Heart-podded Hoary Cress

An in-depth review of the characteristics and control methods for this troublesome weed.

By Michael L. McInnis, Gary L. Kiemnec, Larry L. Larson, Jay Carr and Dan Sharratt

Heart-podded hoary cress or whitetop (*Cardaria draba* (L.) Desv.) is a native plant of Eurasia that was accidentally introduced into North America in the early 1800's. The first botanical collection in the United States was made at Long Island, New York, in 1862. By the early 1900's heart-podded hoary cress had spread across the United States and was recognized as a noxious weed of alfalfa, small grains, peas, and other crops.

Heart-podded hoary cress is now found throughout the United States except in southern portions of California and the south central States. Movement from cultivated fields to adjacent rangelands is common and increasing. In a report to the Oregon Department of Agriculture, H.D. Radtke estimated heart-podded hoary cress occupies nearly 1.7 million acres in Oregon alone, and is responsible for annual production losses of $2.5 million in that state.

Heart-podded hoary cress is classified as a noxious weed in 24 States and four Canadian Provinces. It can form dense monocultures that displace native plants and reduce biodiversity, wildlife habitat and forage production (Fig. 1), and contains chemicals called glucosinolates that may be toxic to nearby vegetation and livestock.

Scientists and land managers in Oregon have studied hoary cress for the past several years. This report summarizes what we have learned about the ecology and management of this troublesome weed.

Figure 1. *Heart-podded hoary cress has a creeping root system and forms dense monocultures that can displace native plants and reduce biodiversity, wildlife habitat and forage production. A single plant growing in absence of competition can spread over an area 12 feet in diameter and produce more than 400 shoots the first year of establishment.*

Plant Characteristics

Heart-podded hoary cress is a deep-rooted perennial forb of the mustard family (*Brassicaceae*) that grows 18-22 inches tall and reproduces by seeds and by shoots produced from buds along a horizontal creeping root system (Fig. 2).

Leaves are alternate, simple, toothed, and lance-shaped. Lower leaves are stalked, and upper leaves are sessile and clasp the stem. The white flowers are typical of mustards and have four petals arranged in a cross. Flowers are clustered at the ends of the stalks in a nearly flat-topped arrangement. The small brownish-red seeds are about 1/16 inch long and resemble alfalfa seeds. They are produced in heart-shaped capsules containing two seeds separated by a partition.

Once mature, seeds are released singly through ruptures in the capsule walls; as individual capsules; or as capsule clusters that break away from the parent plant.

Two other species of hoary cress occur in the United States and Canada: lens-podded hoary cress (*C. chalepensis* (L.) Hand.-Mazz.); and globe-podded hoary cress (*C. pubescens* (K.A. Meyer) Jarm.). The primary identifying charac-

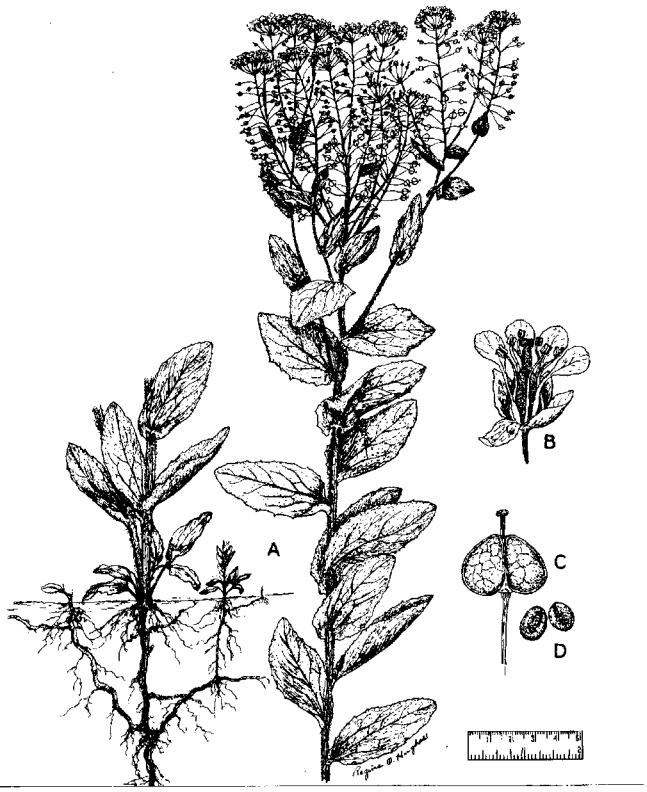

Figure 2. *Heart-podded hoary cress. A, habitat; B, flower; C, seed capsule; D, seeds (USDA 1971).*

teristics used to separate species are differences in seeds and seed capsules.

Lens-podded and globe-podded hoary cress are suited to moist sites, and are not abundant in semi-arid environments. Heart-podded hoary cress is the most common species of *Cardaria* on North American rangelands. Plants that may be mistaken for hoary cress include field pennycress (*Thalapsi arvense* L.) and western yarrow (*Achillea millefolium* L.).

Seed Production and Germination

G.W. Selleck reported in 1965 that a single plant can produce 1,200 to 4,800 seeds, of which 84 percent are viable. In our studies, we measured nearly 17,000 viable seeds/ft^2 in a single year on a site near Keating, Oregon. When moistened, seeds exude mucilage that helps them stick to the soil surface to aid germination and establishment.

Seeds can be distributed to new sites in many ways including sowing contaminated crop seed; in hay contaminated with seedheads; seedheads attached to the undercarriages of vehicles and equipment; in surface runoff and running water; and through digestive tracts of animals.

Amaya Lowry, graduate student in the Department of Rangeland Resources at Oregon State University, found germination of hoary cress seeds may be diminished by ruminant digestion, but remains high enough for managers to be concerned with spread of viable seeds in manure.

Seeds mature in late July or early August, but are not likely to germinate until the following spring (February–April). We conducted laboratory trials in environmental chambers and found seeds require approximately 4 days of near-optimum moisture and temperature conditions to germinate.

In another laboratory study we found lower germination rates and poor root development when available moisture was below field capacity. We also found germination and root growth was not diminished in saline environments.

Field germination of seeds varies with landscape position, and is favored on sites where soil moisture can be maintained near field capacity in the spring. Our work showed germination was greatest on lower slopes, less on ridgetops and north slopes, and least on south slopes. We also found highest germination among seeds placed on the soil surface compared to buried seeds.

Establishment From Seeds And Creeping Roots

Heart-podded hoary cress seedlings have a better chance of becoming established on disturbed sites such as ditch banks, roadsides, haystack yards and gopher mounds than on sites fully occupied by desirable vegetation.

Emergence of seedlings is greater in annual grass communities such as cheatgrass than in sagebrush/perennial grass communities. A study conducted by G. Scurfield in 1962 showed that plants established from seeds on open ground reach full size about 3 weeks after spring germination and then begin to develop lateral roots.

He also found that a single plant growing in the absence of competition can spread over an area of 12 feet in diameter and produce 455 shoots the first year of establishment. We observed an average of 45 shoots/ft^2 on a site fully occupied by heart-podded hoary cress in eastern Oregon.

Shoots can be produced every year from adventitious buds on the creeping root system but density of shoots varies by year. Production of shoots is highest during years with cool-dry weather in April and/or warm-moist conditions in the first half of May. While warm-moist weather during April stimulates shoot production, subsequent spring frosts can reduce total shoot density that year.

Pocket gophers and other small mammals cache root fragments in tunnels and may spread adventitious buds to new locations where they can grow into new plants.

Allelopathy

Allelopathy is an ecological process in which growth or reproduction of an organism is inhibited by chemicals produced by a competing organism. Seeds and leaf tissues of heart-podded hoary cress contain several of the same glucosinolates that are found in rape and known to be allelopathic.

We examined the influence of heart-podded hoary cress root extract (ground roots mixed with distilled water) on germination of alfalfa, winter wheat, bluebunch wheatgrass, and crested wheatgrass. Seeds were placed in Petri dishes and germination was compared using root extract versus only distilled water. Seeds were germinated in an environmental chamber for eight days.

Hoary cress root extract slowed the rate of germination (% seeds germinated/day) of all species. Total germination (following eight days) in the extract treatment was less than with water for all species except wheat. Initial root growth of all species was reduced by the extract compared to distilled water. These results suggest that hoary cress roots may contain chemicals that inhibit germination and initial seedling growth in natural environments.

Nutritional Value

Heart-podded hoary cress is generally considered poor forage for livestock. However, sheep will consume the early growth stages and cattle will ingest seedheads in late summer after more palatable forage has dried.

We conducted chemical analysis of heart-podded hoary cress from eight sites in Baker County, Oregon during each of five growth stages: rosette, bolting, early bloom, full bloom, and hard seed. Collections of whole plants from rosette to hard seed, respectively, indicated the following trends: crude protein (29 to 8%), organic matter digestibility (77 to 49%), and digestible energy (3 to 2 Mcal/kg). Levels of 11 micro- and macro-elements were typical of other rangeland plants, but sulfur varied from 0.7 to 2.7%, and was therefore higher than the reported maximum tolerable level for most grazing animals (0.4%).

In 1931, C.E. Flemming stated hoary cress "contains an irritant principle and may cause trouble under conditions of forage shortage." It is now known that 11 plant families, including mustard, contain glucosinolates that can form toxic chemical compounds in the digestive tracts of animals. More than 60 glucosinolates are present in the mustard family and all are sulfur-containing compounds. This probably accounts for the high levels of sulfur we found in our samples.

Toxic chemicals produced when glucosinolates are digested may inhibit iodine uptake by the thyroid, and can cause thyroid enlargement (goiter) and growth depression, especially in young animals. The effect is most pronounced when dietary iodine is low but can be overcome by increasing iodine levels of the diet. Other by-products of glu-

Which herbicides work on heart-podded hoary cress?

Knutson and Ransom (1998) examined several herbicides for control of heart-podded hoary cress in a non-cultivated setting. Herbicides were applied via a CO2-pressurized backpack sprayer calibrated to deliver 20 gallons/acre at 30 psi. Herbicides were mixed with water and Sylgard 309 ®, a silicone surfactant. Treatments were applied mid-May, 1997 when hoary cress plants were in the late flower stage and 12- to 24-in tall.

Herbicides that provided over 90% control the year following application included Escort® (metsulfuron) applied at 0.0188 lb ai/acre (95% control); and Escort® (0.0188 lb ai/acre) combined with 2,4-D LV Ester (1.0 lb ai/acre) (93% control). 2,4-D LV Ester applied at 2 lb ai/acre resulted in 88% control of hoary cress and was judged to be the most cost-effective treatment.

The authors noted that none of the herbicides provided 100% control and follow-up treatment is required for all chemicals.

Figure 3. *A single plant can produce 1,200 to 4,800 seeds. Proactive management to reduce seed dispersal is one of the most effective and least expensive measures to help prevent infestations of new areas. Hoary cress should be cleared from along irrigation ditches and streams to prevent movement of seeds in running water.*

cosinolate digestion are irritating compounds that can cause blistering of tissues, severe gastro-enteritis, salivation and diarrhea. Under some conditions, nitriles are produced that can result in liver and kidney lesions and poor growth.

Management Requires Integrated Approach

Effective management of heart-podded hoary cress requires an integrated approach that consists of (1) *containment and prevention* to assure new sites are not invaded; and (2) *control* to reduce or eliminate density of plants in areas already infested.

Containment and Prevention:

This strategy attempts to prevent the spread of hoary cress from infested areas onto adjacent sites. Containment should be considered a temporary measure until long-term control can be initiated. Containment can be achieved by reducing movement of seeds onto new sites and by treating the boundary of the invasion with herbicides to prevent shoots from lateral roots forming an advancing front.

Initial encroachment into new areas is frequently by seed dispersal. Consequently, proactive management to reduce seed dispersal is one of the most effective and least expensive measures to help prevent infestations of new areas.

Hay from fields infested with hoary cress should not be transported to areas free of the weed. Undercarriages of vehicles and equipment should be checked for seedheads and cleaned if necessary. Hoary cress should be cleared from along waterways such as stream banks and irrigation canals to prevent movement of seeds in running water (Fig. 3). Animals grazing infested areas after seed production should be dry-lotted 3–5 days before being moved to non-infested areas to prevent seeds becoming established in manure.

Invasion of weeds into new areas may be reduced by managing rangelands for high ecological condition. Plant communities in which all niches are fully occupied by vigorous perennial plants may be more resistant to weed invasions than areas on which community resources such as soil nutrients, water, space and light are underutilized and therefore available to invading plants. Management strategies such as proper grazing consisting of moderate forage utilization and seasonal rotation of livestock help assure perennial plants maintain vigor and competitive ability.

Control:

Before the development of modern herbicides, Oregon State University Range Extension Specialist E. R. Jackman controlled heart-podded hoary cress experimentally using repeated deep cultivation ("15–20 workings the first year, about a dozen the second and less during the third year").

Canadian researchers G. A. Mulligan and J. N. Findlay reported in 1974 that three consecutive years of cultivation were required to effectively control hoary cress. The reason heart-podded hoary cress is difficult to control by cultivation was reported by R. F. Miller and his colleagues in 1994. They found that its massive root system (76% of total plant biomass) provides a large pool of stored carbohydrates for regrowth, and numerous belowground buds that can develop into new shoots.

Insects have not been developed as biological control of hoary cress for two reasons. First, while it is listed among the noxious weeds of many states, it is of lower priority than other widely distributed and economically important weeds such as leafy spurge and knapweeds.

Second, hoary cress is a member of the mustard family that contains numerous important agronomic

Figure 4. *Application of translocated herbicides is most effective during flowering when the greatest flow of carbohydrates is to the roots and rhizomes.*

plants such as canola, turnip, radish and mustard condiments. Identifying insects that feed specifically on hoary cress and not closely related mustards is difficult.

Conventional control consists of applying one of several different translocated herbicides. R. F. Miller and colleagues reported in 1994 that chemical control of heart-podded hoary cress is most effective during the flower stage when herbicides are translocated with carbon into roots and rhizomes (Fig. 4).

Herbicides applied prior to flowering may not be as effective because the flow of carbon is mainly to above-ground tissues. Herbicides applied prior to flowering may damage shoots, but will not enter the root system in high enough concentrations to kill the plant. Herbicides applied after flowering will not be effective because low soil moisture causes leaves to senesce, thus reducing photosynthesis and translocation within the plant.

Effective chemical control is often variable because the growth stage of individual stems may not be uniform at any given calendar date. When some stems reach the flowering stage and are susceptible to herbicides, others are still in the rosette stage and resist herbicides.

We found that regrowth of mowed heart-podded hoary cress plants is more uniform than non-mowed plants. Thus, an effective control strategy may include mowing followed by herbicide application to the regrowth when it flowers. This strategy may also result in greater penetration of herbicide through the canopy because regrowth of mowed plants is shorter than unmowed plants.

The date of mowing also influences subsequent reproductive effort. Plants mowed during flowering produced fewer viable seeds than plants mowed during bolting. However, mowing alone will not provide effective long-term control.

Eight Steps For Success

Heart-podded hoary cress is here to stay. But instead of allowing it to rob our wildlands of biodiversity, forage production and wildlife habitat, we can take steps to help prevent it from spreading and reduce it where it occurs.

Our studies have identified weak links that can be exploited by control measures. Land managers and others who frequent our nation's rangelands must be vigilant in recognizing and controlling weeds such as hoary cress. These eight steps should be taken:

(1) learn to identify hoary cress and look for it whenever you are in the field; (2) take measures to prevent dispersing seeds to non-infested areas;

(3) treat infestations when they are small and easy to control;
(4) apply control techniques known to be effective;
(5) apply translocated herbicides to heart-podded hoary cress when it is flowering;
(6) always read and follow herbicide labels;
(7) monitor treated infestations and follow-up with additional treatment if necessary; and
(8) strive to manage rangelands for an abundance of vigorous and diverse vegetation.

About the authors: McInnis is an associate professor, Dept. Rangeland Resources, Oregon State Univ. Corvallis; Kiemnec is an associate professor, Dept. Crops and Soil Science, Oregon State Univ., Corvallis; Larson is a professor, Dept. Rangeland Resources, Oregon State Univ., Corvallis; Carr is an Extension staff chair, Baker Co., Oregon State Univ., Corvallis, and Sharratt is an agronomist, Oregon Dept. Agric., Union, Ore.

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