The biology and non-chemical control of Redshank (*Persicaria maculosa* Gray)

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Redshank

(Lady's thumb, lakeweed, peachwort, pink persicaria, red legs, red spot, saucy Alice, Virgin Mary's pinch, willow weed)
***Persicaria maculosa* Gray**
(Polygonum persicaria L.)

Occurrence

Redshank is a native summer annual generally distributed throughout the UK on waste, cultivated and open ground often in damp situations (Clapham *et al.*, 1987; Stace, 1997). It is recorded up to 1,500 ft (Salisbury, 1961). Redshank occurs on most soils but especially on moist, rich soils and on acid peaty loams (Long, 1938). In early surveys of Bedfordshire and Hertfordshire redshank was found on all soils except chalk and was dominant on boggy land (Brenchley, 1911). It was said to occur on soils deficient in lime and that liming was an aid to its reduction (Fenton, 1931). Redshank occurs occasionally as a birdseed alien (Hanson & Mason, 1985).

Redshank is a common garden weed (Copson & Roberts, 1991). It is not associated with any particular crop but is regarded as a species that is always associated with man and having no natural habitat (Simmonds, 1945). It was thought to be discouraged by competitive crops like cereals (Brenchley, 1920). In a survey of weeds in conventional cereals in central southern England in 1982, redshank was found in 2, 0.5 and 3% of winter wheat, winter barley and spring barley respectively (Chancellor & Froud-Williams, 1984). In a study of seedbanks in some arable soils in the English midlands sampled in 1972-3, redshank was recorded in 25% of the fields sampled in Oxfordshire and 22% of those in Warwickshire but never in large numbers (Roberts & Chancellor, 1986). Redshank was one of the most frequent dicotyledonous weeds recorded prior to herbicide application in cereals in NE Scotland in 1973 but was less frequent in 1985 (Simpson & Carnegie, 1989). Redshank seed was found in 39% of arable soils in a survey in Scotland in 1972-1978 (Warwick, 1984). It accounted for 7% of the seeds in the soil seedbanks. It was a common weed in a seedbank survey in swede turnip fields in Scotland in 1982 (Lawson *et al.*, 1982). It was found in 61% of fields sampled. Redshank was troublesome in flax crops in Northern Ireland being difficult to separate from the flax fibres during processing and discolouring the final product (Courtney, 1970).

Redshank appears to have a wealth of genetic variability accompanied by great phenotypic plasticity (Simmonds, 1945). The leaves vary in shape and size, and the flowers may be red, pink or white. It is extremely tolerant of a wide range of edaphic conditions. Many varieties have been described. Redshank can form hybrids with pale persicaria (*P. lapathifolium*) (Grime *et al.*, 1988).

Redshank is regarded as nutritious and has been fed to horses and cattle as green food (Long, 1938). However, as it contains oxalate it is potentially toxic (Grime *et al.*, 1988). The leaves are rich in vitamin C (Barker, 2001).

Biology

Redshank flowers from May to September or even later (Simmonds, 1945). The time from emergence to flowering varies from 6 weeks to 2 months. Automatic self-pollination takes place but cross pollination by insects is possible. Seeds ripen from July onwards (Grime *et al.*, 1988). Average seed numbers per plant range from 200 to1200 (Salisbury, 1961), 200 to 800 (Guyot *et al.*, 1962), 500 to 1,550 (Stevens, 1932; 1957) and up to 5,952 (Pawlowski *et al.*, 1970). The 1,000 seed weight ranged between 1.177 and 2.700 g. Pekrun & Claupein (2006) give the 1,000 seed weight as 1.5 g. Redshank can be found in fruit for 5 months of the year (Salisbury, 1962).

Redshank seeds exhibit considerable variation in weight and shape both between and within populations (Hammerton, 1967). Seeds from parent plants grown in low light conditions were 25% smaller than those from plants grown in full sun (Sultan, 1996). Pericarp thickness was reduced but viability was high and seedlings emerged 1-2 days earlier than those from the seeds produced by plants in normal light. Seeds from plants grown at low soil moisture levels had larger seeds than those from plants grown at field capacity. Plants deprived of water allocated more reserves to the seeds which had high viability and produced large seedlings.

Seed is dormant at shedding and for around 60 days afterwards. The germination of fresh seed is not promoted by light (Wesson & Wareing, 1969). Diurnal fluctuations in temperature with an amplitude of 8^{o}C promote seed germination in the light (Thompson *et al.*, 1977). In Petri-dish tests with seed given alternating or constant temperatures in diffuse light, light had no effect alone but interacted with alternating temperature to promote germination (Vincent & Roberts, 1977). The response was improved in the presence of nitrate and by pre-chilling. Seeds require a period of low temperature for after-ripening (Simmonds, 1945). Germination capacity increased following 15 days moist storage at 4^{o}C and remained high for a further 4.5 months (Henson, 1969). Viability was soon lost if the seed was dried. Scarification, exposure to low temperature and stratification at 2-4^{o}C for 8 weeks increase germination levels (Justice, 1941) but not when the dormancy was innate (Staniforth and Cavers, 1979). In laboratory tests with dry stored seed sown on moist paper or soil in the light there was negligible germination 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).

When buried seeds were exhumed at intervals and the germination tested, seeds were deeply dormant at the time of burial but over the burial period germination increased (Bouwmeester & Karssen, 1989). Germination occurred from November to June, there was no germination from July to October. Innate primary dormancy was lost during soil burial in autumn and early winter (Karssen, 1980/81a; 1980/81b). Seeds were therefore able to germinate in late-winter and early spring. Seed that did not germinate developed secondary dormancy with rising temperatures during late spring and summer. The pattern was repeated in the following year. Freshly collected seeds mixed into the surface 75 mm of soil in cylinders sunk in the field and stirred periodically emerged from April to June with a peak in April (Roberts & Neilson, 1980). Most seedlings emerged in the first year of the 5-year trial with a gradual decline to year 5.

In the field, 72-100% of seedlings emerged from the surface 4 cm of soil with the odd seedling from as far down as 7 cm (Chancellor, 1964).

Persistence and spread
If the plant is cut back early it may persist into a second year (Simmonds, 1945).

Seeds can remain viable in soil for 45 years (Salisbury, 1961). Seeds recovered from excavations and dated at 30 and 300 years old are reported to have germinated (Ødum, 1974). In Duvel's burial experiment, seed buried at 8, 22 and 42 inches did not germinate readily initially but at 10 years germination was 62, 32 and 8% for each of the three depths respectively (Toole, 1946; Goss, 1924). After 30 years germination was 3, 9 and 9% but at 39 years no seed germinated. Redshank seedlings were abundant on land ploughed for the first time after 45 years (Simmonds, 1945). Seed buried in mineral soil at 13, 26 or 39 cm depth and left undisturbed retained 1, 2 and 2% viability respectively after 20 years (Lewis, 1973). Seed buried in a peat soil at 26 cm for 1, 4 and 20 years retained 23, 32 and 17% viability respectively. Seed stored under granary conditions exhibited only trace viability after 20 years. In dry storage seeds gradually lose viability. There is a 50% reduction after 3 years and 100% loss after 7 years.

The decline of seeds broadcast onto the soil surface and then ploughed in was followed over a 6-year period of cropping with winter or spring wheat (Lutman *et al.*, 2002). The experiment was made on a clay and a silty loam soil. Every effort was made to prevent further seed return to the soil. Redshank had a mean annual decline rate of 24% and an estimated time to 95% decline of 10-14 years. The annual percent decline of seeds in cultivated soil was 38% (Popay *et al.*, 1994). Redshank 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.

Viable seeds have been found in cattle droppings (Salisbury, 1961). Seeds can pass unharmed through the digestive systems of horses, cattle and deer (Simmonds, 1945). The seeds are also ingested and dispersed by birds.

Ripe seed can be retained on the plant and may contaminate cereal grain at harvest (Grime *et al.*, 1988). Redshank seed has been found as an impurity in cereal and clover seed. In cereal seed samples tested in 1961-68, redshank was one of the most frequent contaminants being found in up to 3.6% of rye, 8.1% of oat, 8.3% of barley and 4.4% 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 18% of samples (Tonkin & Phillipson, 1973). Most of this was home saved seed. In the period 1978-1981, it was found in 3-6% of wheat and 8-20% of barley seed samples tested (Tonkin, 1982). In cereal seed samples tested in 1986-97, redshank was found as a contaminant in up to 1.2% of oat, 0.7% of barley and 0.5% of wheat samples tested (Don, 1997). Seed has also been found in flax and grass seed, often in samples from abroad (Simmonds, 1945). The mean number of seeds in red clover was 6 per 1,000 equivalent to 21,000 weed seeds per ha sown with the clover. In a survey of weed seed contamination in 1960-61, redshank seed was found in 1-2% of vegetable brassica, 1% of onion, 6% of carrot and 2% of celery seed samples tested (Gooch, 1963).

Seeds can float in water for 24 hours and may be dispersed this way (Simmonds, 1945). Seed was recovered from irrigation water in the USA (Kelley & Bruns, 1975). In a reclaimed bog in Ireland, debris cleared from drainage channels and spread on the field contained redshank and other seeds (MacNaeidhe & Curran, 1982).

In Canada, the seeds are dispersed by water and by cottontail rabbits (*Sylvilagus floridanus*) (Staniforth & Cavers, 1977). Dispersal by cottontails follows passage through the digestive system and deposition in faecal pellets at some distance from the feeding site. In feeding studies most seeds emerged within 2-8 hours of digestion, although some continued to emerge for up to 48 hours. Around 2.1% of seeds are viable after digestion.

Management

Seeding should be prevented (Morse & Palmer, 1925). Well hoed root crops and surface cultivations in spring and early summer should keep redshank under control (Long, 1938). In moist conditions, stem fragments can root at the nodes allowing re-establishment after soil disturbance. Care should be taken not to introduce seed in manure.

In a trial with spring wheat at two seed rates (140 and 180 kg/ha), and three row spacings (10, 20 and 30 cm), redshank biomass and dry weight were 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 at the 30 cm row spacing with a Rabe hoe with V blades in addition to the harrowings.

In laboratory studies, imbibed seeds in trays of moist soil held at 75 or 100^{o}C for 12 hours lost viability but at 56^{o}C the results were variable and seed viability was reduced by around 81-98% after 0.5-16 days (Thompson *et al.,* 1997). Seed held at 102^{o}C or higher for 5 minutes was generally killed but the results were again variable.

In greenhouse tests of seedling susceptibility to ultraviolet-B radiation, redshank was the least sensitive of the species tested (Furness & Upadhyaya, 2002). It would probably be at an advantage in a high UVB environment. Redshank seed is susceptible to soil solarization.

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