

Dandelions and other broadleaf weeds are highly visible and thus are considered the most troublesome pests by homeowners in their professionally managed lawns. Though the majority of broadleaf weeds are relatively easy to control in turf, they are quick to reinvade thin turf after difficult winters or summers, or next to sidewalks and drives.

Where do broadleaf weeds come from?

- Seeds exist in the soil seed bank and can remain viable for up to 30 years.
- Many weeds can produce thousands of seeds per year, which can move on wind currents for miles.
- Poor quality grass seed, topsoil or compost can contain viable seeds of broadleaf weeds.

Weed life cycles

Identifying the weed and its lifecycle are critical for determining the most effective control methods. Similar to categorizing turfgrass species, cool-season weeds grow best in the fall, winter, and/or spring, whereas warm-season weeds grow best in the summer.

- Annuals have a one-year life cycle. They germinate from seed, mature, and produce seed for the next generation in less than 12 months. Common chickweed and henbit are examples of cool-season winter annuals that germinate in the fall, overwinter, produce seed in spring, and die with the heat of summer. Other cool season annuals germinate early in the spring like prostrate knotweed and kochia. Warm-season annuals germinate when soil temperatures warm in May or June and prostrate spurge, oxalis, and purslane are two examples.
- Biennials require two years to complete their life cycle. They form a rosette the first year, then flower and die during the second year. There are few biennial

turfgrass weeds, but many thistles are biennials.

- Perennials are plants which live for more than two years, and may live indefinitely. Most perennials grow originally from seed, but may also arise from reproductive structures such as stolons, rhizomes, or tubers. Dandelions and white clover grow best in spring and fall and are considered cool-season perennials. Field bindweed regrows from rootstocks in early to mid-summer, and is considered a warm-season perennial.

Cultural control

There is no way to eradicate weeds from a turf site, but the best way to minimize weeds AND improve herbicide effectiveness is by good cultural management of the turf including the following:



Figure 1. Prostrate knotweed (above) is a cool-season summer annual germinating very early in the spring. Henbit (below) is a cool-season winter annual germinating in the fall, flowering and setting seed in spring, and dying with summer heat.

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- Mow at 3.0 to 3.5 inches throughout the year and frequently enough to avoid removing 1/3 of the leaf blade.
- When irrigating, keep the lawn as dry as possible and practice deep and infrequent irrigation. Water enough to wet the soil to the depth of turfgrass rooting and only water again at first signs of drought stress.
- Fertilize primarily in the fall with 60 - 100% of the annual nitrogen applied after Labor Day, usually mid-September and again in late October near the final mowing. Minimize fertilization in the spring and summer to avoid excess growth which compromises turfgrass health in the long run.
- Maximize turfgrass growing conditions by creating a conducive environment. Minimize shade through tree management and minimize soil compaction through traffic management and aerification. Furthermore, certain weed species are indicators of poor environmental conditions. Table 1 lists several of these indicator weed species and the environments in which they are typically found.

Herbicide control

There are at least 13 different active ingredients (a.i.'s) currently used in turf that will control broadleaf weeds postemergence (POST) (Table 2). It is important to use more than one a.i. in every application to increase the spectrum of controlled weeds and also to limit potential resistance to a single herbicide developing in weed species like is currently common in field crops with glyphosate (RoundUp).

Most a.i.'s are systemic and move with the photosynthate in the phloem to the growing points of the plant. Therefore it is important to apply herbicide when the weeds are actively growing and not under stress from heat, drought, traffic, cold, etc. Two exceptions to this are carfentrazone

(QuickSilver and others) and pyraflufen-ethyl (Octane) which are contact herbicides. Most of the a.i.'s available have POST properties and must be applied to emerged plants. Isoxaben (Gallery, Isoxaben) is a preemergence (PRE) herbicide and will not control emerged plants. Tenacity (mesotrione) has both PRE and POST properties depending on the weed species. Many traditional PRE herbicides for crabgrass may provide minimal control of broadleaf weeds if applied prior to germination.

Most professionals use liquid formulations, but granular herbicide/fertilizer combinations may be needed in some situations. Granular products usually have to be applied to wet foliage in order to stick to the leaf surface and be absorbed. One exception to this is penoxalium (LockUp) which is absorbed by roots and foliage. Clopyralid is also taken up partially by roots, but is no longer labeled for residential lawns.

Herbicide Timing

Fall applications from Sept through late October (near the last mowing) are most effective for controlling cool-season perennials, winter annuals, and biennials (if present). The weeds are preparing for winter, translocating photosynthate to storage organs and thus herbicides also translocate, providing complete kill. Furthermore, fall applications are usually safe on turf because of lower air temperatures and fewer ornamentals are present in susceptible stages to cause off-target damage. Even applications well into October are very effective rated the following spring (Hanson and Branham, 1998; Reicher and Wiesenberger, 2007; Wilson and Michiels, 2003). Some recommend waiting to apply until after the first frost (Wilson and Michiels, 2003), but recent data show that applications throughout the fall are effective (Reicher and Wiesenberger, 2007). Applications

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made late in October will likely not show symptoms until next spring.

Spring applications can be effective on cool-season perennials like dandelion if applied at flowering. However, spring applications on winter annuals, like common chickweed, are usually not justified because these weeds are near the end of their life cycle. Summer annuals germinating in the spring or early summer are difficult to control. These weeds mature quickly and a single herbicide application will only control a few of the summer annuals since the others either have not germinated or have grown too large to be controlled. In addition, summer annuals have a waxy layer on their leaves to prevent water loss, which will also limit herbicides from entering the leaves. For most effective control, multiple applications of a POST herbicide throughout the summer and/or apply a PRE herbicide containing isoxaben in April to control summer annual weeds before they germinate. Since isoxaben has no effect on emerged weeds, a POST herbicide should be applied at the same time for weeds that have already germinated.

Weather and herbicides

Best control and turf safety occur with ample soil moisture and air temperatures between 50 and 85F for most products (check label for specifics). Avoid applying to buffalograss when temperatures exceed 75F. Most herbicides are rainfast within 4 to 8 hours, but this varies widely depending on formulation, spray volume, humidity, temperature, etc. If rain occurs shortly after application, observe the area for 7 to 10 days and consider reapplying if no herbicide symptoms are seen (Fig 2). Surfactants and other adjuvants are often used with the hope of improving control or rainfastness.

However, only use adjuvants when specifically recommended on the label or previous experience justifies the use. Adjuvants can increase the risk of burn to desired turfgrass.

Ornamentals, trees, and vegetables are extremely sensitive to herbicide drift damage. Drift can occur from the liquid form during windy conditions. Furthermore, drift damage can occur in warm weather if these herbicides volatilize and move to non-target plants. Limit applications to during low wind conditions and relatively cool conditions. Amine and low volatile ester formulations drift less than traditional ester formulations.

Use over new seedlings

Almost all broadleaf herbicides will damage young turfgrass seedlings if applied prior to seeding or shortly after germination. Carfentrazone (Quicksilver) tends to have the most flexible label of the POST a.i.'s, whereas mesotrione (Tenacity) has the most flexible label of the PRE a.i.'s. Check the herbicide labels for specific recommendations.



Figure 2. POST broadleaf herbicides will cause curling of leaves or flowers within hours or a few days of application.

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Difficult-to-control weeds

Field bindweed is a deep-rooted perennial regrowing from rootstocks and rhizomes in late spring (Figure 3). It is similar to morning glory, often climbing ornamentals, fences, etc. It is an aggressive seed producer and seed can remain viable for 60 years, so long-term control is needed and PRE's like isoxaben may be effective. POST herbicides like clopyralid where labeled (Calhoun 2002) or quinclorac (Zawierucha et al., 2010) can be very effective on mature bindweed.

Ground ivy is a cool-season, shade tolerant perennial that regrows from crowns and stolons in the spring. It is highly stoloniferous, and herbicides do not translocate well through the stolons (Kohler et al., 2004b). Ground ivy usually has hairy leaves so herbicides do not penetrate the leaves. Furthermore, ground ivy is genetically highly variable and some populations are susceptible to a specific herbicide while other adjacent populations are tolerant (Kohler et al., 2004c). Therefore it is critical to alternate or tankmix multiple a.i.'s. Triclopyr (Turflon), fluroxpyr (Spotlight), and 2,4-D applied in the fall are most effective (Kohler et al., 2004a; Reicher and Wiesenberger, 2007) and efficacy is improved with multiple applications on 3-week intervals. (Kohler et al., 2004a) Isoxaben applied in spring will also help prevent stolons from rooting (Kohler et al., 2004a)

Puncturevine (Fig. 3) is a warm-season annual that is drought tolerant because of its deep tap root. It flowers within three weeks of germination, is a prolific seed producer, and reproduces entirely by seed. Therefore, PRE crabgrass herbicides or especially isoxaben may be effective if applied in spring. Herbicides are most effective when applied to young plants and 2,4-D+MCP+dicamba+carfentrazone (Speedzone) has been most effective in the few research trials found on this weed



Figure 3. Characteristic arrowhead-shaped leaves of field bindweed that will often grow over fences or ornamentals if left uncontrolled (top photos). Puncture vine (bottom photos) is a fast growing summer annual, best controlled by PRE's prior to emergence or POST applied to young plants.

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(Henry and Williams, 2011; Fagerness, 2003).

Wild violets are perennials that spread by seeds or thick rootstocks. Violets are often found in shaded lawns where turf is not well-adapted. As a perennial, fall applications of herbicides would be most effective. Products containing triclopyr (Turflon, and others) have been effective, especially when combined with quinclorac (Calhoun, 2001).

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Table 1: Weeds as indicators of poor growing environments.

Acid soil: prostrate knotweed (*Polygonum aviculare*), plantain (*Plantago major*), red sorrel (*Rumex acetosella*)

Wet or poorly drained soil: mosses, common chickweed (*Stellaria media*), ground ivy (*Glechoma hederacea*), mouse-ear chickweed (*Cerastium vulgatum*), violets (*Viola species*), yellow nutsedge (*Cyperus esculentus*)

Wet Fertile Soil: curled dock (*Rumex crispus*), henbit (*Lamium amplexicaule*), yellow woodsorrel (*Oxalis stricta*)

Wet infertile soil: white clover (*Trifolium repens*)

Dry soil: black medic (*Medicago lupulina*), red sorrel (*Rumex acetosella*)

Dry infertile soil: yarrow (*Achillea millefolium*)

Compacted or heavy soil: dandelion (*Taraxacum officinale*), plantain (*Plantago major*), common chickweed (*Stellaria media*), knotweed (*Polygonum aviculare*), mouse-ear chickweed (*Cerastium vulgatum*), prostrate spurge (*Euphorbia supina*)

Soil with a hardpan or hard crust: morning-glory (*Ipomoea purpurea*), pineapple weed (*Matricaria suaveolens*)

Cultivated soil, New Seedings: Lamb's-quarters (*Chenopodium album*), plantain (several species), purslane (*Portulaca oleracea*), dandelion (*Taraxacum officinale*), chickweed (*Stellaria media*), pigweeds (family *Amaranth*), carpetweed (*Mollugo verticillata*), henbit (*Lamium amplexicaule*)

High fertility soil: pigweeds (family *Amaranth*), purslane (*Portulaca oleracea*), dandelion (*Taraxacum officinale*), lamb's-quarters (*Chenopodium album*), Henbit (*Lamium amplexicaule*), yellow woodsorrel (*Oxalis stricta*)

Low fertility soil: plantains (*Plantago species*), red sorrel (*Rumex acetosella*), white clover (*Trifolium repens*)

Shaded soil: common chickweed (*Stellaria media*), ground ivy (*Glechoma hederacea*), mouse-ear chickweed (*Cerastium vulgatum*)

Wet shaded soil: violets (*Viola species*)

Low mowing height: white clover (*Trifolium repens*)

Adapted from (Anonymous, 2011; Cella and Voigt, 2011)

Table 2: Commercially available postemergence active ingredients for broadleaf weed control

2,4-D (many brand names, often mixed with other a.i.'s)

Carfentrazone-ethyl (Quicksilver and mixed with other a.i.'s in Speed Zone, PowerZone, etc)

Clopyralid (Lontrel or mixed with other a.i.'s, not labeled for residential use)

Dicamba (Banvel, many brand names, often mixed with other a.i.'s)

Diclorprop (many brand names, often mixed with other a.i.'s)

Fluroxypyr (Spotlight or mixed with other a.i.'s)

MCPP, mecoprop (many brand names, often mixed with other a.i.'s)

MCPA (many brand names, often mixed with other a.i.'s))

Penoxalium (LockUp)

Pyraflufen-ethyl (Octane)

Quinclorac (Drive, Drive XLR8, Quinclorac, Quinstar, and others, plus often mixed with other a.i.'s in Q4 Plus, etc.)

Sulfentrazone (Dismiss and mixed with other a.i.'s in Surge, Q4 Plus, TZone, etc.)

Triclopyr (Turflon or mixed with other a.i.'s)