Field Bindweed

Convolvulus arvensis L.: Convolvulaceae

Field bindweed (*Convolvulus arvensis* L.: Convolvulaceae) is one of the most common noxious weeds in the Pacific Northwest (PNW) and one of the most difficult to control. It was introduced from Europe to Virginia in 1739, and even before 1900 the U.S. Department of Agriculture recognized the weed as a national menace.

By 1900 field bindweed was established in all western states. By 1955 it was present in every Idaho county, occupying 140,000 acres of cropland. It is estimated to occupy more than 500,000 acres of Idaho cropland plus an equivalent acreage of pasture and rangeland. In Oregon and Washington, it is estimated to infest approximately 500,000 acres in each state. The only noxious weed that infests more crop acreage is Canada thistle (*Cirsium arvense* (L.) Scop.).

Field bindweed is known as morningglory, wild morningglory, corn-bind, and creeping Jenny, but to avoid confusion with other species, it should be called field bindweed.

Crop yields often are reduced 50 percent or more where field bindweed infestations are dense. Field bindweed has a deep root system that competes with crop plants for water and soil nutrients. Field bindweed vines climb on plants and shade them. They complicate tillage and harvesting by clogging machinery and entan-

Figure 1. Field bindweed *climbs upright plants, binding together all plants within a colony or patch. Creeping in every direction, it grows in circles. Pink to white floral petals fuse into a funnel shape.*

Figure 2. True seedlings*, at left and lower right, emerged from seed. Upper right seedling comes from a root stock so it doesn't have cotyledonary (seed) leaves.*

Figure 3. Crop yields *can be reduced 50 percent or more where field bindweed infestations are dense.*

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gling plants. Agricultural land infested with field bindweed is reduced in resale value.

Field bindweed also is common around home landscapes, frequently infesting shrubs, gardens, and other ornamental plantings. As new homes are built on land that once was farmland, field bindweed can continue to trouble homeowners, interfering with garden production and competing with ornamental plants. It is not frequently found in range or forest land unless the soil has been disturbed and seed or plant parts have been introduced.

State Laws

Field bindweed is a noxious weed species under the noxious weed laws of many states. In Idaho, Oregon, and Washington field bindweed is considered noxious, although each state has a slightly different categorization of noxious. Currently, Idaho uses a single designation of noxious weeds while Oregon and Washington have multiple categories of noxious weeds depending on established criteria. Field bindweed in Oregon is a Class B noxious weed, which means that it is a weed of economic importance in areas of the state in which it is regionally abundant. In Washington, field bindweed is a Class C noxious weed, which means that it is widespread in the state and long-term control programs are a county option.

Field bindweed also is designated as a "primary noxious weed" in the Idaho, Oregon, and Washington Seed Laws, which prohibit the sale of desirable plant seed containing seeds of any primary noxious weed. All crop seed offered for sale in all three states must be tagged to show it is free of these pests. The tags also give the percentage of purity and germination of the crop seed. Clean seed of adapted crop varieties is always a good investment.

The Idaho, Oregon, and Washington seed certification laws prohibit certification of crop seed that contains field bindweed seeds or that comes from fields in which field bindweed was found during the field inspection phase of the certification process. This means that for control, aboveground growth must be destroyed and prevented from producing seed.

Description

Field bindweed and weed species resembling it differ in leaf size and shape, flower color, and growth habit within and between populations (Fig. 6). However, they all share the following characteristics:

Growth habit—Field bindweed is a perennial species with creeping roots and slender green, twisted, and vining stems that may grow as long as 6 feet. When other plant species are absent, field bindweed stems lie on the ground. Field bindweed will climb upright plants, binding together all plants within a colony or patch. Field bindweed normally grows in circular patches because it creeps in every direction. Cultivation or other types of mechanical or physical control may change this pattern by physically moving creeping roots.

Figure 4. Leaves shaped *like an arrowhead have two pointed basal lobes that extend at right angles to the leaf midvein.*

Leaves—Although field bindweed leaves vary in size and shape, they always are shaped like an arrowhead with two pointed basal lobes that usually extend at right angles to the leaf midvein. This is an identifying characteristic of many plants in the Convolvulaceae (morningglory) plant family. Field bindweed leaves have no stipules and have a petiole (leaf stalk).

The leaf blade is usually blunt-tipped with a tiny point at its end. In some biotypes, the blade is sharply pointed. Leaves are dark green, vary from smooth to slightly hairy, and are usually 1/2 to 1 inch long, but vary in size depending upon the biotype and growing conditions.

Figure 5. Field bindweed *flowers, faintly scented, are about 1 inch in diameter and l/2 to 1 inch long.*

Flowers—The flowers originate and grow from the leaf axils (at the junction of leaf and stem). See figures 1, 6, and 9. They have pink to white petals that are fused into a funnel shape. The funnel shaped flowers are another identifying characteristic of many plants in the Convolvulaceae family. Two tiny bracts are located 1 1/2 to 2 inches below each flower, and secondary flowers can grow from buds in the bracts' axils.

Flowers are faintly scented and about 1 inch in diameter and 1/2 to 1 inch long. The exterior of each flower has five lengthwise, thickened strips that may be light green or pink. Flowers fold at night to form a 5-part twisted tube and open during the day. Flower blooming starts about 4 weeks

after emergence in mid-spring and continues until the plant foliage is killed by frost.

Seeds—A pure stand of field bindweed can produce 22 million seeds (about 3/4 ton) per acre. Seeds are mature about 3 weeks after flowers bloom, but have been known to germinate within 10 days after the flowers open. Field bindweed seeds have a hard, impervious seed coat that enables some seeds to remain dormant, yet viable in the soil for many years. Bindweed seed germination has occurred in a field even after no bindweed seed production was allowed for 28 years, and seeds have been documented to survive 50 years.

Field bindweed seeds are contained in two-sectioned capsules, each with one to four (usually four) seeds. Seed shape is determined by the number of seeds in each capsule, but is typically egg-shaped with one or two flat sides and a squared-off tip at the tapered end. When four seeds form, each one has two flat sides and one rounded side. When two seeds form, they have only one flat side. Occasionally, capsules have single seeds; these seeds have no flattened side. Seeds are grayish brown to black and have a rough, pebbly surface.

Seeds are about 1/8 inch (3 mm) long. This, combined with their variable shape, makes them very difficult to separate from wheat, barley, and other seeds in seed cleaning equipment. As a result, field bindweed seeds are common contaminants in these crops.

Roots—Field bindweed spreads primarily by roots when weed control practices suppress flowering and where tillage implements carry roots to uninfested areas. Buds at various intervals along the roots send up shoots creating new plants aboveground. Roots spread out belowground laterally from a field bindweed and also can penetrate 20 feet deep in soil, but normally do not send up shoots from any deeper than 2 feet. Studies have shown that root systems increase in vigor and regenerative ability as root diameter increases and as the root gets older. Buds on broken root segments as short as 1 inch can produce new shoots.

Another factor affecting the ability of a root segment to re-grow is the depth from where the root segment originated. Fragments taken from below the plow layer are much more likely to grow than fragments taken from the top 2 to 4 inches, due to the lack of buds above the plow layer.

Seedlings—Field bindweed seed germinates in the fall and spring. See figure 2. The optimum germination temperature is 86°F and can range from 34°F to 104°F. Bindweed seedlings can be identified easily by their two cotyledons (seed leaves) shaped like kidneys or hearts.

As soon as the plant begins producing true leaves, their outline is the same arrowhead shape as leaves on a well established plant. Seedlings develop a deep taproot about 6 weeks after emergence. More importantly, at approximately the same time—6 weeks after emergence—these plants can also begin producing underground rootstocks capable of producing new plants from vegetative buds. Therefore, mechanical control such as tillage or hoeing can be effective for seedlings only during the period from emergence to 6 weeks after emergence. After this period, when field bindweed plants develop lateral roots, the plants resist mechanical control, but usually are not difficult to control with herbicides until they are two to three years old.

Similar species

Hedge bindweed—*Calystegia sepium* (L.) R. Br. is in the same family and occurs in waste areas and fencerows. It is nearly identical to field bindweed, but has much larger, hairless leaves and flowers that measure 1 1/2 inches across. At the flower base, two large but not overlapping bracts enclose the flower calyx (green protective covering of a bud).

Hedge bindweed has been reported in the Idaho counties of Gem and Bingham in 1989 and 2001, respectively. It is more common in western Oregon and Washington. Several other bindweed or morningglory species occur in the United States, but none has been reported in the PNW.

Annual morningglory—*Ipomoea purpurea* (L.) Roth, another member of the morningglory family, is a related, commercially available ornamental species that is rarely weedy in the PNW. Varieties of this species have much larger, showy flowers of various colors. Because it is an annual, it is more easily controlled by mechanical means such as cultivation. This species is also a weed in many other parts of the country.

Wild buckwheat—*Polygonum convolvulus* L., is a member of the Polygonaceae or buckwheat family, and is sometimes called black bindweed. This annual weed occurs throughout the PNW and often is mistaken for field bindweed. Wild buckwheat has a twining growth habit and leaf sizes and shapes similar to those of field bindweed, which is why the species are often confused. Buckwheat is distinguished easily by the following characteristics: (1) untwisted, often red or white stems, (2) tiny, inconspicuous flowers in groups at the leaf axils, (3) an inconspicuous papery sheath that encircles the stem at the base of each leaf petiole, (4) leaf blades with basal lobes that point downward and (5) long, very pointed leaf tips that do not vary in shape.

Each wild buckwheat flower has a single seed that is distinctly triangular in cross-section, with sharp angles and sharply pointed ends. The plant is not unusually hard to control and seldom occurs outside of cropland, gardens, or ornamental plantings.

Silver lace vine—*Polygonum aubertii* Henry, also in the Polygonaceae family, has woody stem bases and may climb as high as 30 feet on trees and poles. Its leaves have nearly the same size and shape as field bindweed leaves, but they have sharp, narrow tips more like those of wild buckwheat, and distinctively ruffled edges, especially when young. The flowers are small and in showy bunches. Silver lace vine is uncommon in the PNW. It is sold as an ornamental and sources can easily be found on the Internet. It is described as a rampant, twining vine that produces a cloud of white flowers and is valued for its adaptability, not its refinement.

Many other species have leaf shapes similar to field bindweed, but lack twisted, vining stems.

How Field Bindweed Spreads

The primary means of long-distance spread is by seed, but once a seedling becomes established, a patch or colony forms and spreads by extending lateral roots. The spreading root system enables undisturbed patches in crops to enlarge 6 to 10 feet in diameter per year. As previously mentioned, such patches tend to be circular.

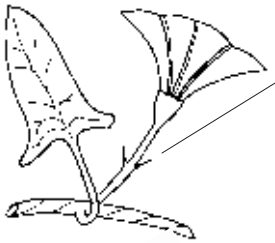
Under favorable soil moisture conditions, new infestations can occur when field bindweed contaminated soil is moved or when field bindweed root sections are transported by agricultural or construction equipment from one location to another.

Field bindweed seeds can pass through animal digestive systems with little or no damage. Grains or forages containing mature field bindweed seeds should not be fed to animals unless the feed is ground or otherwise processed to destroy the seeds.

Effects on Livestock

Although field bindweed is not productive forage, sheep have grazed and eaten it in the United

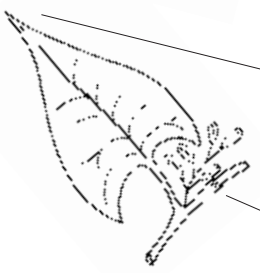
Figure 6. See field bindweed and species resembling it. Distinctive differences in field bindweed compared to similar weeds are labeled. Growers will want to eliminate all of these from crop, pasture lands, and from home landscapes.



Field bindweed
Small bracts well below flower
Leaf: *Arrowhead shaped, up to 2 l/2 inches long, tiny point in rounded leaf tip. Basal lobes point at nearly right angles to midrib. No stipules. One leaf per node.*
Flower: *Funnel-shaped, up to 2 l/2 inches long, 3/4 to 1 inch across. White to pink. Stalk has 2 bracts l/2 to 2 inches below the flower. Flower folds at night.*
Stem: *Twisted, green.*

Hedge bindweed
Large bracts enclose flower base
Leaf: *Sharply pointed. Blade up to 8 inches long. No stipules. One leaf per node.*
Flower: *1 l/2 to 2 inches across. 2 to 3 inches long. White to pink. Bracts are large at base of petals. Distinct points on calyx lobes.*
Stem: *Green, very slight twist.*

Russian vine
Ruffled edge
Leaf: *Sharply pointed, up to 2 l/2 inches long. Ruffled edges. Rounded basal lobes. Sheathing stipules. Two or more leaves per node.*
Flower: *Small, white, in profuse bunches.*
Stem: *Brown woody lower part. Green upper part, not twisted.*



Wild buckwheat
Narrow, sharp point
Sheathing stipule
Leaf: *Arrow shaped. Sharply pointed. Basal lobes point opposite to leaf tip. Up to 3 inches long. Sheathing stipules. One leaf per node.*
Flower: *Small, green to white, inconspicuous, one triangular seed per flower*
Stem: *Red to white, not twisted.*

States with no reported ill effects. Continuous, intensive sheep grazing over a period of several years can temporarily suppress field bindweed. Afterward, however, it will recover fully if undisturbed. More importantly, grazing that is intensive enough to control field bindweed usually destroys desirable grass species as well, opening the way for erosion and more weed invasion.

Cattle do not readily graze field bindweed, and hog poisoning from field bindweed consumption has been reported. Other members of the Convolvulaceae family have been reported to possess purgative properties and have caused cattle, goats, and sheep to become ill, although the illness has not been clearly defined. As a result, even though small amounts (5 to 10 percent by weight) of field bindweed in an animal's diet have produced no reports of adverse effects, heavy grazing on dense stands of field bindweed appears to be risky. Allowing livestock to eat field bindweed after seed maturity can result in weed spread since seeds can pass through livestock and germinate. Any transport of noxious weed seeds, even in animals, violates many states' noxious weed laws.

Control and Management

Since field bindweed seeds can survive in the soil for many decades, total eradication is not a realistic short-term goal where seeds lie dormant. However, with diligence you can eliminate field bindweed root systems by integrating the use of biological, mechanical, and chemical control agents into certain cropping or land management practices. When only the more easily controlled seedlings growing from seed remain, a field bindweed infestation causes negligible economic losses. The best control methods and materials depend on the size of the infestation and the conditions under which the weed is growing. Using a combination of control strategies will provide the greatest chance for success.

Figure 7. A pure stand *of field bindweed can produce 22 million seeds (about 3/4 ton) per acre. Seeds mature about 3 weeks after flowers bloom, but have been known to germinate within 10 days after flowers open.*

Biological control

Competition—Perennial grasses can compete well with field bindweed. Most of these grasses begin growth much earlier in the season than field bindweed does, and can take early advantage of limited soil moisture and establish a canopy that competes with field bindweed for light.

Bindweed will persist in rangeland, pasture, and lawns in a suppressed condition and will grow vigorously if competitive species are absent, overgrazed, or mismanaged. Enhance competition from desirable grasses by avoiding early and mid-spring grazing or by grazing all plants in a short duration high intensity system, applying nitrogen fertilizer, and reseeding where needed.

Alfalfa can be used to contain a field bindweed infestation, but will not crowd it out. Alfalfa may, however, be used as a soil-building crop in a rotation designed to control bindweed by other means. This may be especially useful under dryland conditions.

To obtain maximum benefits from any cropping method, grow healthy, vigorous crops. For maximum crop yield, test the soil to determine crop nutrient needs, and apply the necessary fertilizer. This will improve the crop's competitive ability and help suppress bindweed.

Insects and Mites—Organisms for biological control are under investigation, but have not yet resulted in substantial field bindweed control. Several insect and mite species attack field bindweed in its native European and Asian habitats. Some of these species already exist in the United States and Canada. However, many insects that feed on field bindweed also damage native and ornamental morninglories (*Ipomoea* and *Calystegia* spp.) as well as sweet potato *(Ipomoea batata*). The U.S. Department of Agriculture will approve the release of those insect and mite species that damage field bindweed only. The single imported insect that has been tested successfully and approved for release in parts of the United States is the European moth (*Tyta luctuosa*). Caterpillars of this moth defoliate bindweed, usually in the later part of the growing season. This is

unlike the other moths, *Bedellia* and *Emmelina*, which feed early. This moth has not been released on a large scale to date; thus, its biology and impact under U.S. conditions are unknown.

A gall-forming mite, *Aceria malherbae*, has become established in Texas, and has had greater success in the southern U.S. Its feeding deforms field bindweed buds and leaves. The insects and mites described here are unlikely to provide satisfactory control unless they work together with other agents.

Field bindweed control with insects and mites is not promising in an annual cropping system, gardens, or turf. The extensive root system, which limits control by other methods, also limits the ability of insects and mites to control this weed. In conventional annual cropping systems and gardens, biological control agents do not control field bindweed because they are seriously damaged by insecticides, tillage, and other farming and gardening practices. Eventual use of biological control agents is expected to be limited to range, pasture, forest, and other noncrop areas.

Insects that occasionally damage field bindweed—A leaf-mining moth (*Bedellia somnulentella*) and a defoliating moth (*Emmelina* (= *Oidaematophorus*) *monodactyla*) occur in the PNW and other parts of the United States. These insects may attack bindweed early in the season and can sometimes cause significant damage. Parasitism and predation of these moths by other insects limit their effectiveness. These moths have a broad host range that includes sweet potato, discouraging their use or further distribution for biological control in the United States.

The golden tortoise beetle (*Metriona bicolor*) and other tortoise beetles are commonly found on native morningglories and sometimes on field bindweed in the western United States. Feeding by adults and larvae generally results in minor damage to weed foliage.

Mites occasionally damage field bindweed—The two-spotted spider mite (*Tetranychus urticae*) and other mites can cause considerable damage to bindweed foliage. Unfortunately, this damage suppresses the plant little because it occurs late in summer. These mites have a broad host plant range that includes many important crop plants and are not considered valuable for field bindweed suppression.

Mechanical Control

Fallow tillage works when consistent 3 to 5 years

Field bindweed control by tillage requires 3 to 5 years of consistent, frequent tillage. Field bindweed stores its food reserves in the roots and will yield only to a thorough, well-timed tillage program. The best time to start a tillage program is immediately after harvest. It is best to keep equipment out of isolated bindweed patches except when weed control operations are in progress.

After harvest, plow 6 inches deep. Then, beginning 12 days after the bindweed re-emerges, perform a tillage operation with an implement that cuts off all of the plants such as a rod weeder or a sharp, duckfoot-type field cultivator. Make an adequate overlap of the sweeps every 14 days until the bindweed shoots are killed by freezing. Cultivate no deeper than necessary to completely cut off all of the shoots, usually 2 to 4 inches.

Clean roots and stems from equipment before moving out of each bindweed patch. Resume tillage in the spring 12 days after the bindweed emerges. Repeat this tillage operation every 14 days until bindweed no longer appears. Research shows that root segments in the early summer are less likely to grow than segments from late summer. Presumably roots from the late summer have a higher amount of food storage built up than do the roots in early summer.

Root segments are much less likely to grow if tillage operations are performed in dry soil, when no rain is predicted, since low moisture content in the soil will decrease the probability of root fragment survival. Tillage performed in dry soil will help break the roots into pieces that are too small to grow and will leave the root segments loose from soil particles, allowing them to dry out. Field bindweed root fragments, which have been disturbed recently by other tillage methods, are less likely to grow than root segments from undisturbed areas. As previously mentioned, segments in the top few inches are less likely to grow than segments from greater depths.

This type of tillage program requires 3 to 5 growing seasons without cropping. Consistency is crucial. A month's lapse can set the program back a year or more. This fallow program may increase erosion on slopes. Erosion can be reduced by planting an alfalfa-grass crop or green manure crop to add organic material to the soil before tillage and by spreading organic materials.

Cultivation in row crops

Cultivation in row crops will substantially suppress field bindweed growth, especially between rows, but will not prevent the weed from causing significant crop loss. Even though young stems emerging within crop rows may be covered with soil thrown by the cultivator early in the season, many will continue to grow. Cultivation can transport roots and stems resulting in considerable weed spread from localized patches. Use other control methods during times in the rotation when cultivated crops are not grown.

Mowing, pulling, and burning

Removal of all field bindweed top growth by pulling or burning can eliminate all but the weed seed if repeated at least every 14 days over 3 to 5 years. Mowing is inadequate because it misses stems lying flat as well as low leaves and flowers, and the plants can reproduce. Mowing is effective only when combined with other control methods such as herbicide treatment. Burning is most effective during the summer because damaged stem tissue

allows less water to leaves, stunting growth of field bindweed. Burning must be repeated like mechanical cultivation. Any lapse in the frequency of these types of control methods will set back progress toward eradication.

Composting

Applying manure to fields is a common practice in many places; however, there is great concern with the amount of weed seed that is being applied with the manure. High temperature composting can be an effective way to help eliminate viable field bindweed seeds in manure. Studies prove that field bindweed seed will be killed if the temperature of the compost reaches 180°F or higher for 7 consecutive days. If the temperature is not maintained at 180°F or higher for at least 7 days, seed viability will only be partially reduced. For instance, compost temperatures reaching 180°F for only 3 days will reduce the seed viability to 30 percent. Be aware that since the outer edges of a compost pile may not reach temperatures high enough to completely reduce viability, turning or mixing the compost is essential. With small amounts, the use of compost bins enable reaching and maintaining the necessary compost temperature more easily. Smaller composting operations that do not meet these temperature and time requirements may kill most soft-coated weed seed, but not seed with hard seed coats like field bindweed.

Soil Solarization

Soil solarization uses the sun's solar energy to kill soil pests. Clear polyethylene tarps may be used singly to cover pre-formed beds in small or large areas. Weed control is most effective when prepared beds are irrigated before covering with polyethylene. To prepare a bed for soil solarization, the surface area should be tilled and leveled. Irrigation also should be done after the polyethylene has been installed if irrigation drip lines are installed first. Moisture under the tarps helps conduct heat and stimulates weed seed germination. The heat trapped under the polyethylene will kill the seeds or seedlings. Soil solarization can suppress field bindweed top growth for as long as 6 weeks. Soil solarization also will reduce the number of seedlings, but field bindweed will not be eradicated totally.

Field bindweed along with some other perennial weeds are hard to control because their underground vegetative structures, like rhizomes, tubers, and bulbs, enable them to survive soil solarization and other non-chemical control methods. Soil solarization of seedling and/or annual weeds can be an effective alternative to chemical control.

Herbicides

For current herbicide information, consult the *Pacific Northwest Weed Management Handbook* or other publications including the labels of specific herbicides. An online version of the handbook can be found on the Internet at http://weeds.ippc.orst.edu/pnw/weeds. This bulletin mentions only those herbicides that are commonly used and currently registered for specific site uses. New herbicides may become available, and current label details will change over the years. Be sure to read the label before using any herbicide.

Selective herbicides

A selective herbicide is one that does not normally harm desirable plants while it injures the target plant. When hormone-type herbicides are used at low dose rates according to label directions, they do not harm grasses such as grain crops or lawn or pasture grasses. Long-term chemical control of field bindweed depends on sufficient herbicide moving into the root system to kill roots and root buds. This requires the use of a translocated or systemic herbicide (a herbicide that moves from one plant part to another). Examples of selective, translocated herbicides are 2,4-D, dicamba (Banvel or Clarity), picloram (Tordon), dichlobenil (Casoron), quinclorac (Paramount or Drive), and triclopyr (Crossbow, which also contains 2,4-D). The translocated herbicide glyphosate (Roundup and many other names) is not selective, but can be used selectively with precise application and protection of desirable plants.

Many translocated herbicides move within plants along with sugars produced from photosynthesis. Best perennial weed control is achieved when the herbicide application coincides with maximum sugar movement to the roots. In a perennial plant newly emerged from a root bud in spring, most sugar is moving upward to help produce new vegetative growth. When the plant reaches the bud or early bloom stage, vegetative growth slows or stops. After that time, most sugar produced in the leaves begins to move toward the roots.

The bud or early bloom stage is the best time to spray field bindweed provided that the plant is not water stressed. Sugar movement to the roots is also high in fall as nighttime temperatures decline, so herbicide treatment of fall regrowth after harvest or tillage has resulted in long-term control of field bindweed. No herbicide will be effective if the plant has gone into dormancy or semi-dormancy due to drought, a killing frost, or other adverse growing conditions.

Figure 8. Blooming begins *about 4 weeks after emergence in mid-spring and continues until frost kills plant foliage.*

Table 1. Ten ways to control field bindweed *are summarizd on pages 8 and 9. With diligence, field bindweed root systems can be eliminated by integrating the use of biological, mechanical, and chemical control agents.*

Control type	Strategies to fight bindweed plant & seeds	Success notes	Cautions/Problems
Biological control-competition	Perennial grasses compete well with field bindweed. Alfalfa can compete with a bindweed infestation, but will not crowd it out. It can be used as a soil building crop in a rotation designed to control bindweed by other means (especially under dryland conditions).	To enhance competition from desirable grasses: • Avoid early and mid-spring grazing; or • Graze all plants in a short duration, high intensity system, • Apply nitrogen fertilizer, as needed • Reseed where needed.	Bindweed will persist in rangeland, pasture, and lawns in a suppressed condition and will grow vigorously if competitive species are absent, overgrazed, or mismanaged.
Biological control—insects and mites	The USDA approves the release of insects and mite species that damage field bindweed only. By 2005, the only one was European moth (*Tyta luctuosa*). A gall-forming mite, *Aceria malherbae*, is established in Texas and shows success in the southern U.S.	Caterpillars of this moth defoliate bindweed, usually in the later part of the growing season. *Aceria malherbae* deforms field bindweed buds and leaves.	This moth has not been released on a large scale, as of fall, 2005. Control with insects and mites is not promising in annual cropping systems, gardens, or turf. Extensive root systems limit abilities of insects and mites to control this weed. Many insects that feed on field bindweed also damage native and ornamental morning-glories.
Mechanical control—fallow tillage	**FALL**: Begin tillage after harvest. Plow 6 inches deep. • Twelve days after bindweed re-emerges, till with an implement that cuts off all plants—a rod weeder or sharp, duckfoot-type field cultivator. • Overlap sweeps every 14 days until bindweed shoots freeze. • Cultivate to cut off all shoots—usually 2 to 4 inches deep. **SPRING**: Resume tillage 12 days after bindweed emerges. Repeat every 14 days until bindweed no longer appears. • Keep equipment out of bindweed patches except during control operations. • Clean roots and stems from equipment before leaving bindweed patch.	Fallow tillage program works when consistent over 3 to 5 years, preferably in dry soil and without cropping. Mechanical controls (tillage, hoeing) can be effective for weed seedlings only from emergence to 6 weeks after emergence. After that, lateral roots cause them to quickly spread. Roots have less food reserves after spring emergence than in the fall.	A month's lapse in this tillage program can set eradication back a year or more.
Mechanical control—cultivation in row crops	Cultivation in row crops will substantially suppress field bindweed growth, especially between rows. Once the crop becomes too large to cultivate, the crop must be healthy and competitive with field bindweed.	Use other control methods, such as herbicides, in combination with cultivation and during times in the rotation when cultivated crops are not grown.	Cultivation in row crops will not prevent the weed from causing significant crop loss. Cultivation can transport roots and stems, spreading weeds. Many young stems covered with soil thrown by the cultivator early in the season will continue to grow.

Table 1. Continued.

Control type	Strategies to fight bindweed plant & seeds	Success notes	Cautions/Problems
Mowing, pulling, burning	Removing all field bindweed top growth by pulling or burning can eliminate all but the weed seed if repeated at least every 14 days over 3 to 5 years.	**Mowing** is effective only when combined with other control methods such as herbicide treatment. **Burning**, which must be repeated, is most effective during summer because damaged stem tissue allows less water to leaves, stunting field bindweed growth.	Mowing alone is inadequate because it misses stems lying flat, low leaves, and flowers, so plants can reproduce Any lapse in repeated burning or mowing will set back eradication.
Composting	Heat compost to 180°F for at least 7 days to kill hard coated seeds such as field bindweed. Mix compost so edge materials also heat up.	Smaller composting operations that do not meet temperature and time requirements may kill soft-coated weed seed, but not field bindweed seed with hard coats.	Field bindweed seed composted less than 7 days at 180°F will survive.
Soil solarization	Use polyethylene tarp over tilled, leveled, irrigated bed.	Can suppress top growth for 6 weeks.	Reduces number of seedlings, but does not totally eradicate them. Deep reproductive roots will not be killed.
Herbicides, selective (doesn't harm desirable plants)	Consult PNW weed management handbook online at http://weeds.ippc.orst.edu/pnw/weeds. • Systemic herbicides include 2,4-D, dicamba (Banvel or Clarity), picloram (Tordon), dichlobenil (Casoron), quinclorac (Paramount or Drive), and triclopyr (Crossbow). • Use translocated herbicide glyphosate (Roundup and many others) with precise application and protection of desirable plants.	Time applications to coincide with maximum sugar movement to the roots (late summer or early fall before killing frost). Selective herbicides enable desirables plants to be more competitive. See guidelines for specific crops on pages 10 and 11.	Carefully follow label instructions.
Herbicides, nonselective (kills or injures all plants)	Examples: glyphosate, a systemic or translocated herbicide; paraquat (Gramoxone Max), a contact or non-systemic herbicide. Revegetate with desirable competitive plants such as perennial grasses.	Contact herbicides (paraquat) kill only tissue contacted directly; can kill seedlings in the cotyledon stage.	Contact herbicides only affect short-term control of field bindweed top growth. New shoots can develop from unaffected roots. Nonselective herbicides can kill all vegetation.
Chemical soil sterilants	Use soil sterilants only on noncrop sites and as a last resort. Soil sterilants do not sterilize soil; they kill or inhibit growth of plants that absorb them. Apply in late fall or winter (not on frozen soil), so winter moisture moves materials into the bindweed root zone. Follow label directions.	Use in areas where vegetation creates a fire or safety hazard such as electrical utility areas, remote gas pumping stations, etc. Inspect areas treated each year for bindweed emergence, and treat again when appropriate/necessary.	Most prevent growth of shallow-rooted weeds only, so their use may result in more bindweed growth. Do not use where erosion could occur after vegetation loss. Soil fumigation can provide substantial suppression, but does not penetrate deeply enough to kill the entire root system. Fumigants cannot kill dormant field bindweed seeds.

Selective herbicides by crop, location

Small grains—In irrigated areas, spring-planted barley or wheat competes well with field bindweed. Most varieties may be sprayed with 2,4-D. Apply the herbicide after the grain has tillered but before the boot stage. If weather conditions prevent this application during this time period, make the application after the dough stage.

Under non-irrigated (dryland) conditions in winter wheat or barley grown east of the Cascade Mountains, 2,4-D is less effective because the fall-planted crop usually reaches the boot stage before the bindweed is advanced enough for most effective spraying. If possible, apply 2,4-D before the small grain crop starts to boot; 2,4-D can be applied to winter wheat or barley after the dough stage if the first application timing is missed. For long-term selective control on dryland, use a crop rotation that includes at least three consecutive years of wheat or barley, and apply the selective treatment each year.

After small grain harvest in irrigated fields, remove excess straw to expose the bindweed, then irrigate the field to stimulate active weed growth. In dryland areas, bindweed regrowth after harvest will depend on adequate fall rain before a killing frost.

When bindweed stem regrowth in the late summer/early fall is 10 to 14 inches in fields where no crop is growing, apply 2,4-D, dicamba, glyphosate, quinclorac, or commercial premixed combinations such as glyphosate plus 2,4-D. The herbicide labels will specify rates and application methods. 2,4-D is less expensive than dicamba or glyphosate, but residual bindweed control the season after a single 2,4-D application averages only 30 to 40 percent. Dicamba is more costly, but is usually more effective than 2,4-D. Fall application of dicamba results in 70 to 85 percent control the next season. Follow label recommendations /restrictions for follow crop planting after dicamba application in the fall since residues from high rates of dicamba can persist in soil to injure sensitive crops the next year.

Glyphosate has no soil activity, so any labeled crop may be planted after a glyphosate application. Glyphosate alone has not consistently controlled field bindweed and in some tests has been no better than 2,4-D. However, combining glyphosate and 2,4-D or dicamba usually improves bindweed control compared with using any of these herbicides alone. Glyphosate may be best for spot treatment in situations requiring a nonresidual treatment or when a field also is infested with quackgrass or other glyphosate-sensitive perennial weeds.

Quinclorac (Paramount) is a relatively new herbicide that is used in wheat cropping systems. It should be applied in the fall just prior to the first killing frost. Field bindweed plants should be actively growing, and the above-ground growth should be at least 4 inches long. In winter wheat cropping systems, it is best to allow a minimum of 30 days for field bindweed to regrow after tillage prior to application. Quinclorac can be mixed with 2,4-D, dicamba, or glyphosate. Spring or winter wheat or grain sorghum are the only crops that can be planted earlier than 10 months after application. Refer to the quinclorac label for other follow crop restrictions.

Sweet corn—Field bindweed growing in sweet corn may be suppressed with 2,4-D. However, some varieties may be injured severely by 2,4-D, so consult the label, a knowledgeable crop advisor, and/or your corn dealer or contractor before applying 2,4-D. When corn height is more than 8 inches tall, corn injury can be reduced by using drop nozzles to keep 2,4-D off the upper leaves and whorl.

Field corn—Field bindweed can be treated with dicamba, 2,4-D, a combination of both, or diflufenzopyr + dicamba (Distinct) in many varieties of field corn. Dicamba may be applied until the fifth leaf stage or corn is 8 inches tall, whichever comes first. Corn from 8 to 36 inches tall may be treated with dicamba or diflufenzopyr + dicamba, but drop nozzles should be used to reduce dicamba drift. Do not use either herbicide if susceptible crops such as potatoes, sugar beets, dry beans, alfalfa, etc., are nearby.

In corn 3 to 8 inches tall, 2,4-D may be used. As with sweet corn, when field corn is taller than 8 inches, reduce injury by using drop nozzles to keep 2,4-D off the upper leaves and whorl. Avoid using 2,4-D esters and do not make any 2,4-D applications on windy or hot days. Do not allow 2,4-D to contact any plant for which there is no label provision.

Some corn varieties will not tolerate selective spraying with 2,4-D. Refer to the label or consult a knowledgeable crop adviser or university extension specialist for variety tolerance information.

Pasture and rangeland—In established grass pasture, apply 2,4-D, dicamba, imazapic plus glyphosate (Journey), and picloram (Tordon) according to label directions when field bindweed starts to bloom. Some of the herbicides have restrictions for returning livestock to treated areas. The limitations of individual herbicides are specified on each label.

Potatoes, sugar beets, peas, dry beans—Apply 2,4-D and/or glyphosate the season before planting potatoes, sugar beets, beans or other sensitive crops. Allow bindweed stems to grow an average of 12 inches before 2,4-D and/or glyphosate application. These crops cannot be planted in the same season 2,4-D is used.

If field bindweed has stopped growing in irrigated fields, irrigate the infested area(s) at least a month before herbicide application. Spray when weed growth resumes and produces 12- to 14-inch stems. Wait 2 days after treatment for herbicide

uptake and movement within the plants, then irrigate the sprayed area as soon as possible to maintain the translocation of herbicides as completely in the plant as possible. Re-treat whenever new bindweed growth reaches 10 to 14 inches in length.

Do not plow for at least 2 weeks after herbicide application.

Orchard floors (apple, blueberry, cherry, grape, nectarine, peach, pear, prune, plum)—Field bindweed can be a major problem in fruit production areas, especially in young orchards. In addition, the 20-year cycle from planting to removal in fruit tree crops such as those listed above, usually allows field bindweed to increase unless intensive control is practiced.

In most orchards, maintain bare soil under trees and grass sod in the row middles. The use of dichlobenil as a selective residual herbicide can effectively maintain bare soil while a planting is becoming established. *Soil-active herbicides should not be applied around trees younger than 1 year old nor should they be applied to shallow, coarse, sandy, or gravelly soils.* Competition from established sod will minimize field bindweed growth in the middles.

In older plantings where bindweed is a problem in bare areas, a paraquat/glyphosate mixture can be a successful nonselective "burn down" treatment. Follow label instructions. Do not let the herbicide contact immature (green or thin) bark or tree foliage.

Roadside, fencerow, and noncropped areas—Maintain an adapted, competitive grass. Apply labeled herbicides as soon as field bindweed begins to bloom, and reapply within 2 weeks of the appearance of new growth. Picloram, dicamba, or 2,4-D may be used.

Lawns and turf—Apply 2,4-D, triclopyr, a mixture of the two (Turflon D), quinclorac (Drive), or other labeled systemic broadleaf herbicides to fully expanded field bindweed leaves whenever they appear. This application must be done consistently over a period of several years in order to destroy all roots. If the roots are successfully killed, seedlings emerging each year can be controlled with these herbicides within 6 weeks of germination or before the seedling produces six leaves, whichever occurs first.

Ornamentals—Glyphosate and some brands of 2,4-D are permitted as long as no spray mist, droplets, or other forms of the herbicide contact desirable plants. Extreme care must be taken to avoid injuring desirable vegetation. Herbicide application can be combined with hand-weeding for more effective control.

Nonselective Herbicides

Nonselective herbicides typically kill or injure all plants. Selectivity however, is sometimes based on the use rate. Examples of nonselective herbicides include glyphosate, which is a systemic or translocated herbicide, and paraquat (Gramoxone Max), which is a contact or non-systemic herbicide. Contact herbicides such as paraquat kill only the tissue contacted directly. They can kill seedlings in the cotyledon stage, but only short-term control of field bindweed top growth can be achieved since new shoots can develop from unaffected roots with root buds. Other types of nonselective herbicides are called soil sterilants.

Chemical soil sterilants

Use soil sterilants only on noncrop sites and as a last resort. Soil sterilants do not sterilize the soil; they kill or inhibit growth of plants that absorb them. Most soil sterilants prevent growth of shallow-rooted weeds only, so their use may actually result in more bindweed growth. Soil sterilants may be used in noncrop areas where high rates may be effective, but only should be used where erosion will not occur after vegetation loss and where the herbicide will not move to sensitive, nontarget areas. Examples of where soil sterilants are used include electrical utility areas, remote gas pumping stations, and other areas where the presence of vegetation creates a fire or other safety hazard.

Apply soil sterilants in late fall or winter (but not on frozen soil) so that winter moisture will move the material into the bindweed root zone. Follow label directions to prevent undesirable side effects such as off-site movement of the herbicide. Areas treated with soil sterilants should be inspected each year for bindweed emergence and treated again when appropriate/necessary.

Soil fumigation can provide substantial suppression, but will not completely kill field bindweed plants since the fumigant does not penetrate deeply enough in the soil profile to kill the entire root system. Deep roots unaffected by the fumigant can produce new shoots. Fumigants also cannot kill dormant field bindweed seeds.

Folair nonselective herbicides

In noncrop, industrial, recreational, and public areas where soil sterilants have been applied and field bindweed is emerging, glyphosate may be applied nonselectively. Certain crops can be planted after glyphosate application in these areas. Refer to the label for restrictions/recommendations. Picloram, dicamba, or 2,4-D also are labeled for use in such areas at much higher, less selective doses than their use rates for weed control in crops.

Prevention

1. Plant seed that is free of field bindweed seeds.
2. Ensure that roughage or grain for feed contains no field bindweed seeds.
3. Buy nursery stock only from nurseries that guarantee soil around the roots to be free of field bindweed roots and seeds.
4. Avoid mature field bindweed patches when harvesting as harvest operations may distribute seeds. Transport of field bindweed seeds in crops or on vehicles or equipment violates

Idaho, Oregon, and Washington state noxious weed laws.

5. Treat all field bindweed infestations appropriately in order to kill roots, prevent shoot growth from root buds, and to prevent seed production. Use effective methods to control seedlings (growing from seed) in subsequent years.
6. Be sure tractors, tillage implements, harvest equipment, and other machinery are clean before allowing entrance onto your land, especially if they have been used in field bindweed-infested areas.
7. Support laws and ordinances that are intended to prevent field bindweed spread.

Figure 9. Flowers originate *and grow from leaf axils at the junction of leaf and stem. Two tiny bracts are located l l/2 to 2 inches below each flower.*

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