The biology and non-chemical control of Hoary Cress (*Cardaria draba* (L.) Desv.)

W Bond, G Davies, R Turner
HDRA, Ryton Organic Gardens, Coventry, CV8, 3LG, UK

Hoary cress

(chalk weed, devil's cabbage, Heart-podded hoary cress, hoary pepperwort, pepper cress, Thanet cress, Thanet weed, white top, white weed, whitlow peppermint)
***Cardaria draba* (L.) Desv.**
(*Lepidium draba* L.)

Occurrence

Hoary cress is an introduced, erect, rhizomatous perennial found on waste ground, roadsides, railways, arable land, pasture and on sandy soil by the sea (Stace, 1997). The UK form, subspecies *draba* was first recorded in 1829. It was introduced into Swansea and several other ports in 1802 probably in ship ballast (Rich, 1991; Scurfield, 1962). It was observed on ballast on a riverbank close to a pottery in Swansea in 1839 (Flower, 1890). It was also introduced into Britain as seeds in the hay filled mattresses of soldiers returning from the Walcheren expedition in 1809 (Long, 1938; Salisbury, 1961). The hay was ploughed in by a farmer on the Isle of Thanet. Most early records were from coastal or waterway areas (Scurfield, 1962). Hoary cress was reported to have been introduced to the area around Newhaven in the 1840's as a seed contaminant in foreign wheat or as seed from foreign wheat in manure (McNab, 1873). It was still rare and local in Britain in 1860 but gradually spread further afield. In 1868-9 it was established and abundant in fields and waste ground around Portsmouth and Southsea (Warner, 1873). By 1887 it was known in several parts of southern Britain, the eastern counties and Wales (Willis, 1953). In 1890 it was reported "in seed in tens of thousands" on cliff edges and in waste places along the coast from White Haven to Ramsgate and inland to Minster (Whitwell, 1890). Hoary cress was considered a serious weed in Hertfordshire by at least 1925 (Gardner, 1950).

Hoary cress is now found throughout the UK but is most abundant in the south and east (Clapham *et al*., 1987). It is not recorded above 1,000 ft in Britain (Salisbury, 1961). It is often limited to hedgerows and field margins but can invade agricultural land (MAFF, 1951). It prefers dry, nutrient rich, sandy and gravely to loamy and clayey soils (Hanf, 1970). Hoary cress occurs on soils ranging from light sands to medium-heavy clays (MAFF, 1951). It prefers neutral to alkaline soils. Hoary cress may be abundant on alkaline soil (Frankton & Mulligan, 1970). It was considered one of the worst weeds in SE England on areas of heavy clay (Gardner, 1950). It is common on previously disturbed soil along field margins, roadsides, hedgerows, and railways (Scurfield, 1962). It prefers open sites but can withstand moderate shade. It thrives under irrigated conditions but does not tolerate waterlogging. In a survey of arable weeds in 1971-1973 it was absent or rare in most of the surveyed fields and common to frequent in only 2% of tetrads surveyed (Chancellor, 1977). It may be more frequent in grassy areas than on arable land.

Hoary cress is a very variable plant due to the introduction of several clones (Rich, 1991; Weber, 2003). Plants exhibit some variation in leaf shape (Sexsmith, 1964).

Sheep are reported to graze it, especially when plants are young (Scurfield, 1962). When eaten by cattle it can taint dairy products. Analysis has shown that it contains moderate levels of calcium and no oxalic acid (Guil *et al.*, 1996).

Biology

Flowering takes place from May to July (MAFF, 1951) or April to November (Rich, 1991). The flowers are automatically self-pollinated (Scurfield, 1962). The seeds mature from May to July (Frazier, 1948). The inverted heart-shaped pods may contain 2 seeds but usually only 1 develops (Willis, 1953). Guyot *et al.* (1962) give the seed numbers per plant as 1,200 to 4,800, Hanf (1970) gives them as 1,000 to 5,000. Seed number per stem is 2,300 (Stevens, 1957). The 1,000 seed weight is 2.15 g.

Hoary cress seed germinates over a wide temperature range from 0.5 to 40^{o}C, but at 0.5^{o}C germination took 5 months (Brown & Porter, 1942). At 35^{o}C germination took 23 days. Seeds germinate at or near the soil surface (Hanf, 1970).

After seed germination the vertical taproot grows directly down (Frazier, 1948). Seedlings develop a taproot 53 cm long within 9 weeks of germination (Salisbury, 1961). Lateral roots grow out mainly in the top layers of soil and these extend horizontally before turning down to form secondary vertical roots. These give rise to more laterals that again turn down to form verticals and so on. At nodes along the rhizomes are buds that can develop into branch rhizomes. New shoots form mainly at the point where laterals turn down to form verticals. Less commonly, shoots form along the horizontal portion of the lateral roots. Apart from the first seedling shoot, all other shoots originate from root borne stem buds that give rise to vertical underground stems or rhizomes. The upright shoots give rise to a rosette of leaves where the rhizomes emerge from the soil. Seedlings that emerge in April may remain in a rosette state in the first year and flower from June on in the following year. Dense colonies are formed that exclude other plants. After 6 months, roots can penetrate to 1 m and spread horizontally to 2 m. Eventually the vertical roots may grow down 3-4 m, well below cultivation depth and the horizontal ones spread out over 4 m or more (MAFF, 1951). Roots may reach 4-5 m deep after 2.5 years.

The aerial shoots appear above ground in May and persist until the hard frosts. Carbohydrate reserves in the roots are lowest in April, highest in July and gradually decline from then into the winter (Scurfield, 1962). If the crown of the plant is damaged, new shoots develop from the upper part of the roots. Hoary cress overwinters as creeping roots with small rosettes of leaves (Hill, 1977; Zimdahl, 1993).

Persistence and Spread

Seed viability declined to nil after 3 years burial in soil at 10 to 45 cm deep (Brown & Porter, 1942). Porter (1944) gave the longevity of seeds in soil as 2 years. Hoary cress buried in soil that was irrigated or left under natural conditions had lost viability after 4 years (Goss, 1939). In dry storage, seed viability after 1, 2 & 3 years was 84, 31 and 0% respectively (Scurfield, 1962). Seeds in running water gave 12% germination after 1 month and less than 2% after 6 months (Scurfield, 1962). Seeds gave 5% germination after 2 months storage in freshwater but there was no germination after 19 months (Zimdahl, 1993).

Hoary cress spreads by seed and by the white rootstock (Frankton & Mulligan, 1970). It develops and increases as patches (Scurfield, 1962). Seeds are dispersed by water and transported in soil (Weber, 2003). The seed coat become mucilaginous when moistened (Young & Evans, 1973). Hoary cress has occurred as a seed impurity in alfalfa and red clover (Long, 1938; Willis, 1953).

Although initial dispersal may be by seed, once established plants spread by the production of new shoots from the underground rhizomes (Salisbury, 1961). The root system can grow out horizontally for 10 m or more (Willis, 1954). Buds can arise from any part of the root system and dispersal can be by root buds as well as seed (Clapham *et al.*, 1987). Vegetative spread is primarily due to mechanical cultivation (Scurfield, 1962). Hoary cress will regenerate from short segments of root. A 5 cm fragment of root established in the field has been shown to spread laterally by more than 4 m over a 6-month period (Sexsmith, 1964). Shoots only form on the deeper roots when the upper parts are killed or damage (Salisbury, 1962).

Management

Small patches and new infestations should be dug out without delay, taking care to completely extract the extensive creeping underground organs (Morse & Palmer, 1925). The shoots should be attacked with a hoe whenever possible. Hoary cress was eradicated in 2 years by hoeing at 7 to 10 cm depth, at intervals of 2-4 weeks during the growing period (Timmons & Bruns, 1951). A very high number of cultivations are needed to control the plant (Scurfield, 1962). During annual cropping over a period of three years, 22-24 or 39 cultivations achieved control.

The spread of hoary cress seed in crop seed, farmyard manure and straw, and on harvesting implements should be avoided (MAFF, 1951). Root pieces can also be spread on and by machinery. New infestations should be eradicated without delay by hand-digging. Hoary cress is difficult to control by normal cultivations. Fallowing alone does not eradicate the weed but deep ploughing to 15 inches followed by a fallow can be effective. Two bare fallows or a bare fallow followed by a cropped fallow were thought to be effective (Long, 1938). Thorough cultivation in hot dry weather will reduce the weed. Hoary cress is favoured in winter cereals where it is able to grow away early with little crop competition. The weed can be kept in check by rotations that include a large proportion of spring crops (Gardner, 1950). Sowing down to a long ley has given good results. Control with smother crops of mustard, vetch, maize or clovers and grasses has had limited success (Long, 1938; Willis, 1953). Hoary cress survives mulching with straw or paper (Scurfield, 1962).

In the UK, regular and frequent cutting to prevent seeding and exhaust food reserves will give some control (Long, 1938). In Canada too, cultural control consists of regular and frequent removal of the above ground parts (McRostie *et al.*, 1932). Repeated cutting when the plant is in flower will reduce vigour (Weber, 2003). Hand pulling gives no additional benefit. It only removes the tops and regeneration from the roots soon occurs. Grazing by sheep is reported to have a good effect but cattle are thought to avoid it (Guil *et al.*, 1996).

Acknowledgement

This review was compiled as part of the Organic Weed Management Project, OF 0315, funded by DEFRA.

References

Brown E O & Porter R H (1942). The viability and germination of seeds of *Convolvulus arvensis* L. and other perennial weeds. *Research Bulletin* **294**, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, USA.

Chancellor R J (1977). A preliminary survey of arable weeds in Britain. *Weed Research* **17**, 283-287.

Clapham A R, Tutin T G, Moore D M (1987). *Flora of the British Isles*, 3rd edition, Cambridge University Press, Cambridge, UK.

Flower T B (1890). *Lepidium draba* L. in South Wales. *Journal of Botany* **19**, 218.

Frankton C & Mulligan G A (1970). *Weeds of Canada.* Publication 948, Canada Department of Agriculture.

Frazier J C (1948). Principal noxious perennial weeds of Kansas, with emphasis upon their root systems in relation to control. *Bulletin* **331**, Agricultural Experiment Station, Kansas State College of Agriculture and Applied Science, Manhattan, Kansas, USA.

Gardner H W (1950). Hoary pepperwort in Hertfordshire. *Agriculture* **56** (6), 272-275.

Goss W L (1939). Germination of buried weed seeds. *Bulletin* **28** *Californian Department of Agriculture*, 132-135.

Guil J L, Torija M E, Giménez J J, Rodríguez-Garcia I, Giménez A (1996). Oxalic acid and calcium determination in wild edible plants. *Journal of Agricultural and Food Chemistry* **44** (7), 1821-1823.

Guyot L, Guillemat J, Becker Y, Barralis G, Demozay D, Le Nail Fr (1962). *Semences et Plantules des Principales des Mauvaises Herbes.* Association de Coordination Technique Agricole, Paris.

Hanf M (1970). *Weeds and their seedlings.* BASF UK Ltd.

Hill T A (1977). *The biology of weeds.* Studies in biology No. **79**. Edward Arnold (Publishers) Ltd.

Long H C (1938). Weeds of arable land. *MAFF Bulletin* **108**, 2nd edition. HMSO, London, UK.

MAFF (1951). The control of Hoary Pepperwort. *MAFF Advisory Leaflet* **371**. HMSO, London, UK.

McNab W R (1873). *Lepidium draba* L., as a weed. *The Journal of Botany* **11** NS, 238.

McRostie G P, Kirk L E, Godel G, Smith W G, Manson J M (1932). Weeds and their control. *Dominion of Canada, National Research Council, Report No.* **27**, 15 pp.

Morse R & Palmer R (1925). *British weeds their identification and control*. Ernest Benn Ltd, London.

Porter R H (1944). Testing the quality of seeds for farm and garden. *Research Bulletin* **334**, Iowa Agricultural Experiment Station.

Rich T C G (1991). Crucifers of Great Britain and Ireland. *BSBI Handbook No.* **6.** Botanical Society of the British Isles, London, UK.

Salisbury E J (1961). *Weeds & Aliens.* New Naturalist Series, Collins, London.

Salisbury E (1962). The biology of garden weeds. Part II. *Journal of the Royal Horticultural Society* **87**, 458-470 & 497-508.

Scurfield G (1962). *Cardaria draba* (L.) Desv. *Journal of Ecology* **50** (2), 489-499.

Sexsmith J J (1964). Morphological and herbicide susceptibility differences among strains of hoary cress. *Weeds* **12**, 19-22.

Stace C (1997). *New Flora of the British Isles*. 2nd edition. Cambridge University Press, Cambridge, UK.

Stevens O A (1957). Weights of seeds and numbers per plant. *Weeds* **5**, 46-55.

Timmons F L & Bruns V F (1951). Frequency and depth of shoot-cutting in eradication of certain creeping perennial weeds. *Agronomy Journal* **43** (8), 371-375.

Warner F I (1873). *Lepidium draba* L., in south Hants. *The Journal of Botany* **11** NS, 21.

Weber E (2003). *Invasive plant species of the world - A reference guide to environmental weeds.* CABI Publishing, Wallingford, UK.

Whitwell W (1890). *Lepidium draba* L. in Wales. *Journal of Botany* **19**, 188.

Willis S J (1953). *Cardaria draba* – A globe-trotting weed. *World Crops* **5** (8), --.

Willis S J (1954). *Weed control in farm and garden.* Vinton & Company Ltd, London, UK.

Young J A & Evans R A (1973). Mucilaginous seed coats. *Weed Science* **21** (1), 52-54.

Zimdahl R L (1993). *Fundamentals of Weed Science.* Academic Press, Inc.