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Ecology and Management of field bindweed [*Convolvulus arvensis* L.]

by

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Figure 1. Field bindweed forms mats of trailing, twining vines.

Abstract

Field bindweed is a persistent perennial weed in the Convolvulaceae taxonomic family found on cultivated fields, orchards, plantations, pastures, lawns, gardens, roadsides and along railways. It is listed as one of the ten most serious weed problems worldwide. Its extensive, competitive root system is capable of vegetative reproduction. This combined with long-lived seeds makes it difficult to manage. Dense tangled mats formed from the trailing vines, and vines climbing on crops, reduce crop yields and increase production costs. Over 500 seeds per plant can be produced from the funnel-shaped flowers.

Field bindweed is native to the Mediterranean region and was first recorded in the United States in 1739. In Montana, it was first collected in 1891 from Missoula County near the University of Montana, and by 2001 it had been reported from all Montana Counties except Richland and Fallon (http://invader.dbs.umt.edu). Propagules of field bindweed migrate as contaminants of crop seed and hay, when attached to farming equipment, and they have been intentionally introduced as ornamental or medicinal plants.

Once established, field bindweed will persist after most control applications. However, the leaves are not shade tolerant and competitive plants will suppress field bindweed and reduce its seed production. On croplands, frequent cultivations will reduce root reserves; however infestations can increase under no-till or reduced till management. Cultivation combined with application of 2, 4-D, glyphosate, or their combination will reduce field bindweed without injury to crops. Dicamba, glyphosate, picloram, quinclorac and 2, 4-D will provide short-term

suppression of field bindweed. The gall mite, *Aceria malherbae*, stunts field bindweed growth and reduces seed production.

Biology and Identification

There are over 84 names for field bindweed. The ancient Greek name translates to “circling plant” and the name given by the Romans means literally “a large worm that wraps itself in vines.” Byndweede was the name applied in England in the 1500s. Other names include creeping Jenny, European bindweed, small-flowered morning-glory, wild morning-glory, devil’s guts, hedge bells, corn lilly, withwind, bellbind, laplove, and the Spanish called it chicken guts. The scientific binomial, *Convolvulus arvensis* designated by Linnaeus in 1753, is the combination of a Latin verb “to roll together” or “to entwine” with Latin for “of the field.” Inter-specific hybrids in field bindweed have not been reported.

Roots. Field bindweed produces an extensive system of roots and rhizomes whitish in color, cordlike, and fleshy. The primary root forms a taproot that can penetrate the soil to depths of two to ten feet (0.5-3 m). Lateral roots grow from buds along the taproot and from adventitious buds at the stem base. Buds along the lateral roots give rise to rhizomes in early spring, and when rhizomes reach the soil surface, they establish new crowns capable of generating independent plants. Rapid growth of rhizomes begins when day temperatures approach 60° F (14° C) and night temperatures do not drop below 35° F (2° C). Rhizomes are found in the upper two feet (60 cm) of the soil profile. The entire root system of one plant can occupy an area 20 feet (6 m) in diameter and 30 feet (9 m) in depth. Roots accumulate starch to a maximum in August and September after which the starch rapidly converts to sugar and by October the amount of sugar in the roots is greatest. The sugar acts as antifreeze to protect roots from freezing injury over winter. Root carbohydrate reserves are lowest in May commensurate with stem elongation. Root nitrogen content is greatest in mid-April prior to shoot emergence and lowest in mid-May. Research has shown that once hardened in the autumn, roots and rhizomes survive temperatures as low as 21° F (-6° C) but when located in the upper soil profile are injured when the ground freezes. One study found roots were killed when exposed to 18° F (-8° C) or lower and root injury is common in frozen ground.

Stems. The stems of field bindweed are slender vines that run along the ground or climb any available object. Stem length ranges from one to six feet (0.3-1.8 m), they often twine, form dense, tangled mats, and they are normally hairless but can be pubescent. The stem surface is corrugated longitudinally with a thick cuticle. Freezing temperatures kill stems back to the root crown. Stems emerge from root crowns in early May. Rapid stem growth begins when day temperatures approach 60° F (14° C) and night temperatures do not drop below 35° F (2° C).

Leaves. The leaves of field bindweed vary in shape and size but are generally described as arrowhead- or spade-shaped because of the hastate lobes at the leaf base, distinguishing it from closely related morning glory species (see Figure 2). Their length ranges from three-quarters to two inches (2-5 cm) and the margins are entire. A petiole attaches them to the stem in an alternate arrangement. Field bindweed leaves are similar to those of wild buckwheat (*Polygonum convolvulus*), however wild buckwheat is an annual, its flowers are green, leaves are heart-shaped and the leaf petiole bases have stipules that sheath the stem.

Figure 2. The leaves of field bindweed are arrowhead-or spade-shaped and grow from the leaf axils on long pedicels.

Flowers. Field bindweed flowers have been described as funnel-, trumpet-, and bell-shaped because the five petals are completely fused together. The lobes are nearly indistinguishable and form a corolla tube that gradually widens upward and flares outward at the edge (see Figure 3). The length of the floral tube ranges from one-half to one inch (1.5-2.5 cm) long, it is three-quarters to one inch in diameter, and it is white or pinkish-purple. The relatively small flower distinguishes field bindweed from other species in the morning glory family. The five sepals subtending the funnel-form corolla are also fused, one- to two-tenths of an inch (3-5 mm) long, and greenish with pink margins. Five stamens are unequal in length and attached to the corolla alternate to the lobes and near the base. The pistil has one style, one two-chambered ovary each producing one or two seeds. The fruit is a capsule. The flowers are single or sometimes in pairs on a long peduncle that grows from the leaf axils. Most flowers have two green, linear bracts less than two-tenths of an inch (4 mm) long on the peduncle about one inch (2.5 cm) below the flower. The size of the bracts and the size and color of the flower can distinguish field bindweed from other morning glory species. Flowering begins in late June and continues into the fall as long as conditions are favorable. An individual flower persists for one day only, beginning expansion in early morning, also when nectar production begins. Flowers are self-incompatible and pollinated by bees in the Halictidae family (Hymenoptera), honeybees, bumblebees, butterflies and moths that are attracted by the nectar.

Figure 3. The flowers of field bindweed are funnel-form.

Seeds. Field bindweed seeds are ovoid, pear-shaped, one- to two-tenths of an inch (3-5 mm) long, three-sided with normally one-side rounded and two-sides flattened, but variable depending on environmental conditions. Seed weight is about ten mg. They have hard, impermeable, dull brownish-grey and coarsely-roughened seed coats. Seed set is greatest in dry, sunny weather and dry-calcareous soils and may fail on heavy, poorly-drained soils and during rainy periods. Seeds can germinate ten to 15 days after pollination when seed moisture content is 80 percent. Impermeability of the seeds to water sets in by 23 to 25 days after pollination. Fresh seeds are 87-99 percent viable, 5-25 percent can germinate, and 60-80 percent has enforced dormancy by the impermeable seed coat. Dormancy can be broken by mechanical scarification or by treatment with concentrated sulfuric acid or ethyl alcohol. Over-wintering reduces impermeability by 30 percent. Peak germinate is in late spring or early summer, however seeds will germinate throughout the growing season if moisture is adequate. Seeds in the soil can remain viable for 20 years or more, and one study found 62 percent of seeds were viable after stored at room temperature for 50 years.

Spread. Field bindweed spreads predominantly by seeds that generally fall near the parent plant. The hard impermeable seed coat enables seeds to remain viable in the stomachs of migrating animals for up to 144 hours, and thus animal and bird migration facilitates long distance dispersal. Seeds also disperse in water. Field bindweed commonly spreads long distances through human transport as seed in flower packets and as a contaminant of crop seed. Farm equipment spreads root and rhizome fragments within and between fields. Field bindweed has been intentionally introduced into the United States as wild morning glory for ornamental plantings, as ground cover and in hanging baskets.

Habitat. Field bindweed grows on cultivated fields, pastures, gardens and lawns, roadsides and railways and in waste places. It can survive long periods of drought. It favors rich fertile soils that are dry or moderately moist, but it can persist on poor, gravely soils. It is found in temperate, tropical, and Mediterranean climates throughout the world but it is most problematic in temperate region croplands. Its distribution extends from 60° N to 45° S latitude and it has been reported at 10,000 feet (3,048 m) elevation in the Himalaya Mountains.

Economic Impacts. The extensive root system of field bindweed enables it to effectively compete for soil moisture and nutrients resulting in reduced crop yield. In Spain, the economic injury threshold in a winter wheat/sunflower crop rotation was estimated at 14 plants per square yard (square meter). The twining stems cause lodging of crops and interfere with crop harvest. Crop seed contamination with field bindweed seed reduces crop value and increases seed cleaning costs. In lawns and gardens, field bindweed increases maintenance costs and reduces the aesthetic value of ornamentals. As an alternate host of the viruses that cause potato X disease, tobacco streak, tomato spotted wilt, and vaccinium false bottom, field bindweed contributes to losses associated with these crop diseases.

Field bindweed is a good fodder plant. Cattle, sheep and goats eat it; however, the alkaloid pseudotropine in field bindweed was reported to cause equine intestinal fibrosis. In India, the root is used as a purgative. It has been used to stop bleeding, as a laxative, a gynecological aid, to stimulate bile flow, and as a medicine for spider bites. The Okanagan-Colville people of British Columbia and Washington fashioned the twining stems into rope. In one study, shoots of field bindweed accumulated more than 3,800 mg chromium, 1,500 mg cadmium, and 560 mg of copper per kilogram of dry tissue and may be a suitable plant for phytoremediation of soils contaminated with heavy metals.

Management Alternatives

Tilling. Frequent cultivations reduce field bindweed root reserves and deplete the soil seed bank. To be effective, fields should be tilled eight to 12 days after re-growth for three to five years. Tilling at the bloom stage when root carbohydrate and nitrogen reserves are lowest may be the most effective timing for suppression. A chisel plow encourages re-growth of field bindweed. After re-growth, using a sweep plow removes top growth and leaves plant residue on the soil surface. Early emerging and fast growing crops will shade field bindweed and reduce its re-growth after tilling. Field bindweed increases under reduced tillage or no-till management that does not include herbicidal or other control methods. Re-vegetation as soon as practical after tilling helps suppress field bindweed re-establishment. If a field is severely infested it is recommended that a cover crop or cereal grain be planted and labeled herbicides applied for at least one growing season.

Herbicide.[1/] Herbicides temporarily suppress field bindweed. The effectiveness of herbicides will be reduced under drought conditions. The wax surface of field bindweed leaves grown under high light and low humidity conditions is three times greater than leaves of plants grown under low light and high humidity conditions. Field bindweed leaves grown under high light/low humidity conditions absorbed nine percent of applied glyphosate compared to 21 percent absorbed by leaves grown under low light/high humidity conditions. Bio-types of field bindweed have different tolerances to herbicides. No herbicide or herbicide combination will provide 100 percent control.

Glyphosate applied pre-crop emergence at four to five quarts of a three pound acid equivalent per gallon formulation will reduce field bindweed during the growing season. The addition of ammonium sulfate at two percent by weight will counteract the antagonistic effect of hard water and cations secreted by the plant on the leaf surface and improve penetration of the leaf surface by the herbicide. Dust covered leaves will reduce the effectiveness of glyphosate. Combining glyphosate with 2, 4-D or dicamba increases the absorption and accumulation of glyphosate in field bindweed roots. Glyphosate will not injure crops when applied pre-emergence, however it will injure or kill established crops and desirable plants when they are actively growing.

The ester and amine formulations of 2, 4-D applied at one pint per acre of a four pound per gallon formulation at the tillering stage of cereal crops suppresses field bindweed during the crop season. Applied at one or two quarts per acre in the fall is most effective when the soil is moist and field bindweed stems are 12 inches long. The ester formulation gives more effective control compared to the amine formulation; however crops may be susceptible to injury from volatile drift of the ester.

Fall application of dicamba at one to two quarts per acre controls field bindweed better than 2, 4-D when applied in the fall. However, crop injury from these rates of dicamba has been reported and dicamba is more expensive than 2, 4-D. Dicamba is appropriate for spot treatment and on pastures and rangeland.

Picloram applied at one quart per acre, and combinations of picloram plus glyphosate, 2, 4-D or dicamba controls field bindweed for one or more years. The long residual activity of picloram in the soil limits crops that can be planted after its application for one or more years. Picloram can be used on pastures, rangeland, and in wheat. In a wheat-fallow rotation field heavily infested with field bindweed, picloram (1 pint/acre) plus 2, 4-D (1 pound/acre) was applied in September post-harvest, and 2, 4-D (1 pound/acre) was applied in September of the fallow year. This management was repeated for four years. Field bindweed control was 80, 41, 79, and 91 percent in the summers following the herbicide applications. Wheat yields were two and four times greater under this management than where no herbicide was sprayed in the harvest years (two seasons after picloram was sprayed).

Quinclorac applied at 3.0 to 5.3 ounces/acre in the fall before the first killing frost controls field bindweed. It must be applied with 0.5 percent by volume methylated seed oil (MSO), and the addition of 28 percent urea ammonium nitrate or ammonium sulfate can improve control. Field bindweed should be actively growing, at least four inches long, and not drought stressed. In one study, quinclorac was applied at one quarter pound (four ounces) per acre in combination with one pound per acre 2, 4-D and MSO at 0.5 percent by volume in September post wheat harvest in a wheat/fallow crop system. In the fallow year, quinclorac was applied at two ounces/acre with the 2, 4-D and MSO. In the third year Quinclorac was applied at two ounces/acre and 2, 4-D was applied at one-half pound per acre, and in the fourth year only 2, 4-D was applied at one pound per acre. Field bindweed was controlled each year by 65, 41, 79, and 92 percent, respectively, compared to the no herbicide treatment. Wheat yields were more than two and four times greater compared to the no herbicide treatment. In a separate study, imazapyr applied at one-tenth, one-quarter, and one-half pound per acre reduced field bindweed by 67, 74, and 96 percent respectively, however severe crop injury can be expected from these rates.

[1/]Any mention of products in this publication does not constitute a recommendation by the NRCS. It is a violation of Federal law to use herbicides in a manner inconsistent with their labeling.

Grazing and Mowing. Cattle, sheep and goats will graze on field bindweed leaves and stems. Hogs and chickens eat leaves, stems, exposed roots and rhizomes, and crowns. Mowing will not reduce infestations of field bindweed, but it may reduce seed production if timed to prevent flowering, and mowing can be used to spread the biological control mite *Aceria malherbae*.

Biological Control. Two biological control agents attack field bindweed: *Aceria malherbae* (initially reported as *A. convolvuli,* now considered a separate species) and *Tyta luctuosa*. *Aceria* *malherbae* is the bindweed gall mite native from central and southern Europe to northern Africa. It has multiple generations per year and over-winters as an adult or nymph on the root buds. The soft-bodied adults are minute and difficult to see without magnification, are worm-like with ring-like body segments and two pairs of legs on the combined head and thorax. The nymphs resemble the adults in appearance except they lack external genitalia. Adults and nymphs are both destructive to field bindweed. When *A. malherbae* attack field bindweed, galls are formed on the actively growing leaves, petioles, and stem tips. Leaves with galls fold or twist upward along the mid-rib. Attacked stem buds fail to elongate and form compact clusters of stunted leaves. *Aceria malherbae* can be collected throughout the growing season as adults or nymphs by handpicking stems with galls and wrapping them around actively growing field bindweed stem tips in other infestations. Spring or early summer releases give mites more time to increase populations than later releases. Mites can also be spread by mowing sites that have established galls. The mite may be difficult to establish where fields are cultivated or sprayed with herbicides, unless herbicides are applied at sub-lethal doses. This mite also attacks species in the *Calystegia* genus (also Convolvulaceae) which includes hedge bindweed and native species that are listed as rare and endangered. However non-target impacts have not been reported.

Tyta luctuosa is the bindweed moth native to Europe north to southern Scandinavia, Asia east to Turkistan, and south into India, and Northern Africa. It over-winters as adults and larvae on the root buds of field bindweed. The caterpillar-like larvae are the destructive stage and feed at night on the flowers and leaves and on litter during the day from May to September. Damage to field bindweed has not been quantified. First generation adult moths emerge in May and are active until June, and second generation moths are active from July to September. This moth also feeds on *Calystegia* (other bindweed) species but no effects have been reported. As of 2002, numerous releases in the United States have not successfully established and availability of the insect is limited because of failures during mass rearing.

Table 1. Biological control agent for management of field bindweed, the site of attack on the plant, insect life stage and plant life stage for collection, and the collection method for re-distribution.

Agent	Type	Site of Attack	Collection	Collection Method
Aceria malherbae	mite	leaves and stems	larval	handpick
Tyta luctuosa	moth	flowers and leaves	larval and adult	handpick and lights

Re-vegetation. Field bindweed is most prolific when growing in full sunlight and is suppressed by plants that are active early in the spring and form a shading canopy. In hazelnut orchards, a cover crop of ryegrass (*Lolium multiflorum*), hairy vetch (*Vicia villosa*) and red clover (*Trifolium pratense*) reduced the density and biomass of field bindweed compared to no cover crop (bare ground). Cover crop residues also suppressed field bindweed. Winter wheat, other crops, and perennial forages with early spring growth will shade and suppress field bindweed. Establishing competitive perennial grasses on disturbed land, followed by prescribed grazing management to maintain grass vigor will suppress field bindweed and prevent spread by seed. Refer to Montana Plant Materials Technical Note 46, 'Seeding Rates and Recommended Cultivars,' and Extension Bulletin EB19 'Dryland Pasture Species for Montana and Wyoming' for seeding rate guidance and re-vegetation species selection. State and area resource specialists can help determine the most appropriate, site-specific species mix, timing of seeding, and seeding methods. Where herbicides have been applied, chemical carryover should be assessed prior to planting permanent vegetation.

Integrated Pest Management

Integrated pest management is the application of two or more management alternatives so they are complimentary in weed suppression and improve production or conservation of resources. The most effective field bindweed control programs in croplands combine tillage and crop rotation with herbicide management. On pasture and rangeland, prescribed grazing management to maintain competitive grasses combined with herbicide management and/or *A. malherbae* may be more effective than any of the treatments applied alone. In mixed grass and legume pastures, the best control is through maintaining a resilient healthy stand through proper grazing management and crop rotation when stands thin and provide open space for weed invasion.

There are many systems used to time the application of multiple control procedures, one of which is based on the economic injury threshold. In weed management, the economic injury threshold is the density of the weed at which there will be crop loss greater than the cost of control if no management action (generally herbicide) is taken. Under no-till management in a wheat/sunflower crop rotation in southern Spain, the economic injury threshold for field bindweed was determined to be 14 stems/m^2. Field bindweed tended to form stable patches in no-till management. In the study, weed density was sampled in May before crop harvest. Maps estimating field bindweed density from samples were used to estimate areas where densities would exceed the economic injury threshold density and where post-emergence herbicides should be applied. Field bindweed densities were greater (and more variable) in wheat than sunflower, and therefore the sunflower rotation reduced the total field area exceeding the economic injury threshold. The study predicted applying post-emergence herbicides only where the economic injury threshold was exceeded reduced herbicide costs by 81 percent during the sunflower rotation.

In a laboratory study, the biological control mite *A. malherbae* and low rates of 2, 4-D or glyphosate were combined on field bindweed. Shoot and root biomass of field bindweed were reduced by 2, 4-D applied at one-tenth pound per acre and there was no reduction of galls formed by mites. Similarly, glyphosate applied at one-quarter pound per acre reduced field bindweed shoot and root weight, however there were two times more *A. malherbae* on glyphosate treated plants than non-sprayed plants. Reduced rates of these herbicides can be used post-crop-emergence to suppress field bindweed with lower risk to crop injury and without reducing populations of *A. malherbae*. On non-crop land, combining *A. malherbae* with mowing management can be used to manage field bindweed and facilitate the spread of *A. malherbae*.

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