The biology and non-chemical control of Black Bindweed (*Fallopia convolvulus* (L.) Á. Löve)

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Black bindweed

(bedwine, bethwine, bindcorn, bunwede, climbing buckwheat, climbing knotweed, cornbind, devil's tether, hay-gob, ivy bindweed, wild buckwheat, wild hop, windweede, withwine)

***Fallopia convolvulus* (L.) Á. Löve**

(*Bilderdykia convolvulus, Polygonum convolvulus* L.)

Occurrence

Black bindweed is native in waste places, arable land and gardens, and is common throughout the UK (Clapham *et al.*, 1987; Stace, 1997; Copson & Roberts, 1991). It may occur along woodland edges, tracks and railways (Frankton & Mulligan, 1970). It is recorded up to 1,500 ft in Britain (Salisbury, 1961). In early surveys of Bedfordshire, Hertfordshire and Norfolk, it was common on loams and light sandy soils and on clay but generally absent from chalk and gravel (Brenchley, 1911; 1913).

Black bindweed is a troublesome summer annual that twines around and drags down both cereals and root crops (Long, 1938). There is evidence that black bindweed was a weed of crops in the Bronze Age (Greig, 1988). It was frequently associated with cereals (Brenchley, 1920). In a survey of weeds in conventional cereals in central southern England in 1982, black bindweed was found in 5, 0.5 and 5% of winter wheat, winter barley and spring barley respectively (Chancellor & Froud-Williams, 1984). It was relatively common in a survey of weeds in spring cereals in N E Scotland in 1985 (Simpson & Carnegie, 1989). In a study of seedbanks in some arable soils in the English midlands sampled in 1972-3, black bindweed was recorded in 81% of fields sampled in Oxfordshire and 59% of those in Warwickshire but never in large numbers (Roberts & Chancellor, 1986). In a survey in Scotland in 1972-1978, black bindweed seed was found in 15% of arable soils sampled (Warwick, 1984). It was a common weed in a seedbank survey in swede turnip fields in Scotland in 1982 (Lawson *et al.*, 198-). It was found in 43% of fields sampled but never in high numbers. In a seedbank survey of arable fields in France in 1983-85, black bindweed was common in the seedbank and relatively more frequent in the standing vegetation (Barralis & Chadoeuf, 1987). In a comparison of the ranking of arable weed species in unsprayed crop edges in the Netherlands in 1956 and in 1993, black bindweed remained in 2nd place (Joenje & Kleijn, 1994). In a series of 4 national weed surveys made in Hungary between 1950 and 1997, it moved from 14th to 16th place in the rankings (Tóth *et al.*, 1999; 1997). In trials in Denmark from 1969-1988, black bindweed was one of the most frequent weeds in spring-sown arable crops but was common in autumn-sown crops too (Jensen, 1991).

There is some variation in plant morphology according to habitat (Lousley & Kent, 1981). Before the flowers develop it is often mistaken for the field bindweed, *Convolvulus arvensis*, but this tap-rooted annual does not have an extensive system of creeping roots and rhizomes of the perennial weed (Hume *et al.*, 1983).

Seeds of black bindweed are known to be a common food in the diet of the grey partridge in Britain (Hume *et al.*, 1983). Black bindweed occurs frequently as a birdseed alien (Hanson & Mason, 1985).

Biology

Black bindweed flowers from July to August (Clapham *et al*., 1987), sometimes into October (Lousley & Kent, 1981). All stages of flowering can be found on a mature plant from the new flower buds to the ripe seeds (Hume *et al.*, 1983). Each flower produces a single seed. Seed is shed from August onwards (Grime *et al.*, 1988). Seed numbers per plant are given as 140 to 200 (Guyot *et al.*, 1962). In winter cereals the average seed number per plant ranged from 92 to 116, in spring cereals from 28 to 48 and in root crops from 255 to 400 (Pawlowski, 1966). In red clover the average seed number per plant was 17. A large plant can produce 11,900 seeds (Stevens, 1932) but numbers can be as low as 170 (Stevens, 1957). The 1,000 seed weight given by different authors varies from 4.65 to 7.00 g.

Seed is usually dormant when mature, this is in part due to the impermeable seedcoat (Hume *et al.*, 1983). Scarification and chilling promote germination but light has no apparent effect. There was complete germination of black bindweed seeds during 3-months moist storage at 5^{o}C (Grime *et al.*, 1981). Seed that was tested after it had been stratified in soil overwinter gave 20 to 80% germination in the light or in darkness with just a 5 second light flash or in complete darkness (Andersson *et al.*, 1997). There was no significant effect of treatment. Dormancy is re-imposed annually in response to rising summer temperatures (Grime *et al.*, 1988). In the USA, Chepil (1946) found seed had a short period of dormancy of 1-3 years. Over 95% germinated at once when sown in trays of soil in the field and none survived beyond year 3. Dry storage for a year and scarification increased seed germination levels, as did stratification at 2-4^{o}C for 8 weeks (Justice, 1941). The best germination occurred after one month of moist storage at 4^{o}C but germination capacity declined after two months (Henson, 1969). There was a rapid loss in germination capacity if seeds were dried. In laboratory studies with dry stored seed on moist paper or soil in the light there was germination of around 8-15% at a constant temperature of 18-20^{o}C and at alternating temperatures of 20 / 30^{o}C and 8 / 20 / 30^{o}C (Cross, 1930-33).

Seed sown in pans of field soil emerged in winter and early spring (Brenchley & Warington, 1930). Seed mixed into a 15 cm layer of soil in cylinders sunk in the field and stirred periodically, emerged from March to May (Roberts & Feast, 1970). Seedling emergence in Scotland recorded in field plots dug at monthly intervals began in April and continued through until August with peaks April/May (Lawson *et al.*, 1974). In the field, 86-95% of seedlings emerged from the surface 60 mm of clay and sandy soils, the odd seedling emerged from down to 90 mm (Chancellor, 1964). In a sandy loam soil, field seedlings emerged from the top 95 mm of soil with the majority evenly spread from the upper 60 mm (Unpublished information). Seeds can emerge from as deep as 190 mm (Hume *et al.*, 1983).

In Sweden black bindweed is considered a summer annual (Håkansson, 1979). Seeds mixed with soil in the autumn, put in frames in the field, exhumed at intervals and put to germinate at alternating temperatures showed the seeds to have the lowest dormancy and greatest tendency to germinate from April to November. Peaks of

emergence occurred in April/May and in November. Many seedlings emerged in the autumn after sowing.

Persistence and Spread

Seed longevity in soil is 4 to 5 years (Guyot *et al.,* 1962). Seeds mixed with soil and left undisturbed had declined by 74% after 6 years but in cultivated soil the decline was 90% (Roberts & Feast, 1973). Seed buried in soil in subarctic conditions had 6, 3 and 1% viability after 2.7, 6.7 and 9.7 years respectively (Conn & Deck, 1995). Seeds recovered from excavations and dated at 30, 50 and 300 years old was reported to have germinated (Ødum, 1974). Black bindweed seed sown in the field and followed over a 5 year period in winter wheat or spring barley showed an annual decline of around 40% (Barralis *et al.,* 1988). Emerged seedlings represented 8% of the seedbank.

The seeds are valuable stock feed and farmers collect up screenings and feed them to stock (Long, 1938). This is risky if the seeds are not ground or scalded. In laboratory studies, rumen digestion caused a gradual decline in seed viability with time. After 24 hours around 40% of seeds appeared viable and 15% were able to germinate (Blackshaw & Rode, 1991). Ensilage for 8 weeks or a combination of ensilage and rumen digestion left 20 to 30% of seeds apparently viable but none germinated. Seeds did not germinate after 2 weeks ensilage (Zimdahl, 1993). After 2 weeks of windrow composting at temperatures of 50-65^{o}C, black bindweed seeds were no longer viable (Tompkins *et al*., 1998). Seeds survive ingestion by birds (Grime *et al.*, 1988).

Grain transport is thought to be a major factor in the spread of the weed around the world (Hume *et al.,* 1983). Seeds are frequently found in samples of cereal grain, many seeds are also shed in the field (Long, 1938). In cereal seed samples tested in 1961-68 black bindweed was one of the most frequent contaminants being found in up to 25% of rye, 15% of oats, 23% of barley and 22% of wheat samples tested (Tonkin, 1968). In a survey of weed seed contamination in cereal seed in drills ready for sowing on farm in spring 1970, it was found in 24% of samples (Tonkin & Phillipson, 1973). Most of this was home saved seed. In the period 1978-1981, it was found in 17-32% of wheat and 7-23% of barley seed samples tested (Tonkin, 1982). The highest number of seeds recorded in a 125 g sample was 300. Black bindweed was again one of the most commonly recorded broad-leaved species. In cereal seed samples tested in 1986-97, black bindweed was found as a contaminant in up to 9.6% of oat, 3.0% of barley and 1.1% of wheat samples tested (Don, 1997). In a survey of seed contamination in 1960-61, black bindweed seed was found in 1-9% of vegetable brassica, 8% of onion, 4% of leek, 31% of mustard, 47% of mangel and 48% of sugar beet seed samples tested (Gooch, 1963). Seed has been recovered from irrigation water in the USA (Wilson, 1980).

Management

Most seeds germinate in early spring and can be dealt with before spring cropping (Chepil, 1946). Control is by surface cultivation in spring and by the destruction of seed from threshing machinery and combines at harvest (Long, 1938). Harrowing the stubble immediately after harvest may encourage some seeds to germinate so that the seedlings can be destroyed at ploughing. Short rotations and the hoeing of root crops will also keep the weed under control. It is important that crop seed for sowing

should be free of weed seeds. Frequent hoeing, and harrowing of young crops in spring will help to keep black bindweed under control (Morse & Palmer, 1925). If crop sowing is delayed, early flushes of black bindweed seedlings can be killed by cultivation (Hume *et al.*, 1983).

In a trial with spring wheat at two seed rates (140 and 180 kg/ha), and three row spacings (10, 20 and 30 cm), black bindweed biomass and dry weight was reduced as crop row spacing decreased and sowing density increased (Mertens & Jansen, 2002). Weed seed production followed the same trend. Mechanical weeding in June and July with a spring tine harrow in the narrower crop rows was considered to give better control of the weed than inter-row weeding with a Rabe hoe with V blades in addition to the tine harrowings in the 30 cm row spacing.

Seed numbers in soil were reduced by 70% following a 1-year fallow and by over 95% if this was extended to a second year (Brenchley & Warington, 1933). The land was ploughed, disked and harrowed in this time. Seed numbers were similarly reduced by cropping with winter wheat for the same period. Seed germination only occurs for a limited period in spring and winter cereals obviously limit this. A long fallow period of 4 years appeared to eliminate the weed and no further seedlings emerged (Brenchley & Warington, 1936).

A novel way to use sunlight for direct weed control involves using a curved freshnel lens to concentrate sunlight into a narrow band at the soil surface. The wheeled device is pulled slowly along between crop rows to wither and burn off the inter-row weeds or kill exposed weed seeds. Under the full mid-day sun the mean soil surface temperatures was 309^{o}C with a 20 second exposure (Johnson *et al.*, 1990). The germination of black bindweed seed left on or near the soil surface was reduced to zero by this treatment.

A number of insects and fungi infest black bindweed, it is also a host of some economical important viruses (Hume *et al.*, 1983).

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