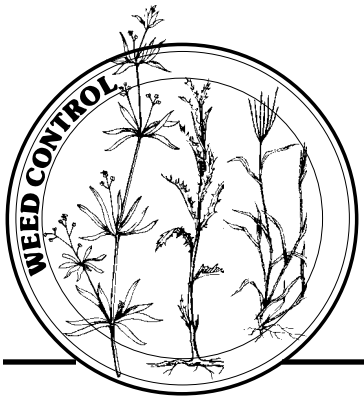

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Weed Management in Pasture Systems

Weeds are troublesome in many ways. They reduce yield by robbing crops of water, light, space, and soil nutrients. Weeds can replace desirable grass species, filling in gaps or voids and reducing yield and overall quality of pasture and forages. Weeds can produce allelopathic substances that are toxic to crop plants. In addition, plants such as poison hemlock (*Conium maculatum*), white snakeroot (*Eupatorium rugosum*), and black locust (*Robinia pseudoacacia*) have toxic properties that can cause livestock injury or loss under certain circumstances. To plan an effective weed management program, a producer must be able to identify weeds and understand how weed biology and ecology affects where weeds are found and their value or detriment.

COMPETITION

Weed competition in pasture systems has not been extensively examined. In addition, the bulk of the competition research in higher rainfall areas like the Northeast has been conducted in Australia or New Zealand, not in the United States. In pasture, weed control decisions are based largely on visual thresholds and intuition. Reliable biological information or cost-benefit analysis is rarely available to support weed management decisions. Without question, weeds can compete directly with forage grasses or pasture to reduce their nutritional value and longevity. However, the impacts of weed species, density, and soil and climatic factors are not well established in pasture systems.

In general, biennial and perennial weeds pose the biggest problems for pasture producers. Both biennials and perennials produce seed each year, potentially starting new infestations. Perennial weeds such as tall ironweed (*Vernonia altissima*), Canada thistle (*Cirsium arvense*), and multiflora rose (*Rosa multiflora*) reproduce from underground roots or rhizomes. Perennial rooting structures can survive for several years in the soil and are often unaffected by occasional mowing or livestock grazing. Pasture-invading weed species should be assessed for their competitive ability, or their potential to reduce desirable forage species; their invasiveness—their potential to multiply and increase; their yield, quality, and nutritive value relative to desirable forage species; and the cost and effectiveness of control measures—cultural, mechanical, and chemical.

General rules about weed competition in forages include:

- Assess weed competitive ability, invasiveness, nutritive value, and potential to control.
- Weeds that emerge with the crop in the spring are generally more destructive.
- Control problem weeds for the first 60 days after seedling establishment.
- Weeds that emerge beyond 60 days after establishment will not influence that year's forage yield.
- Later-emerging weeds may still influence forage quality.
- Winter-annual weed competition in early spring is most damaging to early-season forage yield.
- Broadleaf weeds that are biennial or perennial are generally more competitive than grassy weeds.

WEED QUALITY

Unlike most grain or fiber crops from which weeds are separated at harvest, weeds are often harvested along with forage crops, potentially reducing quality. In the case of pasture, they remain in the field where they continue to interfere with desirable forage. Reductions in quality often take the form of lower protein content, feed digestibility, or even reduced intake by the animals.

Although weeds do have some feed value, the value differs among species. The feed value of many pasture species has not been extensively studied. However, based on traditional

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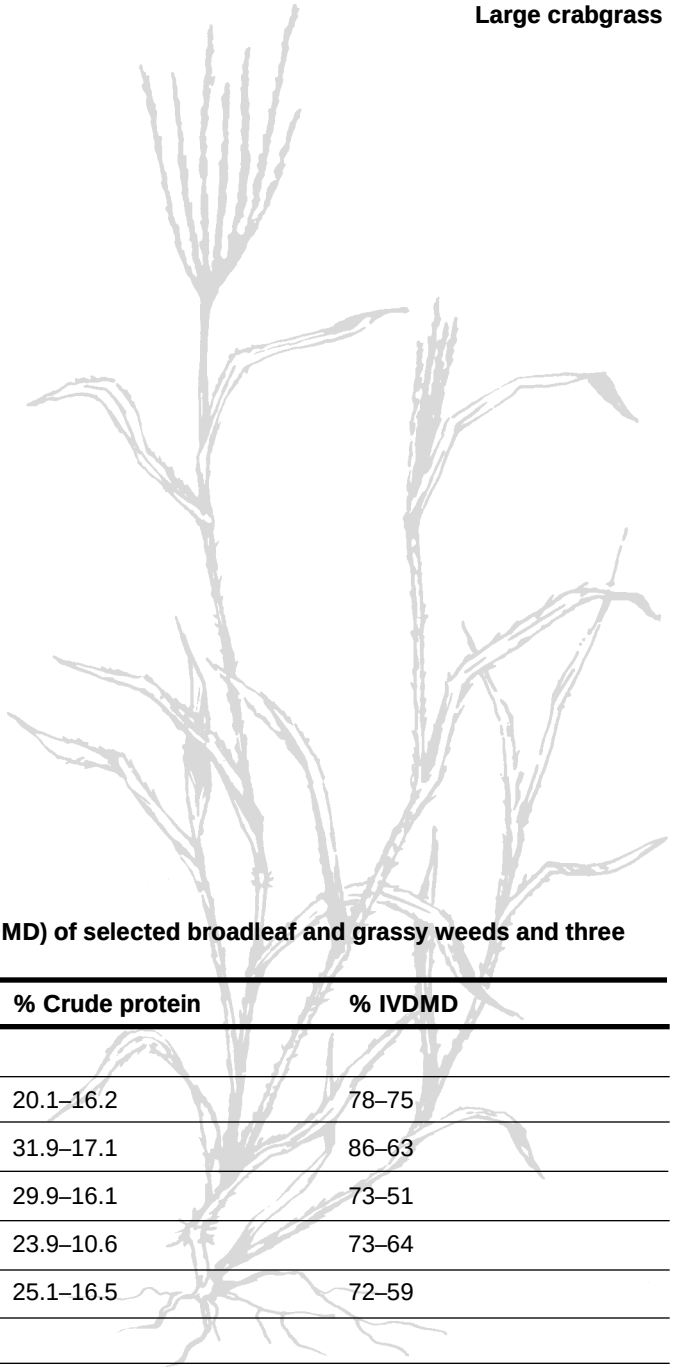
forage quality measures—crude protein and digestibility—many weeds are nutritious and readily digested during the growing season (Table 1). Wild carrot (*Daucus carota*), a common pasture weed in some fields, has about 16 percent crude protein in the vegetative stage. Common yarrow (*Achillea millefolium*) has only about 10 percent crude protein during the flowering stage.

Grassy weed quality can be similar to that of grass forage. In general, weedy grasses have about 75 percent of the quality of forage legumes. Weeds with woody stems or flower stalks, such as tall ironweed, yellow rocket (*Barbarea vulgaris*), and curly dock (*Rumex crispus*), have protein levels about half to two-thirds the levels of a legume forage and are of slightly lower quality than forage grasses. Managing them may be more important for the quality of your pasture or forage.

As is true of grass and legume forage species, the quality of weeds is better during their vegetative stages and decreases as the plant flowers and matures (Table 1). Finally, even though some weeds are highly nutritious and digestible, ruminants may avoid grazing these plants because of taste, smell, or toxicity.

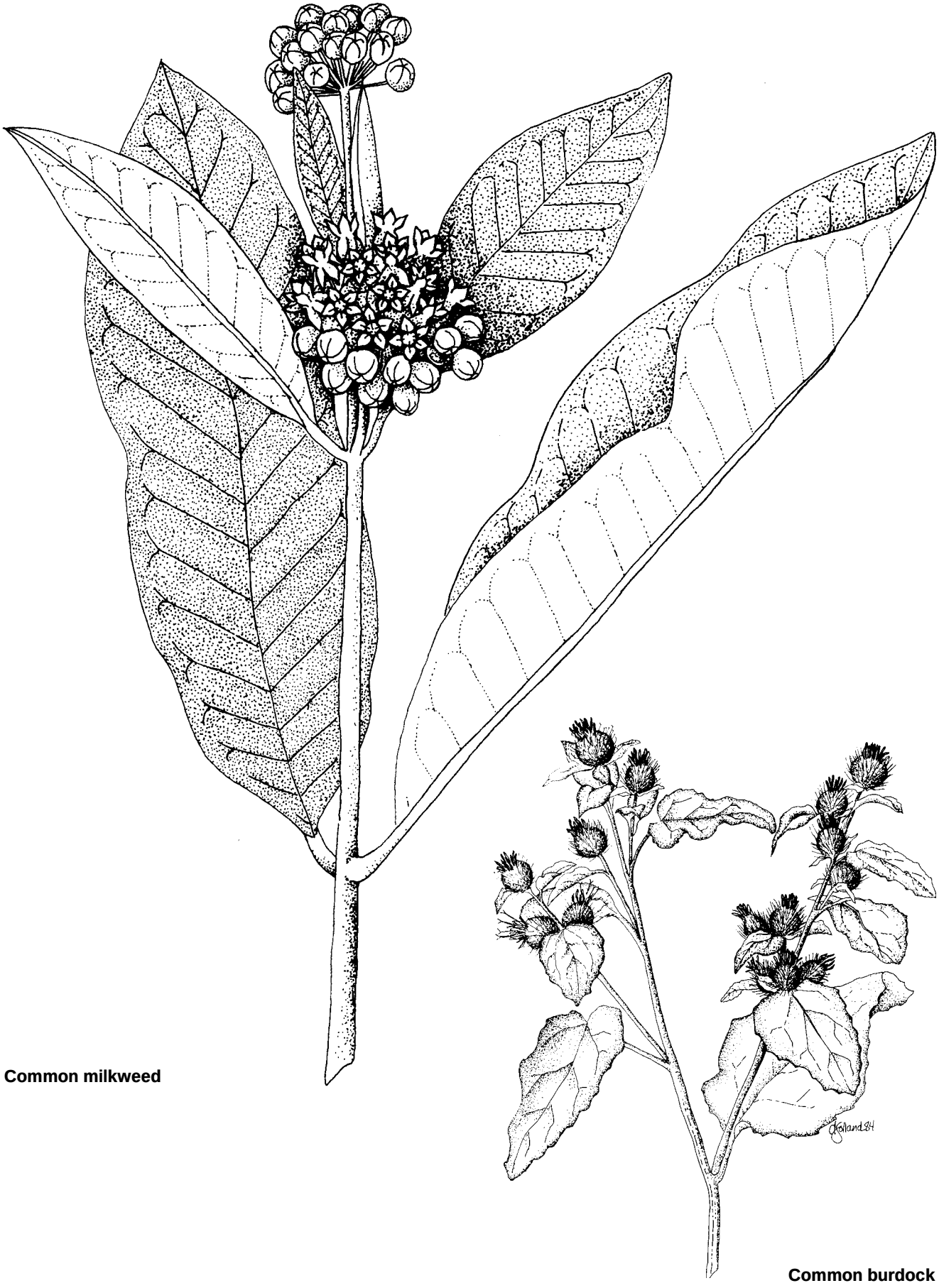


Large crabgrass

Table 1. Crude protein and in vitro dry-matter digestibility (IVDMD) of selected broadleaf and grassy weeds and three forage species.[a]

Weed	% Crude protein	% IVDMD
Broadleaves		
Henbit (*Lamium amplexicaule*)	20.1–16.2	78–75
Virginia pepperweed (*Lepidium virginicum*)	31.9–17.1	86–63
Curly dock (*Rumex crispus*)	29.9–16.1	73–51
Redroot pigweed (*Amaranthus retroflexus*)	23.9–10.6	73–64
Jimsonweed (*Datura stramonium*)	25.1–16.5	72–59
Grasses		
Cheat (*Bromus secalinus*)	23.4–13.8	81–61
Little barley (*Hordeum pusillum*)	23.6–13.8	82–62
Fall panicum (*Panicum dichotomiflorum*)	19.0–7.2	72–54
Yellow foxtail (*Setaria lutescens*)	17.5–14.3	73–57
Large crabgrass (*Digitaria sanguinalis*)	14.3–6.4	79–63
Forages		
Ladino clover ‘Regal’	27.2–23.2	81–83
Tall fescue ‘Kentucky 31’	22.1–12.5	78–67
Rye ‘Wrens Abruzzi’	27.9–13.4	79–70

[a]Range of values corresponds to samples evaluated from the vegetative stage to fruiting stage (broadleaves or forbs) or heading (grasses). Palatability for these weed species was not determined. (Adapted from Bosworth et al. 1980, 1985)



Common milkweed

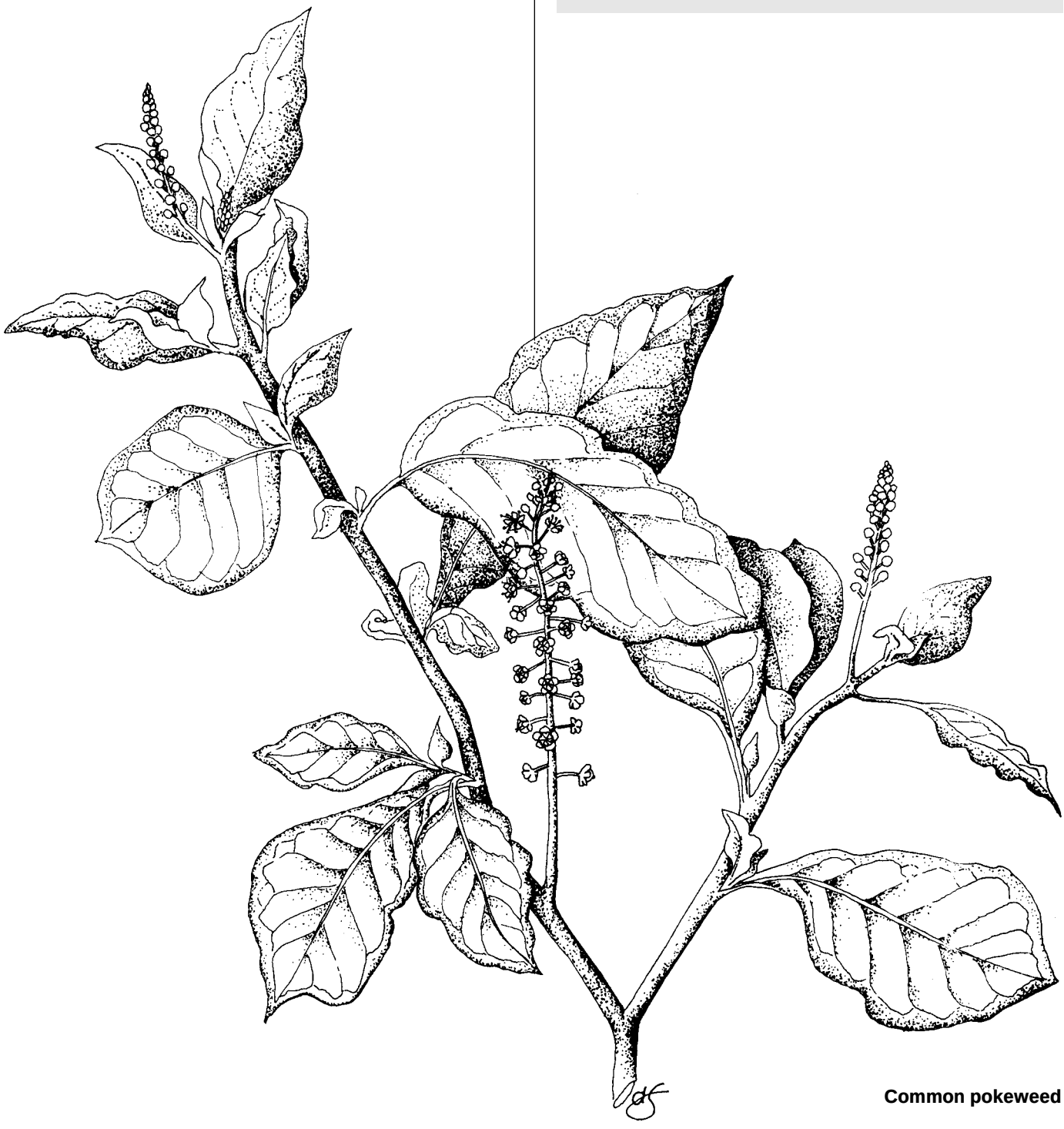
Common burdock

POISONOUS PLANTS

Many plants contain poisonous substances that may be toxic to livestock if consumed. In addition, certain plants may be problematic because of mechanical irritation when eaten, photosensitization, and disagreeable tastes or odors in meat, milk, or milk products. If you suspect livestock poisoning, call a veterinarian immediately. If death occurs, the stomach contents should be examined for consumed herbage. Identify the suspected plants and remove livestock from the grazing area until all poisonous plants have been removed or destroyed. Table 2 lists some common weeds and their poisonous properties.

Key points about weed forage quality and poisonous plants:

- Some weeds have excellent nutritive quality.
- Weeds in the vegetative stage of development usually are more desirable than mature weeds.
- Regardless of weed quality, livestock may avoid grazing certain plants because of taste, smell, or toxicity.
- Some plants contain poisonous substances that may be toxic to livestock if consumed. Properly identify potential problem weeds and consult with a veterinarian if necessary.



Common pokeweed

Table 2. Selected poisonous weeds of the Northeast.[a]

Common name	Scientific name	Problem/symptoms	Toxic ingredient/toxicity
Bouncing bet	*Saponaria officinalis*	Leaves and stem—effects delayed for several days; depression, vomiting, abdominal pain, diarrhea	Saponin—amount equivalent to 3% (dry wt) of sheep wt killed within 4 hr
Buttercup	*Ranunculus species*	Leaves and stem, especially in flower; dried hay loses toxicity—anorexia, weakness, convulsions, breathing difficulty, death	Protoanemonin—toxicity reported to vary with species, age, and habitat
Cherry, black	*Prunus serotina*	Leaves (wilted leaves are worse), stems, bark, fruit—anxiety, staggering, breathing difficulty, dilated pupils, bloat, death	Cyanogenic glycosides—less than 0.25 lb leaves (fresh wt) can be toxic to 100-lb animal
Clover species	*Trifolium* species	Vegetation—hairballs; sweet clover—nose bleed, anemia, abdominal swelling	Coumarin in sweet clover—varies
Fern, bracken	*Pteridium aquilinum*	Entire plant—dullness, fever, bleeding, loss of appetite, salivation	Glycoside thiaminase—toxic to cattle fed a diet of 50% bracken fern for 30–80 days
Garlic, wild	*Allium vineale*	All plant parts—tainted milk and meat	Only toxic in large quantities
Hemlock, poison	*Conium maculatum*	All plant parts—salivation, vomiting, diarrhea, weakness, paralysis, trembling, dilation of pupils, convulsions, coma	Coniine and others—0.5 to 4% (fresh wt) equivalent of cattle wt is toxic
Jimsonweed	*Datura stramonium*	Entire plant (seeds are most toxic)—thirst, mood swings, convulsions, coma, death	Solanaceous alkaloids—0.06 to 0.09% (dry wt) equivalent of animal body wt is toxic
Locust, black	*Robinia pseudoacacia*	Leaves (especially wilted), seeds, and inner bark—weakness, depression, anorexia, vomiting, diarrhea	Phytotoxin robin, glycoside robitin—bark extract and powder in amount equivalent to 0.04 to 0.1% of animal wt toxic to horses. Cattle 10 times more tolerant.
Milkweeds	*Asclepias* species	Stems, leaves, and roots—muscle tremors, spasms, bloat, difficulty breathing	Glycosides and galitoxin—varies
Mustards	*Brassica, Thlaspi,* and *Lepidium* species	All parts (especially seeds)—oral and gastrointestinal irritation, shaking, salivation, abdominal pain, vomiting, diarrhea	Thiocyanates, irritant oils, nitrates (large quantities generally necessary for toxicity)
Nightshade species	*Solanum* species	Vegetation, unripe fruit—loss of appetite, salivation, weakness, trembling, paralysis	Solanine—toxic at 42 mg/kg (LD_{50})
Pigweed species	*Amaranthus species*	Foliage—kidney disease, weakness, edema, rapid respiration	Nitrates, nitrate oxalates, unknown—sheep, hogs, young calves most susceptible
Pokeweed, common	*Phytolacca americana*	Entire plant, especially roots—gastrointestinal cramps, weakened pulse, respiration, salivation	Phytolacctinm—10 or more berries can result in toxicity to humans
Snakeroot, white	*Eupatorium rugosum*	Leaves and stem—constipation, loss of appetite, salivation, rapid respiration. Toxin passes through milk (milksickness).	Trophine alkaloid—varies from 1 to 20% of animal body wt. Toxin cumulative.
St. Johnswort	*Hypericum perforatum*	Flowers and leaves—photosensitivity	Hypercin—uncertain

[a]Information taken from Fishel 2000; Hardin 1973; and Hill and Folland 1986.

PROBLEM WEEDS

Based on their life cycles, weeds are grouped into three categories.

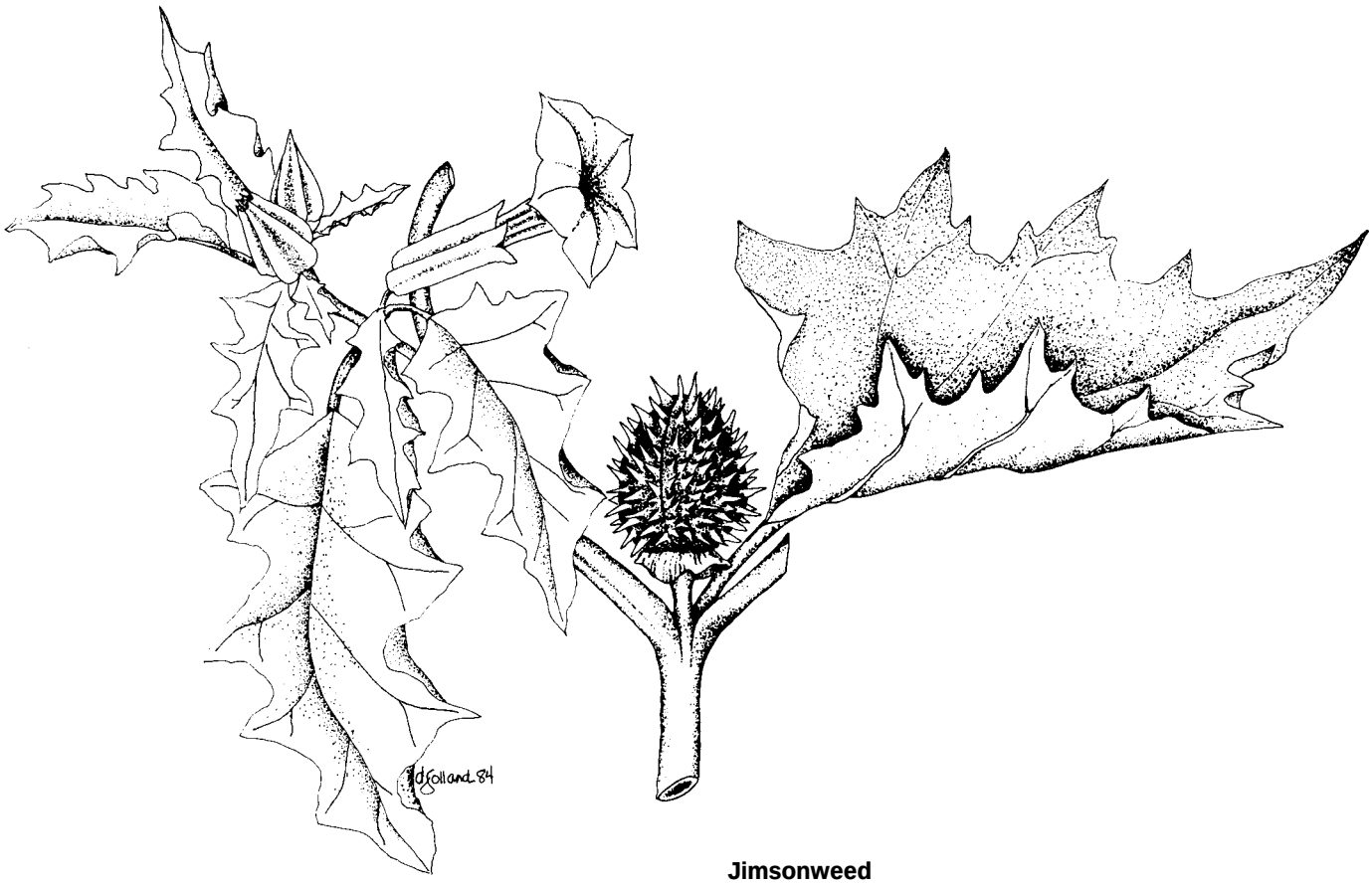
Annuals complete their life cycle within one year and reproduce only by seed. Annuals may produce as few as 100 seeds or as many as 500,000 seeds per plant, depending on species and growing conditions. Annual weeds are classified as winter or summer annuals. Winter annuals germinate in the fall, overwinter as a rosette or small clumps of leaves, and complete their reproductive cycle in the spring or early summer. These weeds are more likely to be found in perennial forages and pastures where soils are not disturbed over the winter. Examples of winter annuals are given in Table 3.

Summer annuals germinate in the spring and set seed in late summer or fall. They thrive when summer annual crops like corn or soybean are grown. They can also be a problem for new spring forage seedings during the establishment year or if established forages become thin or irregular. Summer annuals complete their life cycle in late summer or fall. Examples of summer annual weeds are provided in Table 3.

Biennial weeds live during two growing seasons and reproduce only by seed. The first year consists of vegetative growth in which the plants produce a rosette or loose clump of leaves and a fleshy taproot. In the second year plants make both vegetative and reproductive growth from which an elongated flower stalk emerges. Because these weeds require two years to complete their life cycles, they are found in areas of low soil disturbance, such as waterways, pastures, hay crops, and fencerows. Biennials are rarely a problem in cultivated soil, because plowing usually destroys them. However, established biennials often survive field cultivation or disking and may continue to be a problem in reduced or no-tillage production. Examples of biennials are provided in Table 3.

Perennial plants live for more than two years and generally reproduce by means of vegetative structures as well as seed. Vegetative reproduction occurs through rhizomes, tubers, bulbs, or budding roots. However, not all perennials reproduce vegetatively. Simple perennials reproduce only by seed and emerge from the same vegetative structure every year. Dandelion (*Taraxacum officinale*) is an example of a simple perennial (Table 3). Creeping perennials often reproduce through both vegetative structures and seed. Canada thistle is an example of a creeping perennial (Table 3). Finally, woody perennials may be either simple or creeping, but they also produce secondary growth or a woody structure that enables them to become very large and usually aggressive. Multiflora rose is a woody perennial that is also creeping (Table 3).

Although perennial weeds are most prevalent in areas of reduced soil disturbance, some are well adapted to row crops. Pasture and hay production systems are often ideal environments for perennial weeds to grow and spread. Managing these weeds is generally more difficult because of their multiple reproductive systems. Consider both vegetative structures and seed when dealing with perennials.



Jimsonweed

Table 3. Selected examples of annual, biennial, and perennial weeds that can infest forage crops.

Annuals		Biennials	Perennials		
Winter	**Summer**		**Simple**	**Creeping**	**Woody**
Bluegrass, annual (*Poa annua*)	Black medic (*Medicago lupulina*)	Burdock, common (*Arctium minus*)	Chicory (*Cichorium intybus*)	Ironweed, tall (*Vernonia altissima*)	Brambles (*Rubus spp.)*
Brome, downy (*Bromus tectorum*)	Crabgrass, large (*Digitaria sanguinalis*)	Carrot, wild (*Daucus carota*)	Dandelion, common (*Taraxacum officinale*)	Garlic/onion, wild (*Allium vineale/A. canadense*)	Honeysuckle, tartarian (*Lonicera tatarica)*
Chickweed, common (*Stellaria media*)	Fleabane species (*Erigeron*)	Hemlock, poison (*Conium maculatum*)	Dock species (*Rumex*)	Groundcherry, smooth (*Physalis subglabrata*)	Olive, autumn (*Elaeagnus umbellata*)
Dead nettle, red (*Lamium purpureum)*	Foxtail species *(Setaria)*	Knapweed, spotted (*Centaurea maculosa*)	Pokeweed, common (*Phytolacca americana*)	Heal-all (*Prunella vulgaris)*	Rose, multiflora (*Rosa multiflora*)
Henbit (*Lamium amplexicaule*)	Jimsonweed (*Datura stramonium*)	Mullein, common (*Verbascum thapsus*)		Hemp dogbane (*Apocynum cannabinum*)	
Horseweed/ marestail (*Conyza canadensis*)	Lambsquarters, common (*Chenopodium album*)	Parsnip, wild (*Pastinaca sativa*)		Horsenettle (*Solanum carolinense*)	
Lettuce, prickly (*Lactuca serriola*)	Nightshade, eastern black (*Solanum ptycanthum*)	Thistle, bull (*Cirsium vulgare*)		Johnsongrass (*Sorghum halepense*)	
Pennycress, field (*Thlaspi arvense*)	Panicum, fall (*Panicum dichotomiflorum*)	Thistle, musk/ plumeless (*Carduus nutans*/*C. acanthoides*)		Milkweed, common (*Asclepias syriaca*)	
Pepperweed, field (*Lepidium campestre)*	Pigweed species (*Amaranthus*)	Cockle, white (*Lychnis alba)*		Nettle, stinging (*Urtica dioica*)	
Radish, wild (*Raphanus raphanistrum*)	Ragweed, common (*Ambrosia artemisiifolia*)			Nutsedge, yellow (*Cyperus esculentus*)	
Shepherds-purse (*Capsella bursa-pastoris*)	Smartweed, Pennsylvania (*Polygonum pensylvanicum*)			Quackgrass (*Elytrigia repens*)	
Yellow rocket (*Barbarea vulgaris*)	Velvetleaf (*Abutilon theophrasti*)			Red sorrel (*Rumex acetosella)*	
				Thistle, Canada *(Cirsium arvense)*	
				Wirestem muhly (*Muhlenbergia frondosa)*	
				Yarrow, common (*Achillea millefolium*)	
				Yellow toadflax (*Linaria vulgaris*)	
				Smooth bedstraw (*Galium mollugo*)	

Smooth pigweed

White snakeroot

WEED MANAGEMENT

Managing weeds in pasture systems begins long before crop establishment. Certain types of weeds are potentially serious problems for forages, so it is important to eliminate them in advance. In particular, perennial broadleaves and grasses such as dandelion, curly dock, Canada thistle, and quackgrass (*Elytrigia repens*) are much easier to manage before planting a forage crop. In addition, biennial weeds including musk thistle (*Carduus nutans*) and burdock (*Arctium minus*) should be eliminated before establishing forage. If these weeds are not removed before the seeding is made, they can persist for many years. The cost of controlling weeds before or at the time of seeding should be considered an investment that will be returned for the life of the forage.

Cultural Management

Cultural practices that aid in weed control include anything that makes the crop more competitive against weeds. In the establishment year, these measures include: preparing the seedbed properly, planting at the optimum planting date, fertilizing properly, planting at higher densities, using the correct seeding rate, choosing high quality crop seed that is free of weeds, and selecting adapted species and varieties for the region. In general, perennial grasses are more competitive against weeds than legumes are.

Provide a seedbed at planting that is free of live weeds. A weed-free seedbed can be achieved using either tillage or a burndown herbicide. It is important that emerging forage species not have to compete for limited resources as they try to gain a foothold in the early weeks of establishment. In addition, emerged vegetation can harbor certain insects or pathogens that could attack young, susceptible forage seedlings.

Date of planting can influence the kinds and numbers of weeds that emerge. Most grass and legume forage species are relatively slow to establish. Think about spring versus fall establishment based on weed history and what you might anticipate as problems. For example, if the field has been planted to corn or some other summer annual crop, then summer annual weeds will likely be the biggest weed threat during establishment. Late summer may be a better time for establishment in this situation. In spring seedings, plant early before summer annuals emerge to give the new forage seedlings every advantage. With late summer seedings, plant before September, the month during which winter annual weeds generally begin to emerge. The weed species present in a field, along with its potential severity, may help determine the best time for planting.

In established pasture systems, prevention is the most important tool for managing weeds. Research shows that pasture weeds can be controlled by increasing forage competition. In fact, crop growth rate stands as the single best measure of plant response to weed competition in forages. Maintaining a dense, competitive forage is a key to preventing weed invasion and interference.

Weeds are opportunistic. Germination and establishment are favored by open areas and by disturbance. Overseed with desirable forage species when necessary to keep open areas at a minimum. Rotationally graze to keep traffic effects minimal, and do not overgraze to ensure that forages remain competitive with weeds. Test soils for nutrients and annually fertilize to keep forage stands healthy and competitive. Control harmful insects or pathogens when necessary—they weaken forage stands and give weeds the opportunity to establish. Develop monitoring programs to locate infestations and place priority on controlling small infestations so that they do not expand.

Preventing weed infestations also means preventing dispersal of seeds or vegetative structures into uninfested areas. Vehicles, humans, wind, water, birds, and livestock can spread weed seeds. Animals may disperse seeds by picking them up in their coats or fur, or between the pads of their feet. Cattle have been shown to readily pick up burs of several weeds when grazing forested range. Clean infested animals regularly, particularly new animals that may be carrying new weed problems. Ruminants also ingest weed seeds in the field—between 5 and 15 percent pass safely through sheep, goats, cattle, and deer. Be cautious of feed or hay infested with noxious weed seed. In the western United States, certified weed-seed-free forage is required on public lands by federal land agencies.

Key points about cultural weed management:

- Consider seedbed preparation, planting date, fertilization, planting population, and high-quality crop seed, and select adapted species and varieties.
- In established pasture systems, prevention is the most important tool for managing weeds.
- Overseed with desirable forage species when necessary to keep open areas to a minimum.
- Rotationally graze to keep traffic effects minimal and do not overgraze.
- Test soils for nutrients and annually fertilize to keep forage stands healthy and competitive.
- Prevent dispersal of seeds or vegetative structures into uninfested areas.

Mowing and Hand Removal

Once forages are up and established, systematic mowing helps to control weeds. Repeated mowing reduces weeds' competitive ability, depletes carbohydrate reserves in their roots, and prevents them from producing seed. Some weeds, mowed when they are young, are consumed and enjoyed by livestock. Mowing can kill or suppress annual and biennial weeds. It can also suppress perennials and help restrict their spread. Mow at a height above the grass seedlings when weeds are 8 to 10 inches in height to reduce shading by weeds.

A single mowing will not satisfactorily control most weeds. However, mowing three or four times per year over several years can greatly reduce and occasionally eliminate certain weeds, including Canada thistle. Also, mow along fences and borders to help prevent the introduction of new weed seeds. Regular mowing helps prevent weeds from establishing, spreading, and competing with desirable grasses and legumes.

Finally, hand removal may be the easiest and most economical way to control some weeds. When few plants are present or if you see a potential new weed, dig it, pull it, or remove the seedhead before the seed can disperse. This technique works particularly well for annuals and biennials. For perennials, it may be difficult to remove all vegetative structures effectively. Properly dispose of weeds after removal to prevent seed or vegetative structure dispersal. This may mean burning, burying, or transporting them to local landfills.

Key points about mowing and hand removal:

- Repeated mowing reduces competitive ability, depletes root carbohydrates, and prevents seed production.
- Mow at a height above the grass seedlings when weeds are 8 to 10 inches tall to reduce shading.
- If you see a new weed, dig it, pull it, or remove the seedhead before seeds can disperse.

Herbicides

Herbicides provide a convenient, economical, and effective way to help manage weeds. They allow fields to be planted with less tillage, allow earlier planting dates, and provide additional time to perform the other tasks that farm or personal life require. Herbicides may not be a necessity on some farms, but without the use of chemical weed control, mechanical and cultural control methods become that much more important.

In pasture systems, a number of herbicides are available for broadleaf weed control in grass forages. Few are available for mixed grass-legume combinations or for the control of grassy weeds in grass forages. Before establishment, herbicide choices are limited to those controlling emerged vegetation. Preplant soil residual herbicides are not common for pasture systems. Most herbicides for pasture systems should be applied postemergence to the weeds and crop once the forage is well established. In pasture systems, spot spraying may be the most economical alternative for scattered infestations of weeds.

Remember, young annual weeds in the seedling stage are most susceptible to control with herbicides. Spray biennial weeds in the rosette stage prior to bolting. Perennials are most susceptible to control with systemic herbicides in the bud to bloom stage or in early fall. Most herbicides for broadleaf control in grass pasture systems should *not* be applied to seedling forage grass until visible tillers are present. Established forage grasses and legumes are more herbicide tolerant than seedling forages.

Most herbicides have haying or grazing restrictions following application. For specific herbicide recommendations, please consult the current *Penn State Agronomy Guide* or manufacturer product labels.

Below are some general rules to follow before using a herbicide in established forage stands:

- Thin or irregular stands do not thicken once weeds are removed. Be sure there are sufficient desirable species to fill in the gaps, or overseed if necessary.
- Weeds tolerant of the herbicide may invade the space left by susceptible species, ultimately creating a more severe weed problem.
- If weeds make up 50 percent or greater of the stand, it is time to renovate or rotate to a different crop.
- If weeds become a problem in established forages, several herbicide options are available. Many products have harvesting, feeding, or grazing restrictions following their use.

Biological Control

Biological control is the deliberate introduction or manipulation of a pest's natural enemies, with the goal of suppressing the pest population. It has been used to manage insects, vertebrates (mice and rats), pathogens, and weeds. Biological control is not intended to eradicate the target weed, but rather to exert enough pressure on the pest to reduce its dominance to a more acceptable level. Biological control can be cost effective, environmentally safe, self-perpetuating, and well suited to an integrated weed management program. Its limitations are that it is a long-term undertaking, its effects are neither immediate nor always adequate, only certain weeds are potential candidates, and the rate of failure for past biological control efforts has been fairly high.

Biological control tools for weeds have included insects, mites, nematodes, pathogens, and grazing animals (e.g., sheep and goats). Historically, insects and mites have been the most important biological control tools for weeds. The emphasis for developing biological control agents for weed management has been on western rangeland and natural areas. In the Northeast, several weeds including bull and musk thistle, Canada thistle, purple loosestrife (*Lythrum salicaria*), mile-a-minute (*Polygonum perfoliatum*), and garlic mustard (*Allaria petifolia*) are receiving attention because of their invasive nature. In addition to the several promising insect biocontrol tools outlined in Table 4, several rust fungi are being evaluated for managing several weeds, including the knapweeds and the thistles. Although slow in coming, biological weed control may have a major impact on managing problem weeds in pasture systems in the future.

Table 4. Potential biocontrol organisms for selected weeds of the Northeast.[a]

Weeds	Biocontrol organisms	Remarks
Knapweed, spotted *(Centaurea maculosa)*	Root gall beetle (*Sphenoptera jugoslavica*)	Larvae feed on root, weakening plants.
	Seedhead weevil (*Bangasternums fausti*)	Larvae feed on seeds in seedhead.
	Seedhead fly (*Chaetorellia acrolophi*)	Larvae feed on seedhead.
	Seedhead gall fly (*Urophora affinis and U. quadrifasciata*)	Larvae feed on seedhead.
	Several others	
Loosestrife, purple (*Lythrum salicaria*)	European beetles (*Gallerucella calmariensis* and *G. pusilla*)	Larvae feed on young buds, leaf, and leaf tissue.
	Weevil (*Hylobius transversovittatus*)	Adults feed on leaves and larvae damage roots.
Rose, multiflora	Rose rosette disease *(Rosa multiflora)*	Mite-vectored virus (Some ornamental roses are also susceptible to this disease.)
	Rose seed chalcid (*Megastigus aculeatus*)	Wasp adults lay eggs in seeds, rendering them sterile.
	Rose stem girdler (*Agrilus aurichalceus*)	Larvae girdle and kill canes.
Thistle: bull, Canada, musk, and plumeless	Seedhead weevil (*Rhinocyllus conicus*)	Feeds on the developing seedhead. Relatively effective where established. Less effective on plumeless and Canada.
	Rosette weevil (*Trishosirocalus horridus*)	Larvae feed on young thistles.
Toadflax, yellow (*Linaria vulgaris*)	Weevil (*Gymnetron antirrhini*)	Adults feed on buds, flowers, and seed capsules.
	Beetle (*Brachypterolus pulicarius*)	Adults feed on young shoots and flower buds. Larvae feed inside the seedhead.

[a]Information taken from Blossey et al. 1994a; Blossey et al. 1994b; Groppe 1992; Kok 1992; McClay 1992; Powell et al. 1988; Smith et al. 1984; Sobhian et al. 1992; Story et al. 1989; Underwood et al. 1996; White and Marquardt 1989.

Canada thistle

Grazing Animals

Grazing management can be used to minimize the spread of certain weeds and to control large infestations. In most cases, however, grazing does not eradicate a mature infestation of weeds. For grazing animals to be useful for weed control, they must be fenced into or off an area in order to adjust grazing pressure. The ability to concentrate stock on weed infestations at some stages of growth or times of the year, and the ability to keep them off pasture or weeds at other times, is often the key to weed control.

Cattle, sheep, and goats are the most common animals used for grazing pasture. Horses may also be of interest. Pigs sometimes graze grass, but their weed control activities are associated more with their rooting behavior. Domestic birds also eat grass and have been known to graze weeds selectively. Only the use of cattle, sheep, and goats is discussed in this fact sheet. Combining ruminant grazing with other weed management tools including herbicides can offer an integrated approach that may be very cost effective.

Cattle

Restricting grazing to one class of stock, like cattle, leads to particular weed problems because some weedy plants are less palatable to some classes of stock. Cattle prefer grasses and tend to avoid forbs and shrubs. Constant grazing by cattle reduces grass forage and promotes forbs and shrubs, some of which may be weeds. For some weeds, cattle can provide effective control partly because of their grazing patterns and partly because their hooves can do more damage to young, tender, emerging shoots. In general, selective and overgrazing by cattle creates more problems, like bare patches in pastures, that allow the invasion of new weed seedlings.

Sheep

Grazing by sheep is a major method of biological weed control on dryland farms in Victoria, Australia. There they are used during fallow periods and to reduce weed seed production before cropping. Sheep prefer broadleaf plants (forbs) over grasses and shrubs. In Saskatchewan, continuous summer-long sheep grazing reduced the number of leafy spurge (*Euphorbia esula*) from about 320 seeds per square foot to 1.5 seeds per square foot after 8 years. In this experiment, sheep grazing had no effect on leaf spurge stem density for the first three years, after which densities declined dramatically. Today, sheep are being used to control leafy spurge along several major rivers in Montana.

Sheep have also been used successfully to control Canada thistle. Control by grazing alone requires intensive grazing of the young, soft, aerial thistle shoots in spring, not usually possible because of pasture feed surpluses during that time. However, combining mowing or a herbicide application with grazing can provide a wider window for control.

Goats

Goats can control a large number of spiny and prickly weed species totally untouched by sheep and cattle. In a North Carolina study, 12 goats per acre alone or 7 goats per acre mixed with cattle mostly eliminated multiflora rose and some other weeds from an abandoned orchard after four grazing seasons. In the same experiment, desirable forage species increased in number over time. Goats have also been used successfully for general brush control in abandoned farmland in Vermont. While goats are known to eagerly consume flowering thistle plants, they are not attracted to the vegetative rosette.

Combining small ruminant grazing with other weed management tools has considerable promise for controlling certain weed species. For example, grazing Canada thistle with sheep and goats during the spring and fall, followed by a fall application of an appropriate herbicide, can have a greater impact on the weed than either tactic used alone. In addition, adding sheep or goats to a cattle enterprise for control of weeds or to help clear land of undesirable vegetation can be profitable. In a West Virginia study, three-year variable costs for brush clearing with goats were estimated at $13.50 per acre versus $54 for mechanical cutting and $240 per acre for herbicides.

Key points about biological control and the use of grazing animals:

- Biological control tools for weeds include insects, mites, nematodes, pathogens, and grazing animals.
- Biological control can be cost effective, environmentally safe, self-perpetuating, and well suited to an integrated weed management program.
- Biological control is a long-term undertaking; it is not immediate or always adequate, only certain weeds are potential candidates, and the rate of failure can be high.
- Grazing does not in most cases eradicate a mature infestation of weeds.
- Combining mowing or a herbicide application with grazing can provide a wider window for control.
- Biological weed control may have a major impact on managing problem weeds in pasture systems in the future.

INTEGRATION

An integrated program that combines cultural, mechanical, chemical, and perhaps biological control tools can provide effective economic weed management in pasture systems. Consider how different tactics can be combined and remember how weed life cycle and other growth characteristics affect management options. Remember that prevention is the most important consideration for managing weeds in established pasture systems. Some general guidelines for managing annuals, biennials, and perennials are provided in Table 5.

Table 5. Management guidelines for some problem weeds of pasture systems.

Weed	Cultural/Mechanical	Chemical	Other
Annuals			
Winter annuals (mustard species, common chickweed, etc.)	Mow after bolting to prevent seed production.	Apply an effective herbicide in fall or spring before bolting occurs.	Most winter annuals emerge by late fall; a smaller percentage emerges in early spring. Prevent seed production to prevent spread.
Summer annuals (pigweed species, common lambsquarters, common ragweed, etc.)	Keep pasture full and competitive. Mow after bolting to prevent seed production.	Apply an effective herbicide in early summer.	Prevent seed production to prevent spread.
Biennials			
(Common burdock, bull and musk thistle, poison hemlock)	Mow after plants have bolted but before seed set to prevent seed production. Remove or dig individual plants by hand.	Apply herbicides to rosettes in spring or fall. Several insect biocontrol tools may help with thistles in the future.	Prevent seed production to prevent spread.
Perennials			
Creeping perennials (Canada thistle, horsenettle, etc.)	Mow to suppress and prevent seed production.	Spray with a systemic herbicide at bud to bloom or in early fall.	Most perennials spread by both seed and vegetative structures. Biocontrol tools may help in the future.
Woody perennials (multiflora rose, autumn olive, etc.)	Mow to suppress and prevent seed production; remove roots by hand or with heavy equipment.	Spray with a systemic herbicide at bud to bloom stage or in early fall.	Insect biocontrols could help manage multiflora rose in the future.

Multiflora rose

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Mustard species

ACKNOWLEDGMENTS

We thank the Pennsylvania Department of Agriculture for permission to reproduce drawings of Jimsonweed, common burdock, common milkweed, white snakeroot, and common pokeweed (from *Poisonous Plants of Pennsylvania* by Robert J. Hill, illustrated by Donna Folland) and large crabgrass, Canada thistle, mustard species, and bedstraw (from *Pennsylvania Weeds,* by Wendell P. Ditmer, illustrated by Margaret Brandt).

The drawings of smooth pigweed and multiflora rose were done by Rae D. Chambers.

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Penn State College of Agricultural Sciences research, extension, and resident education programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

This publication is available from the Publications Distribution Center, The Pennsylvania State University, 112 Agricultural Administration Building, University Park, PA 16802. For information telephone (814) 865-6713.

Issued in furtherance of Cooperative Extension Work, Acts of Congress May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture and the Pennsylvania Legislature. T. R. Alter, Director of Cooperative Extension, The Pennsylvania State University.

This publication is available in alternative media on request.

CAT UC172 5M4/01ps3141

Bedstraw