prickly margins. Leaves that occur on the flowering stem are alternate and have rounded lobes that clasp the stem. Leaves also emit a milky sap when broken. Yellow flowers occur in clusters at the ends of stems and range from ½ to 1 inch in diameter.



**Winter annual broadleaf**

**Speedwell, corn** (*Veronica arvensis*)

**Winter annual broadleaf**

A winter annual with a prostrate growth habit initially, then developing flowering stems that are upright. Seedlings have triangular or spatula-shaped cotyledons that are covered with hairs. Leaves on the lower portion of the plant are opposite, occur on petioles, are hairy, and have rounded teeth along the leaf margins. Leaves on the upper flowering portions of the plants are much different and are arranged alternately, without petioles and narrow in outline. Flowers occur in the upper portions of the flowers stems. Individual flowers are no more than 4 mm in diameter and are light blue to white in color.



**Speedwell, purslane** (*Veronica peregrina*)

**Winter annual broadleaf**

A winter annual weed primarily of agronomic crops found throughout the United States. Seedlings have oblong cotyledons and with opposite true leaves. Lower leaves are opposite, occur on petioles, and are linear to ovate in outline with toothed margins. Upper leaves are alternate, without petioles, smaller and much more linear in outline with entire margins. Flowers are very small and occur in the upper leaf axils of the flowering stems. Individual flowers consist of four white petals. The fruit is a triangular to heart-shaped capsule that contains many small seeds.



**Violet, field** (*Viola arvensis*)

**Winter annual broadleaf**

Field violet has leaves that are oval to spatula shaped in outline with round teeth along the margin. Upper leaves that occur along the flowering stem are much more linear in outline than basal leaves. Stipules occur at the base of the leaf petioles in the upper portions of the flowering stem, and these stipules are divided into five to nine linear segments. Individual flowers are typically ½ inch in length and width and consist of five petals that are white to yellow in color, usually with some purple markings or purple tinges. Four smaller petals occur above one larger petal.



**Wallflower, bushy** (*Erysimum repandum*)

**Winter annual broadleaf**

A winter annual weed of agronomic crops found throughout much of the United States. Seedlings have spoon-shaped cotyledons that are notched at the tip. Mature plants have leaves that are alternate and linear in outline. Basal leaves are generally more lobed and have wavier margins than those of stem leaves, which have entire margins and are more linear in outline. Basal and stem leaves are covered with short hairs. Flowers are relatively small and pale yellow in color. The fruits are long, slender pods that are very noticeable at maturity.



**Burdock, common** (*Arctium minus*)

A biennial that produces a rosette of very large leaves during the first year and branched, upright stems with many burs during the second year of growth. Primarily a weed of pastures and other noncrop areas but is becoming increasingly problematic in no-till cropping systems. Rosette leaves are broadly heart shaped, 6 to 18 inches long, 4 to 14 inches wide, with hollow petioles and wavy, toothed margins. Stem leaves are much smaller, alternate and egg shaped. Small purple to lavender flowers occur in clusters at the ends of branches or from the region between the stem and leaf petioles. Flowers dry to a bur that has distinctly "hooked" bracts.



**Biennial broadleaf**

**Poison hemlock** (*Conium maculatum*)

A taprooted biennial that may reach as much as 10 feet in height. Primarily a weed of pastures and roadsides throughout the United States, but becoming more problematic in no-till cropping systems. Leaves are alternate, triangular in outline, 8 to 16 inches long, finely divided, and often have a dark glossy green appearance. Stems that are produced during the second year of growth are erect, branching, without hairs, ridged, hollow except at the nodes, and distinctly purple-spotted. Large white, flat-topped flowers (compound umbels) occur at the ends of the branches.



**Biennial broadleaf**

**Wild carrot** (*Daucus carota*)

also called Queen Anne's lace

A biennial that is closely related to garden carrots, but with a much reduced taproot. During the second year of growth, the plants produce stalks with white, flat-topped flowers. A solitary purple flower often occurs in the center of the cluster of white flowers and these flower clusters often curve inward at maturity producing a "bird's nest." Cotyledons of emerging seedlings are linear to the extent that they are often mistaken for a grass seedling. Leaves have long petioles, are without hairs on the upper surface, and may have hairs on the veins and margins of the lower surface. Leaves on the flowering stems are alternate, oblong in outline, with lobed segments.



**Biennial broadleaf**

**Bindweed, field (*Convolvulus arvensis*)**

**Perennial broadleaf**

A perennial trailing or climbing vine with white trumpet-shaped flowers that may reach 3½ feet in length. Field bindweed is primarily a weed of nurseries, agronomic crops, and fencerows and can be found throughout the United States. Cotyledons are square shaped and dark green with relatively prominent white to light green veins. Leaves are triangular in outline with leaf bases that are lobed and point outward. Leaves and stems may be with or without hairs. Field bindweed is often confused with wild buckwheat. However, wild buckwheat has inward-pointing bases and an ocrea at the base of each petiole.



**Chicory (*Cichorium intybus*)**

**Perennial broadleaf**

A perennial that resembles dandelion when in the rosette stage but produces an attractive blue or purple flower when mature. Chicory is primarily a weed of pastures and no-till cropping systems throughout the United States. Plants initially develop as a basal rosette of leaves that are 3 to 10 inches long by ½ to 3 inches wide. Stems are branched and produce blue or purple flowers during the latter part of the growing season. Leaves that occur on the flowering stalks are much smaller than the rosette leaves and also have leaf bases that surround or clasp the stem.



**Dandelion (*Taraxacum officinale*)**

**Perennial broadleaf**

A taprooted perennial from a basal rosette with yellow flowers and a "puffball" seedhead. Dandelion is one of the most common and problematic weeds of turfgrass throughout the United States and also occurs as a weed of no-till cropping systems. All leaves occur on the basal rosette and are oblong in outline with deeply indented lobes that point toward the center of the plant. Yellow flowers occur on the end of unbranched leafless hollow stalks. The feathery pappus attached to each seed collectively forms the "puff-ball" seedheads and aids in wind dispersal of the seed.



**Dock, curly (*Rumex crispus*)**

**Perennial broadleaf**

also called sour dock, yellow dock

A taprooted perennial that emerges in the fall, persists throughout the winter as a basal rosette then bolts and produces seed on the end of unbranched stems in early summer. Found throughout the United States as a weed of pastures, forages, landscapes and some agronomic crops. Rosette leaves occur on long petioles, are without hairs, and are dark green with conspicuously wavy margins. Stem leaves are arranged alternately along the stem, have a membranous sheath (ocrea) that encircles the stem, and become progressively smaller up the flowering stalk. Leaves and stems become more reddish purple with age.



**Dogbane, hemp** (*Apocynum cannabinum*)

A perennial that resembles a milkweed with opposite leaves that secrete a milky sap when broken. Leaves are ovate or elliptic in outline, as much as 1½ inches wide by 5 inches long, and are arranged oppositely along the stem. Stems reach 5 to 6 feet in height, branch especially in the upper portions of the plant, and often have a reddish tint when mature. The seedpods are long and narrow and usually turn reddish brown and split open when mature to expose the seed with long white silky hairs. Flowers occur in inconspicuous clusters and are greenish white in color.



**Perennial broadleaf**

**Groundcherry** (*Physalis* spp.)

A perennial from rhizomes (creeping roots), 8 inches to several feet in height. Mature plants develop a papery case over the berry. Leaves are alternate, ovate in outline, and may be either hairless or hairy depending on the species. Stems are erect and branching and have hairs. Yellow flowers with purple centers are produced singly on the ends of flower stalks. A distinctive papery case (calyx) surrounds the single, round berries. The berries of smooth groundcherry are orange, red, or purple when mature while those of clammy groundcherry are yellow when mature.



**Perennial broadleaf**

**Healall** (*Prunella vulgaris*)

A perennial with square stems and light blue to purple tube-shaped flowers. Seedlings have cotyledons that are spatula shaped. First true leaves as well as all subsequent leaves have "crinkled" surfaces. Leaves are arranged oppositely along the stem and are oval shaped in outline. Lower leaves occur on petioles while upper leaves may not. Stems are branched and usually grow prostrate along the ground. Stems are distinctly square and hairy when young but usually without hairs on older plants. Stems can root at the nodes. Flowers occur in spikes at the ends of erect stems.



**Perennial broadleaf**

**Horsenettle** (*Solanum carolinense*)

A perennial from rhizomes (creeping roots) with conspicuous spines on the leaves and stems. Leaves are arranged alternately along the stem, occur on petioles, and are covered on both surfaces with star-shaped hairs. Leaves also emit a potato odor when crushed, and contain prominent spines on the midvein and petiole underneath. Flowers occur in clusters on prickly stalks and are star shaped with five white to violet petals and a yellow cone-shaped center. Round berries are produced that are green when immature and turn yellow and wrinkled with maturity. A single berry may contain from 40 to 120 seeds.



**Perennial broadleaf**

**Knotweed, Japanese** (*Solanum carolinense*)  
also called Japanese bamboo

An invasive perennial introduced to the United States from Japan as an ornamental that spreads by rhizomes and seed. Japanese bamboo now occurs as a weed of riverbanks, landscapes and occasionally no-till agronomic crops. Leaves are arranged alternately along the stem, are egg shaped in outline and about 4 to 6 inches long by 2½ to 4¼ inches wide. Leaf bases are cut straight across. Stems are stout, hollow and jointed and resemble those of bamboo. A thin membranous sheath (ocrea) encircles the stem at each joint. Stems may reach as much as 13 feet in height. Flowers occur in clusters and are small and white.



**Perennial broadleaf**

**Milkweed, common** (*Asclepias syriaca*)

A perennial from a deep rhizome (creeping root) that excretes a milky sap when broken. Various milkweed species occur throughout the United States, this is one of the few that also invades agronomic production fields in addition to pastures and roadsides. Leaves are opposite, oblong to oval in outline, 4 to 12 inches long, 2 to 4 inches wide. Stems are unbranched, hollow, and also emit a milky sap when broken. Pinkish to white flowers occur in clusters at the end of stems. Large teardrop-shaped fruit often split open in the fall to facilitate aerial dispersal of seeds, which have tufts of silky hairs.



**Perennial broadleaf**

**Milkweed, honeyvine** (*Ampelamus albidus*)

A perennial with slender, climbing or trailing stems that may reach 10 feet in length. Although the name implies a secretion of milky sap as in other milkweed species, this does not occur in the leaves or stems of honeyvine milkweed. Leaves are opposite, heart shaped, as much as 7 inches long and 5 inches wide, hairless, and occur on petioles that are 1 to 4 inches long. Unlike other morning-glory or bindweed species, leaf surfaces have distinctive white veins that arise from a common point. Flowers are small and white and occur in clusters. A large, smooth teardrop shaped fruit with many seed is produced later in the season.



**Perennial broadleaf**

**Mugwort** (*Artemisia vulgaris*)

Perennial weed that is similar in appearance to the garden chrysanthemum but with persistent rhizomes that may be spread or transported by cultivation equipment. Leaves are 2 to 4 inches long, 1 to 3 inches wide, simple, alternate, deeply lobed, and have a distinctive aroma. Leaves on the upper portions of the plant are more deeply lobed and may lack petioles. Leaf undersides are covered with soft, white to gray hairs, while upper leaf surfaces may be smooth to slightly hairy. Stems may reach 5 feet in height and become woody with age. Flowers are inconspicuous and occur in clusters at the top of plants.



**Perennial broadleaf**

**Passionflower, maypop** (*Passiflora incarnata*)

A herbaceous perennial vine with distinctive three-lobed leaves and attractive white and purple flowers that may reach 6½ feet or more in length. Seedlings can occur but sprouts from perennial rootstocks are much more common. Seedlings have thick, oval cotyledons that are glossy in appearance. Mature leaves are arranged alternately along the stem, are slightly hairy, and are distinctly three-lobed (rarely with five lobes). Roots initially occur as a taproot but eventually develop a very deep perennial rootstock from which subsequent sprouts emerge. Mature plants have relatively large oval fruits that “pop” when they are stepped on, thus the name.



**Perennial broadleaf**

**Pokeweed, common** (*Phytolacca americana*)

A large, 3 to 10 feet tall perennial with thick, reddish-purple branched stems and dark purple to black berries. All parts of the plant are poisonous to cattle, horses, swine and humans, especially the roots. Leaves are alternate, up to 12 inches long and 4 inches wide, egg shaped, petiolated, and without hairs. Plants persist from a large white taproot that may reach up to 6 inches in diameter. Seedlings have cotyledons that are long and pointed. Stems below the cotyledons are often succulent and purplish in color.



**Perennial broadleaf**

**Smartweed, swamp** (*Polygonum coccineum*)

An erect perennial from rhizomes. It typically occurs in low, wet areas of no-till crop fields but also in ditches or along the shorelines of ponds and marshes. Plants may reach as much as 3 feet in height. Leaves occur alternately along the unbranched stems and are oval to lanceolate in outline and are up to 2½ inches wide with wavy margins that taper to a point. A membranous sheath called an ochrea surrounds the stem at the base of each leaf. Flowers are pink to rose-colored and occur as 1- to 3-inch spikes at the ends of stems.



**Perennial broadleaf**

**Sorrel, red** (*Rumex acetosella*)

A perennial from rhizomes with distinctive arrowhead-shaped leaves and red flowers and stems. Leaves initially develop as a basal rosette, but some leaves occur on the flowering stem as well. Basal rosette leaves occur on petioles and are 1 to 3 inches long, without hair, and arrowhead shaped because of two lobes that occur at the leaf base. Leaves that occur on the flowering stem are arranged alternately, are usually linear in outline (not arrowhead shaped), and are without distinctive petioles. All leaves have a thin membranous sheath (ochrea) surrounding the stem at the point of the leaf petiole attachment.



**Perennial broadleaf**

**Thistle, Canada** (*Cirsium arvense*)

A perennial from creeping horizontal rhizomes that is generally a weed of no-till cropping systems, pastures, and noncrop areas. Seedlings have dull green thick cotyledons and young leaves that are covered with short hairs. Mature leaves are alternate, irregularly lobed, with spiny margins and without hairs on the upper surface. Flowers are pink or purple, typically  $\frac{3}{4}$  inch in diameter with spineless bracts beneath unlike musk or bull thistle.



**Perennial broadleaf**

**Trumpet creeper** (*Campsis radicans*)

A perennial woody vine with showy red-orange trumpet shaped flowers that can reach 40 feet or more in length. Trumpet creeper is primarily a weed of fencerows, landscapes, and wooded areas, but can become a problem in areas where continuous no-tillage agriculture is practiced. Mature leaves are opposite and composed of several similar leaflets also arranged oppositely from one another. A single leaf may contain 7 to 15 leaflets that are 1-3 inches long,  $\frac{1}{2}$  to  $1\frac{1}{2}$  inches wide, and coarsely toothed. Stems climb or trail along the ground and become woody with age. Stems root when they come in contact with the ground.



**Perennial broadleaf**

**Violet, common blue** (*Viola sororia*)

A perennial from short rhizomes with heart-shaped leaves and blue or purple flowers, most commonly 2 to 5 inches tall. Leaves arise from a basal crown and occur on long petioles. Leaves are also hairless and have rounded teeth along the margins. Common blue violet is increasing as a weed of no-till cropping systems and is also commonly found as a weed of pastures, turfgrass, and landscapes.



**Perennial broadleaf**

**Virginia-creeper** (*Parthenocissus quinquefolia*)

A perennial, often woody vine that climbs on other objects or trails along the ground. Primarily a weed of fencerows, landscapes and vineyards, Virginia-creeper can occur in no-till cropping systems. Leaves consist of three to seven (usually five) leaflets that originate from a common point. Leaflets are from  $2\frac{1}{2}$  to 5 inches long and have toothed margins. Leaves turn red to maroon in the fall. Flowers are small and inconspicuous, greenish white in color. Stems climb by tendrils and can root where they touch the ground. Virginia-creeper is sometimes confused with poison ivy. However, poison ivy has three leaflets, unlike Virginia-creeper, which usually has five.



**Perennial broadleaf**

**Woodsorrel, creeping (*Oxalis corniculata*)**

An erect, stoloniferous perennial that may mimic a summer annual in cooler climates. Leaves are alternate, occur on long petioles, and are divided into three heart-shaped leaflets. Leaf margins are fringed with hairs. Stems are green to pink, branched at the base and more prostrate than erect. Plants spread by stolons, which are aboveground, modified stems. Flowers occur in clusters that arise from long stalks at the leaf axils. Individual flowers consist of five yellow petals that are 4 to 9 mm long. The fruit is a long angular capsule that is cylindrical, pointed and sparsely hairy. Seeds disperse from capsules by explosively ejecting up to 13 feet.



**Perennial broadleaf**

**Woodsorrel, yellow (*Oxalis stricta*)**

A perennial with trifoliate, heart-shaped leaves and yellow flowers. Seedlings have cotyledons that are very small and round to oblong in outline. Mature plants grow prostrate along the ground and have leaves that are arranged alternately along the stem, occur on long petioles, and are divided into three heart-shaped leaflets. Flowers occur in clusters that arise from long stalks in the leaf axils. Individual flowers consist of five bright yellow petals. Mature plants develop ¾-inch-long capsules that are cylindrical and pointed, and are sparsely hairy. Seeds disperse from capsules by explosively ejecting up to 13 feet from the parent plant.



**Perennial broadleaf**

### Barnyardgrass (*Echinochloa crus-galli*)

Summer annual grass

A summer annual with thick stems that may reach 5 feet in height. One of the few grass weeds in which ligules are absent. Seedlings have leaves that are without hairs, auricles, or ligules, and the leaf sheaths are often tinted red or maroon at the base. Mature plants have leaves that range from 4 to 20 inches in length and may be 5 to 30 mm wide. Leaves have a distinct white midvein that becomes keeled toward the basal portions of the leaf. Seedheads are a terminal panicle ranging from 4 to 16 inches in length that may be green to purple in color. The characteristic absent ligule of barnyardgrass helps to distinguish this weed from most other grasses in both the seedling and mature stages of growth.



### Bluegrass, annual (*Poa annua*)

Summer annual grass

An erect or clump-forming annual grass that tolerates close mowing, or may reach 11 inches in height. Annual bluegrass is primarily a weed of lawns, landscapes, and occasionally agronomic crops, and is found throughout the United States. Leaves are light green in color, ½ to 5 inches long, 1 to 5 mm wide, folded in the bud and lack hairs on either surface. Leaves are "keeled" and have a distinctive boat-shaped tip. The ligule is slightly pointed and membranous. Stems may be either erect or bending and may root at the base of the tillers. The seedhead is an open panicle, ¾ to 2½ inches long, and pyramidal in outline.



### Crabgrass, large (*Digitaria sanguinalis*)

Summer annual grass

A summer annual with a prostrate or ascending growth habit and stems that root at the nodes. Seedlings have sheaths and blades that are covered with hairs and have a jagged membranous ligule. Mature plants have leaves that are 1¼ to 8 inches long, 3 to 10 mm wide, with hairs on both surfaces. The ligules are 1 to 2 mm long and membranous. Leaves and sheaths may turn dark red or maroon with age. The seedhead is composed of 4 to 6 branches (spikes) at the top of stems, each about 1½ to 7 inches long.



### Crabgrass, smooth (*Digitaria ischaemum*)

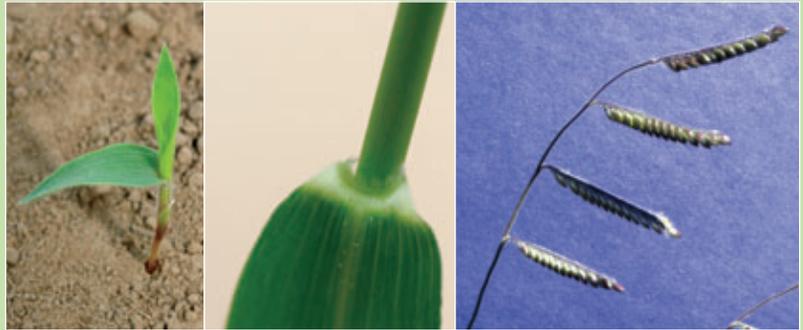
Summer annual grass

A summer annual grass with a prostrate or ascending growth habit, but unlike large crabgrass, with leaves and sheaths that do not have hairs and stems that do not root at the nodes. Leaf blades are 2 to 6 inches long, 2 to 7 mm wide, without hairs. Sheaths are essentially hairless but occasionally may have hairs in the collar region only. Ligules are 1 to 2 mm long and membranous. Seedlings or mature plants often have a reddish tint at the base. Seedheads are composed of 2 to 6 branches (spikes) at the top of stems, each about 2 inches long. Smooth crabgrass is often confused with broadleaf signalgrass and Texas panicum but does not have a hairy ligule like these other species.



### Cupgrass, woolly (*Eriochloa villosa*)

A summer annual weed of agronomic crops. Seedlings are relatively robust with wide leaves that are covered with very short (1 mm or less) hairs. Seedlings are often tinged red at the base. Mature plants have leaves with very short hairs on both surfaces. Leaves have rough margins, are without auricles, and have a small ligule that is a fringe of hairs. Leaf sheaths can root at the nodes. The seedhead is a branched panicle that contains the relatively large tan seed (4 to 5 mm) with a distinctive “cap” at the base.



Summer annual grass

### Foxtail, giant (*Setaria faberi*)

A clump-forming summer annual with a seedhead that resembles a fox's tail. Giant foxtail is a weed of many agronomic crops, turf, landscapes and nurseries that is found throughout the United States, especially in areas with fertile soil. Leaves may reach 16 inches in length and 15 to 25 mm in width, and are generally covered with many small hairs on the upper leaf surface, except near the leaf base. Auricles are absent and the ligule is a fringe of hairs reaching 3 mm in length. The seedhead is a cylindrical, bristly panicle that becomes drooping with maturity. Giant foxtail is generally larger and has a nodding seedhead, unlike green or yellow foxtail.



Summer annual grass

### Foxtail, green (*Setaria viridis*)

A clump-forming summer annual with a seedhead that resembles a fox's tail. Seedlings have leaves that are rolled in the bud and without hairs except occasionally along the leaf sheath margins. The ligule is a row of hairs about 0.5 mm long on small seedlings; therefore this is rarely seen by the casual observer. Mature plants have leaves that may reach 12 inches in length and 5 to 15 mm in width, and are most often without hairs or only sparsely hairy. The leaf sheath is mostly without hairs, except along the margin near the mouth.



Summer annual grass

### Foxtail, yellow (*Setaria pumila*)

A clump-forming summer annual with a seedhead that resembles a fox's tail. Seedlings have leaf sheaths that are mostly without hairs, but with a few long silky hairs on the upper surface near the leaf base only. Mature plants have stems that are erect, flattened, hairless, reaching 3 feet in height. Stems often have a reddish tint at the base. Leaves may reach 12 inches in length and 7 to 12 mm in width, and have long silky hairs at the leaf bases. Auricles are absent and the ligule is a fringe of hairs reaching 2 mm in length. The seedhead is a cylindrical bristly panicle, reaching 6 inches in length and  $\frac{1}{3}$  to  $\frac{2}{3}$  inch in width. Bristles on the seedhead turn yellow at maturity, giving the plant its name.



Summer annual grass

**Goosegrass (*Eleusine indica*)**

**Summer annual grass**

A summer annual with stems radiating outward from a central, distinctive white center. Seedlings have a first leaf that is 3 to 5 times longer than it is wide, which opens parallel to the ground. Leaf sheaths are flattened, smooth and even on seedlings are distinctly white to silver at the base. Mature plants have leaf blades that are 2 to 14 inches long, 3 to 8 mm wide, without hairs or only sparsely hairy, and folded along the midvein. The ligule is 1 to 2 mm long, fringed, uneven and membranous. Sheaths are flattened, whitish at the base and sparsely hairy in the collar region. Seedheads are composed of 2 to 13 spikes, each 1½ to 6 inches long in clusters at the end of stems.



**Millet, browntop (*Bracharia ramosa*)**

**Summer annual grass**

A summer annual with relatively wide leaves and open panicles. Browntop millet may grow erect or prostrate along the ground with tips ascending. This grass is primarily a weed of agronomic crops, hay fields, and abandoned fields. Leaf blades may reach 7 inches in length and 15 mm in width and are without hairs on both surfaces. However, minute hairs that are rarely visible to the naked eye may occur on the upper leaf surfaces near the leaf bases. Leaves are without auricles and have a ligule that is a fringe of hairs approximately ½ to 1½ mm long. Seedheads are an open panicle, 1½ to 7 inches long, ¾ to 2½ inches wide.



**Millet, wild-proso (*Panicum miliaceum*)**

**Summer annual grass**

A summer annual grass weed of nursery, vegetable and agronomic crops. Seedlings are relatively large and robust in appearance and covered with hairs. Leaves are without auricles and have an auricle that is 2 to 4 mm long, membranous at the base and fringed with hairs at the top. Leaf blades are 4 to 8 inches long and 6 to 20 mm wide and are covered with hairs especially on the lower surfaces. The seedhead is a panicle that is pyramid-like in outline and can produce many yellow, orange or reddish brown seed.



**Panicum, fall (*Panicum dichotomiflorum*)**

**Summer annual grass**

A summer annual with large round, smooth sheaths that are often bent at the nodes. A primary identifying characteristic of this grass weed is the "zigzagged" growth pattern it takes on due to bending at the nodes. Seedlings are uniquely different from the mature plants in that the seedlings have many hairs on the lower surface of the leaf blades, but these hairs disappear from plants with maturity. Mature plants have leaves that are rolled in the shoot, 15 to 20 mm wide, 4 to 20 inches long, and auricles are absent. The ligule is a fringe of hairs reaching 2 to 3 mm in length and is often fused at the base. The seedhead is a wide, spreading panicle that develops a purplish tint when mature.



### **Panicum, Texas** (*Panicum texanum*)

A spreading summer annual that may have an erect growth habit or can also grow close to the ground with tips ascending. Texas panicum may reach as much as 32 inches tall and can root at the lower nodes. Seedlings have leaves that are covered with soft hairs on both surfaces. First leaves are relatively broad compared to most annual grasses. Leaves of mature plants range from 3 to 11 inches in length and may reach 20 mm in width. Leaves are covered with short, soft hairs on both surfaces. Auricles are not present and the ligule is membranous on the bottom and fringed with hairs on the top, from 1 to 2 mm long. Seedheads are a simple, narrow panicle that ranges from 2¾ to 10 inches in length.



**Summer annual grass**

### **Sandbur** (*Cenchrus* spp.)

An annual grass with conspicuous burs along the seedhead that is primarily found in sandy areas of fields throughout the southeastern United States. Leaves are rolled in the shoot and are without auricles. Leaf blades may reach 8 inches in length and 6 mm in width and are rough above but without hairs below. The ligule is a fringe of hairs that is approximately 1 mm long. Sheaths may reach 20 inches in height and are without hairs and somewhat flattened in appearance. Seedheads consist of many round, spiny burs. Each bur is approximately 5 to 7 mm wide and contains two to four spikelets that are 4 to 5 mm long.



**Summer annual grass**

### **Shattercane** (*Sorghum bicolor*)

An annual that closely resembles johnsongrass and grain sorghum in growth habit and appearance. Leaves are usually without hairs, 12 to 24 inches long, 1 to 2 inches wide, and have a prominent midvein. The ligule is membranous at the base and a fringe of hairs at the top, reaching 5 mm in length. Sheaths are robust and usually hairless, but some hairs can occur in the collar region. Plants can produce tillers and adventitious roots, as in grain sorghum. The seedhead is a large, open panicle much like that of johnsongrass but with individual seeds that are much larger and more robust than those of johnsongrass.



**Summer annual grass**

### **Signalgrass, broadleaf** (*Brachiaria platyphylla*)

A spreading summer annual that is commonly found growing along the ground but with tips ascending (decumbent growth habit). Leaf blades are overall short and wide in appearance, approximately 1½ to 6 inches long and 6 to 15 mm wide. Leaves are rolled in the bud and without hairs on either leaf surface except on margins and in the collar region. The ligule is a narrow membrane fringed with hairs, ½ to 1 mm long (unlike large or smooth crabgrass). Leaf sheaths are hairy and stems can root at the nodes. The seedhead is a raceme with 2 to 6 "branches," approximately 1 to 3½ inches long.



**Summer annual grass**

**Stinkgrass (*Eragrostis ciliaris*)**

**Summer annual grass**

A summer annual grass that emits a distinctive odor. Stinkgrass is a common grass weed of many agronomic crops, pastures, hayfields and noncrop areas. Seedlings develop into tufted plants relatively quickly. Leaves are rolled in the bud and are approximately 5 to 10 mm wide. Leaves are smooth and glossy below while upper leaf surfaces are rough and may have hairs along the margins. Auricles are absent and the ligule is a fringe of hairs that are usually less than 1 mm long. Sheaths are round to slightly flattened, without hairs except occasionally where the leaf joins to the sheath. Seedheads are triangular panicles that have a grayish green cast.



**Witchgrass (*Panicum capillare*)**

**Summer annual grass**

A densely hairy, erect summer annual grass that may reach as much as 32 inches in height. Seedlings and mature plants have leaves that are covered with hairs on both surfaces. Leaves are rolled in the bud, lack auricles and have a ligule that is a fringe of hairs often fused at the base. Ligules are usually 1 mm but may reach 2 mm in length. Leaf blades have a conspicuous white midvein and are from 4 to 10 inches long, 5 to 15 mm wide. Sheaths are erect and also covered with hairs. The seedhead is a dense panicle that eventually becomes open and may range from 8 to 16 inches in length. Panicles may account for as much as half of the entire height of the plants.



**Barley, foxtail, or Squirreltail (*Hordeum jubatum*)**

**Winter annual grass**

An erect short-lived perennial grass that grows throughout the winter months and therefore is mistaken to be a winter annual. This weed is found most commonly as a weed of agronomic crops, pastures and roadsides. Foxtail barley ranges from 10 to 24 inches in height and has a conspicuous “foxtail” seedhead. Mature plants have leaves that are 2 to 6 inches long, are without hairs or auricles and have a membranous ligule. Leaf sheaths may be without hairs or may have a few sporadic short hairs. The seedhead is a nodding, bristly 2- to 4-inch-long spike that initially has a greenish to purplish tint and becomes pale with age.



**Barley, little (*Hordeum pusillum*)**

**Winter annual grass**

A short winter annual grass that resembles cultivated barley or wheat when mature. Leaves are rolled in the bud and without auricles. Leaf blades may reach as much as 8 inches in length and range from 1½ to 6 mm in width. Leaves may be without hairs or may have short hairs above and below. Leaves have a membranous ligule that is cut squarely across the top and not tapered or rounded. Ligules are very small and usually range from 0.2 to 0.6 mm in length. Seedheads consist of flattened spikes with long bristly awns that resemble wheat or barley when mature. Leaf sheaths and seedheads turn tan or brown with maturity in the spring.



**Brome, downy (*Bromus tectorum*)**

**Winter annual grass**

Usually a winter annual grass with densely hairy leaves and sheaths and a drooping seedhead. Downy brome is found throughout the United States except in the extreme southeast. The leaves are rolled in the shoot and are densely soft hairy on both surfaces. Leaves lack auricles and have a membranous ligule that is approximately 1½ to 3 mm long and is usually distinctly toothed or fringed with hairs near the top. Leaf blades are approximately 5 to 10 mm wide. Leaf sheaths are round and also densely hairy. The seedhead is a soft drooping panicle that is often purple-tinged. Individual spikelets are 10 to 18 mm long.



**Cheat (*Bromus secalinus*)**

**Winter annual grass**

A winter annual grass similar to downy brome but leaves are less hairy and seedheads are more upright and robust. The leaves are rolled in the shoot and can be smooth or occasionally hairy on both surfaces. Leaves lack auricles and have a membranous ligule that is 1½ to 2½ mm long and is usually distinctly toothed or fringed with hairs near the top. Leaf blades are approximately 5 to 10 mm wide. Leaf sheaths are round and can also be smooth or slightly hairy on the lower portions. The seedhead is a drooping panicle but more upright than that of downy brome. The spikelets also have shorter awns than those of downy brome.



**Foxtail, Carolina** (*Alopecurus carolinianus*)

A winter annual grass that grows in fallow fields, pastures and some agronomic crops and especially favors wet areas in these locations. Carolina foxtail will produce seed in the spring and die back by early summer. This plant has a small "fox's tail" seedhead similar to that of timothy grass. This weed only grows to a total height of 4 to 6 inches. The leaves are without auricles and have membranous ligules that are 2 to 3 mm long. Leaves are 1 to 5 mm wide, 2 to 5 inches long. This foxtail is not related to the common summer annual foxtails like giant, green or yellow foxtail.

**Winter annual grass**



**Ryegrass, annual or Italian ryegrass** (*Lolium multiflorum*)

A troublesome winter annual weed usually of small grains that is also planted for use as a forage in some areas. Leaves are rolled in the bud with conspicuous clawlike auricles in the collar region. This is one of the few winter annual grasses with an auricle. Leaf blades are 2½ to 8 inches long and 4 to 10 mm wide when mature and have a membranous ligule. Leaves usually have a shiny appearance, especially on the lower surfaces. Leaf sheaths are usually tinged red at the base. The seedhead is a spike that ranges from 4 to 16 inches in length. Spikes have individual spikelets arranged alternately up the stem.

**Winter annual grass**



**Bermudagrass** (*Cynodon dactylon*)

A perennial grass that has both rhizomes and stolons and is capable of forming a turf or mat of fine leaves. Leaves are rolled in the bud, without auricles, and have a ligule that is a fringe of hairs about ½ mm long. Leaf blades are 2 to 7 inches long by 2 to 5 mm wide and smooth to only sparsely hairy above but usually only with a few hairs near the leaf base. Leaves emerge from opposite sides of the stem and have margins that are slightly rough. Leaf sheaths are usually distinctly flattened. Seedhead consists of three to seven fingerlike spikes that originate from a single point. Individual spikes are 1 to 3 inches long and flattened.



**Perennial grass**

**Fescue, tall** (*Festuca arundinacea*)

A clump-forming perennial grass planted for use as a forage and turfgrass but also occurring as a weed of certain environments. Mature plants have leaves with small, inconspicuous blunt auricles and a ligule that is a fringe of hairs. Leaf blades are 4 to 12 mm wide and have distinctive veins on the upper leaf surface. Lower leaf surfaces are shiny, and leaf margins are rough throughout. The seedhead is initially a compressed panicle that spreads out with maturity. Quackgrass and annual or Italian ryegrass are some of the only other grass species with auricles like tall fescue.



**Perennial grass**

**Johnsongrass** (*Sorghum halepense*)

A perennial from thick, white rhizomes that may reach 6½ feet in height. Leaves are rolled in the shoot, without auricles, 6 to 20 inches long by 10 to 30 mm wide, with a prominent white midvein. Leaf blades are usually without hairs on both surfaces, although some hairs may be present at the base of the leaf blade. The ligules are 3 to 4 mm long, membranous, and often toothed at the top. Sheaths are round to somewhat flattened and usually without hairs, but sometimes hairs may be present along the margins. Seedheads are large, open panicles, often with a purplish tint.



**Perennial grass**

**Oatgrass, bulbous** (*Arrhenatherum elatius* var. *bulbosum*)

A perennial, clump-forming grass that goes dormant during the summer and carries out its life cycle during the winter months. Leaves are rolled in the bud, without auricles, and have a membranous ligule approximately ½ to 1 mm long. Leaf blades are about 10 mm wide and may reach 12 inches in length. Leaf blades may be sparsely hairy above or without hairs, but lower surfaces are usually completely hairless. Plants have a fibrous root system and bulbous fragments (called corms). These bulbs allow for the vegetative reproduction and spread of this species. The seedhead is a narrow, shiny, erect or nodding green or purplish panicle.



**Perennial grass**

**Orchardgrass** (*Dactylis glomerata*)

A clump-forming perennial often grown as a forage but also occurring as a weed of turf, landscapes and occasionally agronomic crops. Orchardgrass has a distinctive bluish green color that stands out from most other grass species. Leaves are 3 to 12 inches long, 3 to 8 mm wide, distinctly keeled, without auricles, and with a large (3 to 5 mm) membranous ligule. Leaf sheaths are strongly flattened or compressed compared with those of most other grass species. Seedheads are panicles ranging from 2 to 8 inches in length.



**Perennial grass**

**Quackgrass** (*Elymus repens*)

A perennial grass from rhizomes that may reach 3½ feet in height. Quackgrass is a common weed of agronomic crops, turfgrass, lawns, nurseries and landscapes. Leaves are rolled in the bud and are 1½ to 12 inches long and usually 2 to 3 mm wide but may reach 12 mm in width. Leaves may or may not have hairs on the upper surfaces, but lower leaf surfaces are without hairs. Leaves have membranous ligules that are less than 1 mm long and also have narrow auricles that clasp the sheath. Seedheads are long, narrow spikes consisting of many individual spikelets arranged in two rows along the stem. Spikes range from 2 to 8 inches in length.



**Perennial grass**

**Dayflower, Asiatic (*Commelina communis*)**

An erect or more often creeping annual monocot often mistaken for a true grass due to its leaf shape and growth habit. Leaves are 2 to 4 inches long,  $\frac{2}{3}$  to 1½ inches wide, have parallel leaf veins and lack petioles and ligules. Leaves clasp the stem at the base and hairs are often present in this area. Stems can root at the nodes where they come into contact with soil. Flowers occur on long flower stalks arising from the region between the stem and leaf. Flowers consist of two blue petals and one white petal. Each flower will appear for only one day.

**Plants resembling grasses**



**Garlic, wild (*Allium vineale*)**

A perennial from bulblets that emits a strong garlic or onion smell when crushed. Seedlings resemble those of a grass, but have hollow, round leaves. Mature plants have round, hollow leaves that arise from a bulb. Bulbs are round to egg shaped with a papery outer covering. Smaller bulblets may form at the base of the bulbs, and fibrous roots are also attached to these bases. Leaf blades are 6 to 24 inches long, 2 to 10 mm wide. All leaves have a scent like that of garlic or onion. Flowers are produced at the top of flowering stems that are slender, solid, waxy, unbranched and 1 to 3 feet tall. Small greenish white flowers occur on short stems above aerial bulblets.

**Plants resembling grasses**



**Horsetail, field (*Equisetum arvense*) and Scouringrush (*Equisetum hyemale*)**

Perennials with spreading rhizome systems that are often mistaken for a grass. Field horsetail (photos 1 and 2 at right) is unique with two types of stems. The fertile stems that appear in the early spring are unbranched, with “cones” at their ends. Nonfertile vegetative stems appear later in the season, are highly branched (8 to 12 inches tall), and resemble a horse’s tail. Scouringrush (photo 3) is found exclusively in ditchbanks and other wet areas and has jointed stems (2 to 3 feet tall) without branches.

**Plants resembling grasses**



**Nutsedge, yellow (*Cyperus esculentus*)**

A perennial from rhizomes and tubers that may reach 2½ feet in height. The stems are distinctly three-sided and triangular in cross section and the leaves are yellow to green in color with a distinct ridge. Leaves have a distinctly shiny appearance. Leaves are 5 to 8 mm wide and have a distinct ridge along the midvein. Leaves are produced in groups of three from the base of the plant. Leaves are without hairs, and no auricles or ligules are present. The leaves of yellow nutsedge taper gradually to a sharp point. Yellow to brown spikelets occur at the ends of the solitary flowering stems.

**Plants resembling grasses**



**Starch grapehyacinth (*Muscari racemosum*)**

A bulbous perennial with leaves that resemble an onion or garlic, and are sometimes confused as a grass. Starch grapehyacinth has attractive clusters of purple flowers and has escaped cultivation to become a weed of landscapes and some agronomic crops. Leaves are linear in outline, ranging from 5 to 16 inches in length and 2 to 5 mm in width. All leaves are hollow and resemble those of wild garlic but have no distinct onionlike odor. Plants have conspicuous bulbs, usually larger than those of wild garlic or wild onion. Many bottle-shaped, purple flowers occur in clusters at the ends of leafless stems. Individual flowers are 4 to 7 mm long, 2½ to 4 mm wide and drooping downward.

**Plants resembling grasses**



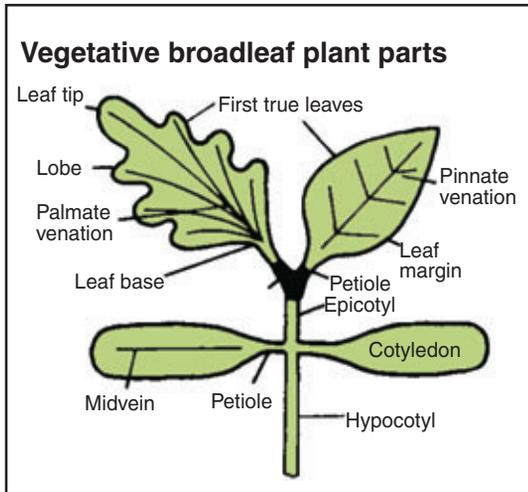
**Star-of-Bethlehem (*Ornithogalum umbellatum*)**

A perennial from a bulb that is often misidentified as a grass or as wild garlic or wild onion. Star-of-Bethlehem has been sold as an ornamental and has escaped to become a weed of agronomic and horticultural crops, pastures and lawns. Leaves are shiny and dark green, with a distinct white midrib. Leaves are 4 to 12 inches long, 2 to 6 mm wide, and hollow in cross section. Leaves lack any garlic or onionlike smell. Flowers consist of six white petals that collectively resemble a star. Flowers occur at the ends of leafless flowering stems. Plants reproduce from large bulbs that are oval shaped. Smaller bulblets occur around the parent bulb.

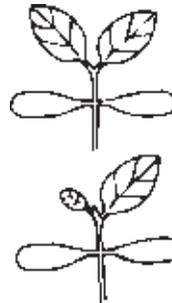
**Plants resembling grasses**



# Broadleaf weed seedling identification key



**STEP 1** - Identify cotyledon shape.  
**STEP 2** - Are first true leaves alternate or opposite?  
**STEP 3** - Answer question yes or no.



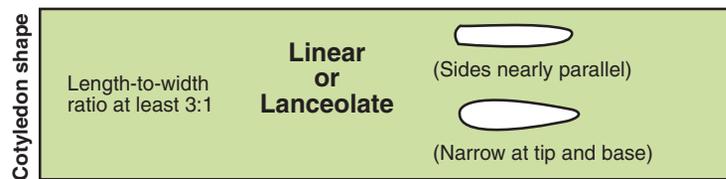
**Opposite leaves**

Two leaves attached per node or opposite sides of stem. Leaves at the same node are of similar size.

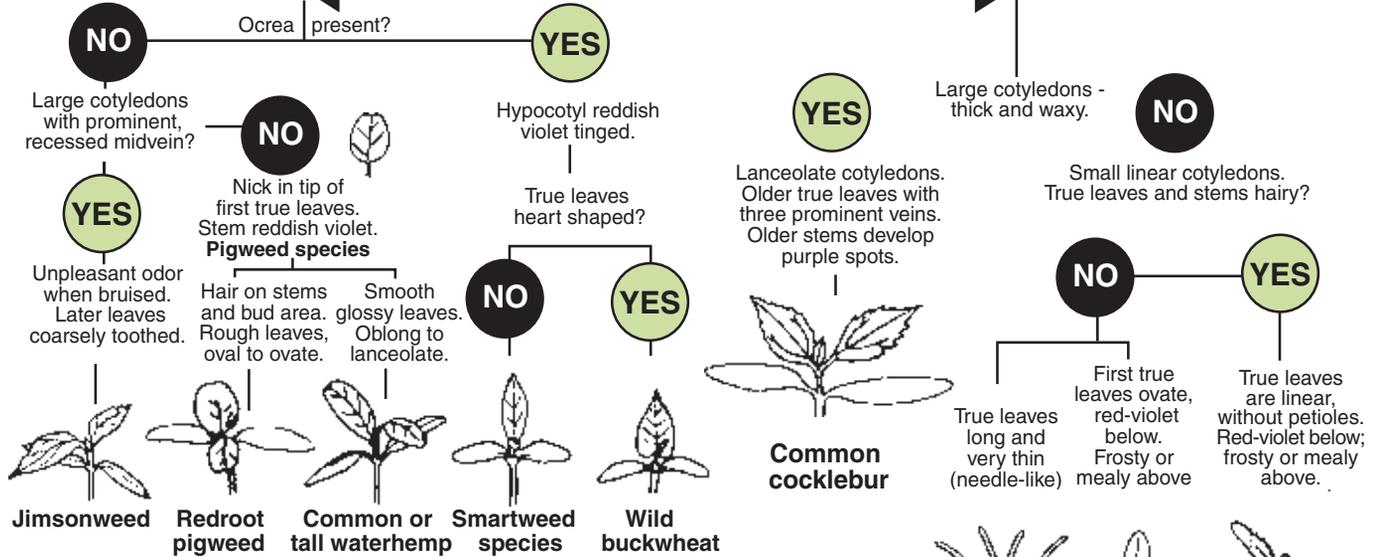
Often the first true leaves are opposite, but later leaves are alternate.

**Alternate leaves**

One leaf per node. Newest leaf is smaller than preceding leaf.



Are the first true leaves alternate or opposite?  
 First true leaves are ALTERNATE. | First true leaves are OPPOSITE but later leaves alternate.



**Jimsonweed**   **Redroot pigweed**   **Common or tall waterhemp**   **Smartweed species**   **Wild buckwheat**

**Common cocklebur**

**Russian thistle**   **Common lambsquarters**   **Kochia**

Other weeds with linear-lanceolate cotyledons and first true leaves **alternate**:

- Buffalo bur
- Cutleaf nightshade
- Pigweed species with fine hairs on stem: Smooth pigweed, Powell amaranth
- Pigweed species without fine hairs on stem: Palmer amaranth, Prostrate, spiny, and tumble pigweeds

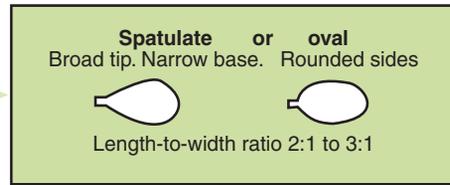
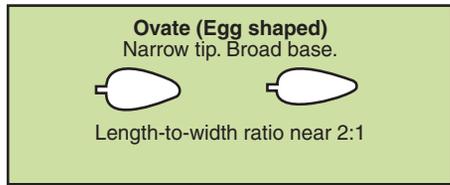
Other weeds with an **ocrea** –membranous, papery sheath encircling nodes and petioles:

- Swamp smartweed
- Docks
- Knotweeds
- Red sorrel

Other weeds with linear-lanceolate cotyledons and first true leaves **opposite**:

- Purslane
- Puncturevine (may appear alternate)

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Cotyledon shape

First true leaves alternate?

**YES** First true leaves opposite? (Later leaves may alternate) **NO**

Often purple underneath.

Leaves sparsely hairy or smooth.

Leaves & cotyledons very hairy.

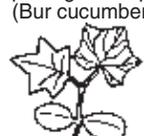
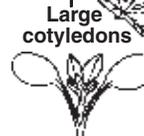


**Eastern black nightshade**

**Hairy nightshade**

**YES** First true leaves lobed?

**NO** Rough leaf surface. Later leaves alternate with three prominent veins.



**Common ragweed**

**Giant ragweed**

**Annual sunflower**

**Wild cucumber bur cucumber**

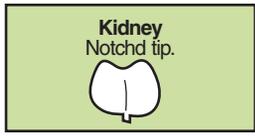
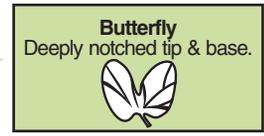
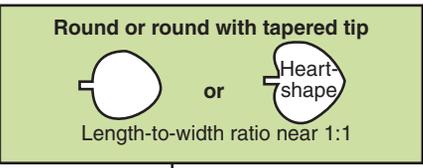
Other weeds with ovate cotyledons:  
First true leaves

<b>Alternate:</b> Ground cherry Horseweed White cockle	<b>Opposite:</b> Chickweed
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Other weeds with spatulate or oval cotyledons:

<b>First true leaves alternate:</b> Blue mustard Tansy mustard Prickly lettuce Hemp sesbania	<b>Canada thistle</b> <b>Musk thistle</b> <b>Shepherd's-purse</b>	<b>First true leaves opposite:</b> Jerusalem artichoke* Marijuana Spurge, annual Devil's-claw*
--	---	--

\*Later leaves alternate



Cotyledon shape

First true leaves alternate?

First true leaves alternate. Large cotyledons with prominent veins.

First true leaves alternate.

**YES**

**YES**

**NO**

Heart-shaped true leaves with short hairs.

Cotyledons velvety

**YES**

**NO**

Third and subsequent leaves deeply lobed?



**Velvetleaf**

**Venice mallow**

**Prickly sida**



**Tall morningglory**



**Ivyleaf morningglory**



**Pitted morningglory**

True leaves hairy with uneven margins.



**Wild mustard**

Arrowhead shaped leaves. Perennial with vinelike growth habit.



**Field bindweed**

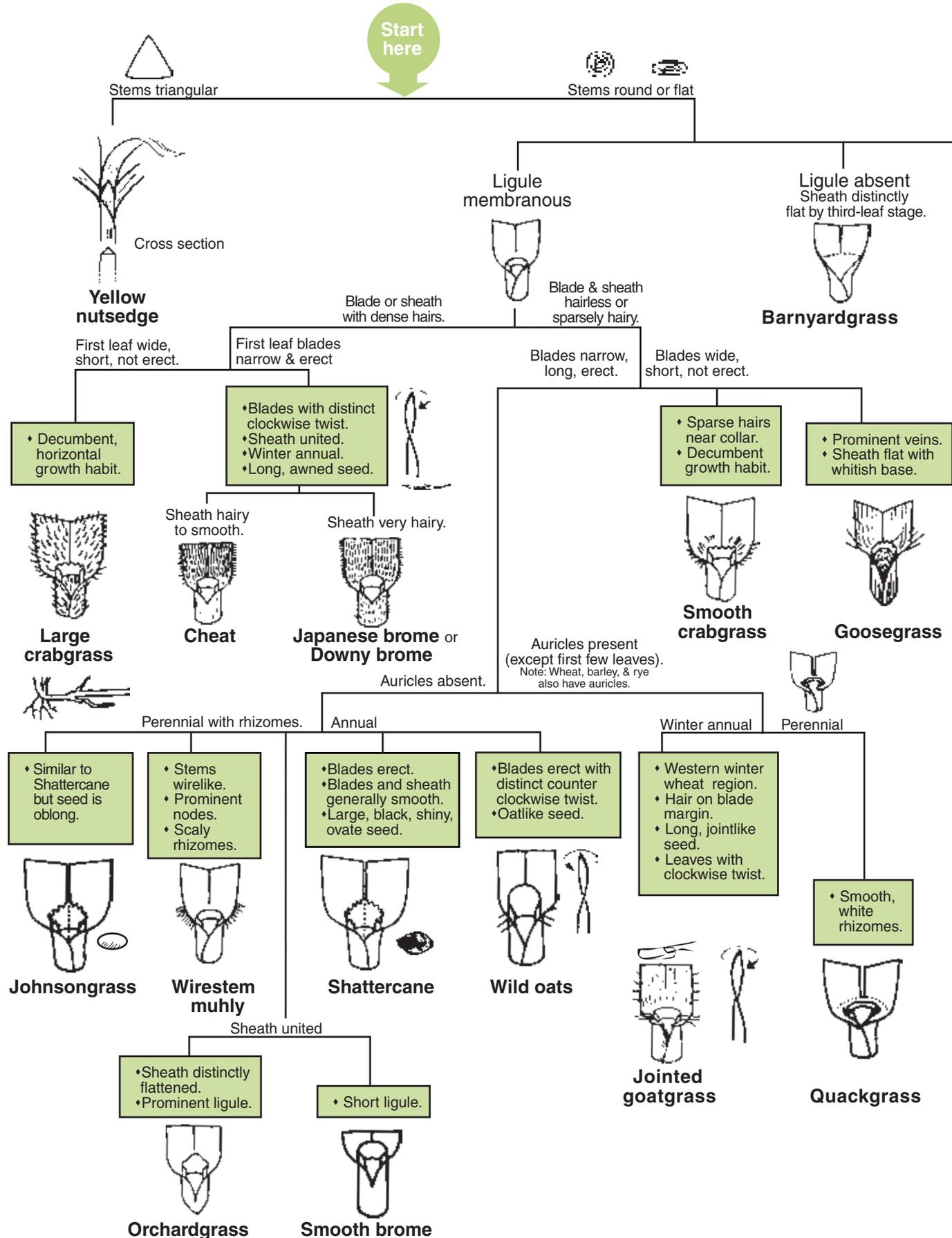
Other weeds with round cotyledons:

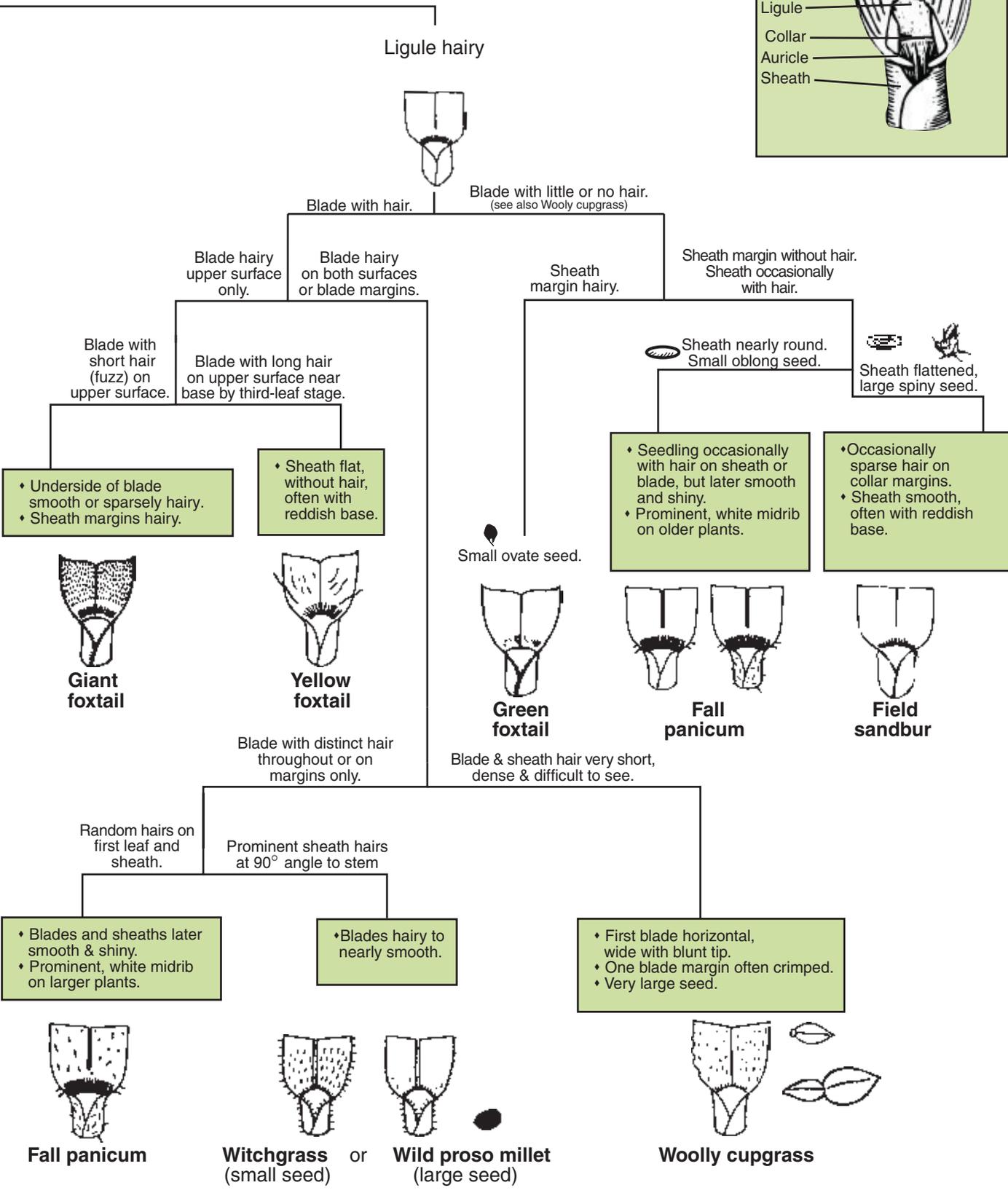
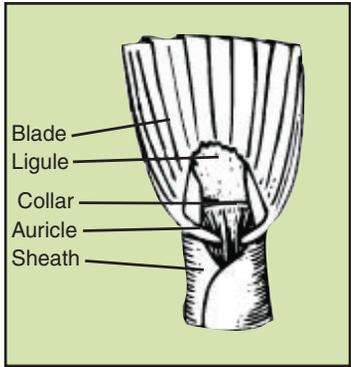
<b>First true leaves alternate:</b> Common mallow Corn gromwell	<b>Sicklepod</b> <b>Yellow rocket</b>
<b>First true leaves opposite:</b> Henbit Marshelder	<b>Copperleaf</b> <b>Field pennycress (later alternate)</b>

Other weeds with butterfly cotyledons:  
  
Most morningglory species

Other weeds with kidney cotyledons:  
  
Hedge bindweed  
Wild radish

# Grass weed seedling identification key





## *Index of weeds, common names*

Amaranth, Palmer . . . . .	29	Foxtail, green . . . . .	56
Anoda, spurred . . . . .	29	Foxtail, yellow . . . . .	56
Barley, foxtail . . . . .	60	Galinsoga, hairy . . . . .	31
Barley, little . . . . .	60	Garlic, wild . . . . .	64
Barnyardgrass . . . . .	55	Geranium, Carolina . . . . .	43
Bermudagrass . . . . .	63	Geranium, dovefoot . . . . .	43
Bindweed, field . . . . .	49	Goosegrass . . . . .	57
Bittercress, smallflowered . . . . .	40	Groundcherry . . . . .	50
Bluegrass, annual . . . . .	55	Groundsel, cressleaf . . . . .	43
Brome, downy . . . . .	60	Healall . . . . .	50
Buckwheat, wild . . . . .	29	Henbit . . . . .	43
Burcucumber . . . . .	30	Horsenettle . . . . .	50
Burdock, common . . . . .	48	Horsetail, field . . . . .	64
Buttercup, bulbous . . . . .	40	Horseweed . . . . .	31
Buttercup, corn . . . . .	40	Japanese bamboo . . . . .	51
Butterweed . . . . .	43	Jimsonweed . . . . .	32
Carpetweed . . . . .	30	Johnsongrass . . . . .	63
Cheat . . . . .	60	Knawel . . . . .	44
Chickweed, common . . . . .	40	Knotweed, Japanese . . . . .	51
Chickweed, mouseear . . . . .	41	Kochia . . . . .	32
Chicory . . . . .	49	Lambsquarters, common . . . . .	32
Cocklebur . . . . .	30	Lettuce, prickly . . . . .	32
Copperleaf, hophornbeam . . . . .	30	Mallow, common . . . . .	33
Copperleaf, Virginia . . . . .	31	Mallow, Venice . . . . .	33
Cornflower . . . . .	41	Marestail . . . . .	31
Crabgrass, large . . . . .	55	Milkweed, common . . . . .	51
Crabgrass, smooth . . . . .	55	Milkweed, honeyvine . . . . .	51
Cress, mouse-ear . . . . .	41	Millet, browntop . . . . .	57
Croton, tropic . . . . .	31	Millet, wild-proso . . . . .	57
Cupgrass, woolly . . . . .	56	Morningglory, entireleaf . . . . .	33
Dandelion . . . . .	49	Morningglory, ivyleaf . . . . .	33
Dayflower, Asiatic . . . . .	64	Morningglory, palmleaf . . . . .	34
Deadnettle, purple . . . . .	41	Morningglory, pitted . . . . .	34
Dock, curly . . . . .	49	Morningglory, smallflower . . . . .	34
Dock, sour . . . . .	49	Morningglory, tall . . . . .	34
Dock, yellow . . . . .	49	Mousetail . . . . .	44
Dogbane, hemp . . . . .	50	Mugwort . . . . .	51
Dovesfoot cranesbill . . . . .	43	Mustard, hedge . . . . .	44
Eveningprimrose, common . . . . .	42	Nightshade, eastern black . . . . .	35
Eveningprimrose, cutleaf . . . . .	42	Nutsedge, yellow . . . . .	64
Fescue, tall . . . . .	63	Oatgrass, bulbous . . . . .	63
Filaree, redstem . . . . .	42	Orchardgrass . . . . .	63
Fleabane, annual . . . . .	42	Panicum, fall . . . . .	57
Foxtail, Carolina . . . . .	61	Panicum, Texas . . . . .	58
Foxtail, giant . . . . .	56	Passionflower, maypop . . . . .	52

Pennycress, field . . . . .	44	Sida, prickly . . . . .	37
Pennycress, thoroughwort . . . . .	45	Signalgrass, broadleaf . . . . .	58
Pepperweed, field . . . . .	45	Smartweed, Pennsylvania . . . . .	37
Pepperweed, Virginia . . . . .	45	Smartweed, swamp . . . . .	52
Pigweed, Palmer . . . . .	29	Sorrel, red . . . . .	52
Pigweed, prostrate . . . . .	35	Sowthistle, spiny . . . . .	46
Pigweed, redroot . . . . .	35	Speedwell, corn . . . . .	47
Pigweed, smooth . . . . .	35	Speedwell, purslane . . . . .	47
Pimpernel, scarlet . . . . .	36	Spurge, spotted . . . . .	38
Pineapple-weed . . . . .	45	Spurry, corn . . . . .	38
Poinsettia, wild . . . . .	36	Squirreltail . . . . .	60
Poison hemlock . . . . .	48	Star-of-Bethlehem . . . . .	65
Pokeweed, common . . . . .	52	Starch grapehyacinth . . . . .	65
Purslane, common . . . . .	36	Stinkgrass . . . . .	59
Quackgrass . . . . .	63	Sunflower, common . . . . .	38
Queen Anne's lace . . . . .	48	Thistle, Canada . . . . .	53
Radish, wild . . . . .	46	Trumpet creeper . . . . .	53
Ragweed, common . . . . .	36	Velvetleaf . . . . .	38
Ragweed, giant . . . . .	37	Violet, common blue . . . . .	53
Rocket, yellow . . . . .	46	Violet, field . . . . .	47
Ryegrass, annual . . . . .	61	Virginia-creeper . . . . .	53
Ryegrass, Italian . . . . .	61	Wallflower, bushy . . . . .	47
Sandbur . . . . .	58	Waterhemp, common . . . . .	39
Scouringrush . . . . .	64	Wild carrot . . . . .	48
Shattercane . . . . .	58	Witchgrass . . . . .	59
Shepherd's-purse . . . . .	46	Woodsorrel, creeping . . . . .	54
Sicklepod . . . . .	37	Woodsorrel, yellow . . . . .	54



Ragweed in soybean field

