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Ecology and Management of Perennial Pepperweed [*Lepidium latifolium* L.]

By

Jim Jacobs, NRCS Invasive Species Specialist, Bozeman, Montana
Jane Mangold, Restoration Ecologist, USDA, Agricultural Research Service, Burns, Oregon

Figure 1. Perennial pepperweed infestation. Photo by Michael Carpinelli.

Abstract

Perennial pepperweed, also called tall whitetop and often confused with whitetop (*Cardaria draba*), is a rhizomatous perennial weed threatening riparian areas, irrigation ditches, and floodplain meadows in Montana. This weed in the mustard family (Brassicaceae) spreads by creeping roots and rhizomes, and prolific seed production. Found most often in seasonally flooded areas, perennial pepperweed can also spread to upland and rangeland sites, and it is adapted to salt-affected soils. It can form dense patches that compete with crops, forage plants, and riparian plants (see Figure 1). Infestations reduce crop yield and increase production costs, reduce livestock carrying capacity, and its control is costly.

Perennial pepperweed is native to southeastern Europe and western Asia. The first record of perennial pepperweed in Montana is from Gallatin County in 1935 along a roadside near Manhattan. By 2002 it had been reported from 17 counties (http://invader.dbs.umt.edu) with a total of 2,750 acres infested. In Montana it has been found along roadways, railroads, the Missouri River, irrigation ditches, in winter wheat, alfalfa, Conservation Reserve Program, pastures, on dry hillsides, and in rangeland. Perennial pepperweed is ranked as a Category 2 noxious weed in Montana, meaning it is currently present and believed to be rapidly spreading from existing infestations.

Perennial pepperweed can be temporarily suppressed using herbicides that contain metsulfuron, chlorsulfuron, or imazapic as active ingredients. Long-term herbicidal control requires repeated applications. Cattle, sheep, and goats will graze perennial pepperweed, but the effects on

population fitness of long-term grazing with these animals are not known. Mowing and sheep grazing reduce stand density for up to one year. There are no approved biological control insects for release on perennial pepperweed.

Biology and Ecology

Roots. There are few white-flowered mustards that grow from creeping roots, therefore once it is established, this characteristic can help identify perennial pepperweed. The roots penetrate deeply into the soil and spread horizontally (see Figure 2). While roots can penetrate the soil to ten feet (2 m) or more, the majority of the root mass can be found in the upper two feet of the soil profile making perennial pepperweed competitive for soil moisture and nutrients. The roots are coarse with minimal development of fine roots or root hairs, are widely spaced, and form a network through connecting branches. The coarse root architecture suggests perennial pepperweed requires high nutrient substrate compared to finely-rooted plants like grasses. The creeping roots form dense colonies of perennial pepperweed that crowd out desirable plants and form near monocultures. New shoots grow from buds that form along the roots. Roots enlarge at the soil surface and form a woody crown from which shoots grow. Root fragments as small as two inches (5 cm) long can re-generate new plants, and root or rhizome fragments dried for three days in the sun and open air can re-sprout on moist soil. Root carbohydrate reserves are lowest at initiation of flower stalks bolting.

Figure 2. Creeping roots displaying vegetative reproduction. Photo by Clare Poulsen.

Stems. Perennial pepperweed stems normally grow from one to three feet (1 m) tall, but can reach up to eight feet (2 m) in wet areas. Stems are hairless, erect, stiff, and branching. The stem base is semi-woody. Stems die back to the base each year, drying to a light tan color, and dead stems can persist for several years (see Figure 3). Plants often grow multiple stems. Stems can form adventitious roots when plants are inundated with flood water for three or more days, and populations can tolerate flooding for up to 50 days.

Figure 3. Old stems of perennial pepperweed showing persistent, light tan color. Photo by Michael Carpinelli.

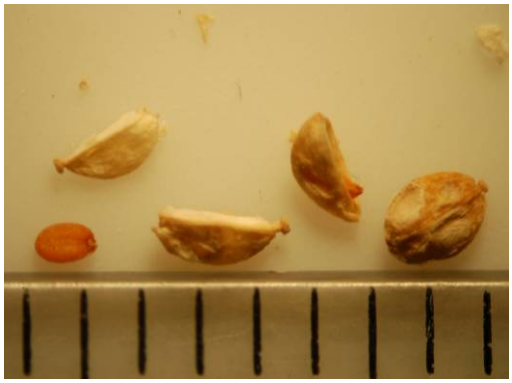
Leaves. Perennial pepperweed forms a tuft of basal rosette leaves and leaves along the floral stems that are bright green to grey-green. The basal leaves are up to 12 inches (30 cm) long by 0.5 to 3.2 inches (8 cm) wide, with entire or toothed margins, have a prominent white mid-rib, and taper to an elongated petiole at the point of attachment to the stem. The stem leaves are smaller than the basal leaves and have a less defined mid-rib, no petiole, but do not clasp the stem as the leaves of whitetop (*Cardaria draba*). The leaves are waxy and have a somewhat leathery texture.

Flowers. The flowers are white, small (petals less than 0.1 inches long), and have four petals and six stamens. They are clustered at the branch ends in ball-like groups of six to eight flowers arranged in a raceme (see Figure 4). Plants begin blooming in early summer and flowering can continue until fall under good conditions.

Figure 4. Perennial pepperweed flowers. Photo by Michael Carpinelli.

Fruits. The pod-like fruits (silicles) of perennial pepperweed have two chambers, each with a small reddish-brown seed (see Figure 5a). The silicles are small, about 0.1 inch (2 mm) long, rounded to ovate, and sparsely covered with long soft hairs (pilose). The pods remain on the plants at maturity and drop irregularly throughout the winter. Plants can produce up to 1,000 seeds and heavy infestations can generate over six billion seeds per acre. Seeds produce a

mucilaginous coating when wet, which possibly helps them adhere to substrates and survive dry periods (see Figure 5b).



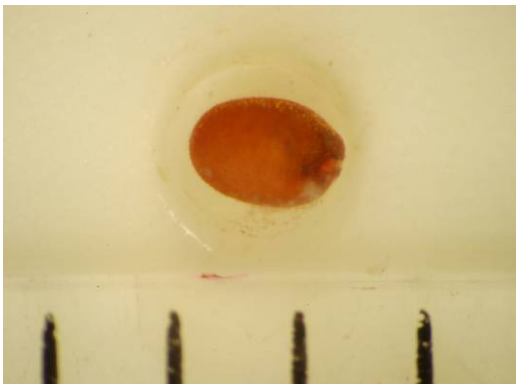


Figure 5a **and** **Figure 5b**

Figure(s) 5a and b. Perennial pepperweed silicles and seed (a) and mucilaginous coat around wet seed (b).

Life History. There is little published information on the phenology of perennial pepperweed. Few seedlings have been observed in field populations indicating that it does not spread locally by seed and that local population expansion is predominantly via spreading roots. Seed viability is reportedly very high. Fluctuating temperatures stimulate germination, and seedlings emerge from mid-winter to mid-spring. Salinity has little effect on the germination of seeds or re-sprouting from root fragments. Rosettes grow from roots in late winter or early spring making perennial pepperweed competitive for early spring moisture and nutrients. In established infestations, early spring canopy cover and litter buildup shade desirable plants. Floral shoots bolt in late May, blooming begins in mid-June, and seed pods form throughout the summer. Plants die back to root crowns under drought conditions or after a hard frost (see Figure 3). Individual plants are believed to survive for several years. Stands as old as 15 years have been reported. Perennial pepperweed is saline tolerant and is a salt pump, absorbing salt from the soil, accumulating it in the leaves, and then depositing it on the soil surface upon leaf fall.

Spread. Perennial pepperweed spreads by seed, creeping roots, and root fragments. Population expansion is mainly through the extensive spreading root system and can be as much as ten feet (2 m) per year. Root fragments can be dispersed within and between fields by cultivation equipment and imported topsoil onto urban landscapes. Roots and rhizomes of hand-pulled plants can remain viable for three days when left on the soil surface and in the sun. Fruits with seeds can be transported long distances in river currents, irrigation ditches, contaminated hay, and by animals and birds. In eastern Oregon, it is believed that perennial pepperweed is commonly spread by haying infested meadows and then moving the hay offsite carrying seeds along with it (see Figure 6).

Figure 6. A hay meadow infested with perennial pepperweed. Perennial pepperweed can be spread in contaminated hay.

Habitat. Perennial pepperweed grows in estuaries, lake shores, water courses, riparian areas, wetlands, agricultural and urban areas, rangeland, grasslands, and woodlands. In Montana, perennial pepperweed is a weed of riparian habitats that are periodically flooded or have a moist soil surface, however it is adapted to dryer upland sites as well. It has been found along roadways, railroads, the Missouri River, irrigation ditches, in winter wheat, alfalfa, CRP fields, pastures, on dry hillsides, and in rangeland. Infestations in Wyoming are found within 100 feet (30 m) of riparian areas. The aboveground biomass production of perennial pepperweed declines in soils without nutrient inputs (particularly phosphorous), and periodic nutrient inputs from flooding may help keep perennial pepperweed competitive with other plants in riparian areas.

Economic impacts. Perennial pepperweed infestations reduce livestock carrying capacity by displacing nutritive forage plants. Hay contaminated by perennial pepperweed has lower nutrient content than weed-free hay. Wildlife habitat is diminished where perennial pepperweed displaces riparian plant species important to browse and bird nesting.

Perennial pepperweed has been used medicinally. An infusion of the plant has been used for liver and kidney diseases and as a remedy for treatment of skin diseases. Leaves can be eaten raw or cooked and have a very hot cress-like flavor. The roots have been grated and made into a hot, pungent sauce used as a substitute for horseradish. The seed has also been used as a condiment.

Management Alternatives

Herbicide.[1/] Metsulfuron (1.0 oz product/ac.) applied to actively growing plants, but before full bloom, or chlorsulfuron (1.0 oz. product/ac.) applied during bud to early bloom are the most effective herbicide treatments and can suppress perennial pepperweed for one to two years. A nonionic surfactant is needed when using chlorsulfuron or metsulfuron. Imazapic (8-12 oz. product/ac.) mixed with methylated seed oil (1 qt./ac. MSO) applied after full bloom until plants start to die will provide similar control. Shoots of perennial pepperweed can be killed using 2,4-D (2 qt. product/ac.), but root crowns will re-sprout new foliage. Glyphosate (2 qt. product/ac.) provides similar control as 2,4-D, however glyphosate is non-selective and re-vegetation may be needed to restore competitive plants (see Figure 7). Repeated herbicide applications are needed to sustain population reductions regardless of the product used.

Figure 7. Perennial pepperweed plants spot-treated with glyphosate.

Hand Pulling. Hand pulling has reduced populations of perennial pepperweed but only where large portions of the root system were removed. Because roots can re-sprout new foliage after

[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.

drying for up to three days, pulled root fragments should be burned, or bagged and placed in the trash. Though labor intensive, hand pulling may be practical for small infestations or to eliminate re-growth after herbicide application.

Mowing and Grazing. Mowing has been shown to reduce perennial pepperweed by 46 percent for one year. It is recommended to mow to a four-inch or greater stubble height to maintain the vigor of native and desirable plant species. Mowing should be applied at the first sign of flowering when root carbohydrates are lowest usually around mid-June, and before the development of seeds to prevent spread. It is likely that perennial pepperweed will re-grow flower shoots after mowing and follow-up management will be needed to prevent seed production. Mowing combined with herbicide application to re-growth has been shown to improve the effectiveness of chlorsulfuron and glyphosate in controlling perennial pepperweed. Mowing should only be re-applied to sites with plant species that are tolerant of repeated mowing.

Cattle and sheep will utilize perennial pepperweed where it grows with other plants but they will not graze in dense, pure stands. In one study, grazing reduced perennial pepperweed in a pasture by 78 percent for one year. Sheep grazing has been reported to reduce perennial pepperweed plants without reducing native plant species. Perennial pepperweed seed will remain viable after passing through animal digestive tracts. One study found germination rates of seeds following rumen incubation were increased by five to 40 percent. Grazing animals that may have ingested seeds should be contained and fed weed-free forage for five days before moving to weed-free areas. Poisoning of horses that were fed perennial pepperweed-contaminated hay has been reported.

Biological Control. There are no biological control agents approved for release on perennial pepperweed largely due to the risk of damage to valuable crops that are closely related taxonomically, including canola, mustard, and cabbage, and there is a potential non-target threat to an endangered native *Lepidium* species.

Tillage. Perennial pepperweed, like other perennial rhizomatous weeds, may be controlled by persistent repeated tillage. However, tillage also spreads root fragments and should be followed by herbicidal control and cropping or re-vegetation.

Re-vegetation. Where perennial pepperweed forms dense near-monocultures, re-vegetation may be needed to establish competitive plants after control procedures. Establishing competitive perennial grasses on disturbed land, followed by prescribed grazing management to maintain grass vigor will suppress perennial pepperweed and prevent re-establishment and spread by rhizomes and 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 recommended re-vegetation species and their appropriate seeding rates. 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 (IPM). Integrated pest management is the application of two or more management alternatives so they are complimentary in weed suppression, increase the longevity of control procedures, and improve production or conservation of resources. Mowing

prior to herbicide application has been shown to improve the herbicidal control of perennial pepperweed. To reduce the frequency of herbicide re-applications, prescribed grazing with sheep, goats, or cows can be applied to prevent re-establishment from roots that survive herbicide treatment (follow herbicide label guidelines for grazing after herbicide treatment). On cropland, tillage followed by herbicide treatment will be more effective than either treatment applied alone.

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