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The biology and non-chemical control of Scentless Mayweed (*Tripleurospermum inodorum* (L.) Sch.Bip)

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Scentless mayweed
(corn feverfew, dog's chamomile, dog gowan, horse daisy, scentless feverfew, white gowlan)
***Tripleurospermum inodorum* (L.) Sch.Bip**
(*Pyrethrum inodorum, Matricaria inodora* L., *M. perforata, M. maritima* ssp. *inodora, M. maritima* var. *agrestis, T. perforatum*)

Occurrence

A native, winter or summer annual, biennial, or even short-term perennial weed of waste and cultivated land that is abundant throughout the UK (Clapham *et al*., 1987; Woo *et al*., 1991). It is a common garden weed (Copson & Roberts, 1991). Scentless mayweed is recorded up to 1,750 ft and has been found in prehistoric deposits (Salisbury, 1961). It is common on all soils in lowland Britain (Stace, 1997). Scentless mayweed is one of the most abundant annual weeds of arable land and its distribution is determined primarily by the location of cultivated farmland (Kay, 1994). However, it does not thrive in conditions of high summer temperatures and drought. It is more abundant on well drained soils of medium to light texture but does occur on heavy soils. It appears to grow equally well on moderately calcareous, neutral and moderately acidic soils. In early surveys of Bedfordshire, Hertfordshire and Norfolk, scentless mayweed was distributed over all types of soil (Brenchley, 1911; 1913). It was most frequent on sandy soils but also found on clay. It was seldom seen on chalk. Scentless mayweed prefers lime-free, neutral, loamy and stony soils (Hanf, 1970). It responds to increased levels of soil fertility, particularly to applications of manure. It is intolerant of dense shade and waterlogging. Scentless mayweed is moderately resistant to trampling and to compaction by wheeled vehicles.

It appears to be discouraged by root crops (Brenchley, 1920). In Eastern Europe scentless mayweed is most frequent in winter cereals (Ionescu, 1999). In a survey of weeds in conventional cereals in central southern England in 1982, scentless mayweed was found in 2% of winter wheat, winter barley and spring barley (Chancellor & Froud-Williams, 1984). In a similar survey of conventional winter oilseed rape in 1985 scentless mayweed was present in 14% of fields (Froud-Williams & Chancellor, 1987). It was distributed throughout the crop, field margins and headland. It has been shown to be a moderately competitive weed in winter oilseed rape (Lutman *et al.*, 1995). Scentless mayweed was one of the most frequent dicotyledonous weeds prior to herbicide application in cereals in NE Scotland in 1973 and was even more frequent in 1985 (Simpson & Carnegie, 1989). Seed was found in 5% of arable soils in a seedbank survey in Scotland in 1972-1978 (Warwick, 1984). Mayweeds were one of the main groups of weed species present in conventional sugar beet crops surveyed in East Anglia in autumn 1998 (Lainsbury *et al.*, 1999). They were recorded in 25% of crops and were common in the field margins too. In a series of 4 national weed surveys made in Hungary between 1950 and 1997, scentless mayweed moved from 66th to 6th place in the rankings (Tóth *et al.*, 1999; 1997). In trials in Denmark from 1969-1988, scentless mayweed was frequent in autumn-sown arable crops but was common in spring-sown crops too (Jensen, 1991).

In populations sampled in the UK a diploid form is predominant (Kay, 1969). In Europe, a tetraploid form is predominant in continental Europe while the diploid form has an Atlantic distribution in Northern and Western Europe. The two forms are morphologically very similar but the tetraploid type is more likely to exhibit perennial growth. Scentless mayweed is phenotypically plastic, being very variable in size and habit (Kay, 1994). There is some evidence that winter and summer annual forms occur. Hybrids have been reported with *Anthemis cotula* and *A. arvensis* but these are sterile (Grime *et al.,* 1988). Populations of scentless mayweed have been found with resistance to the phenoxy-herbicides 2,4-D and MCPA (Putwain & Mortimer, 1989).

Scentless mayweed is unpalatable to livestock and is avoided by hens (Woo *et al.,* 1991; Kay, 1994). It is a host of several insect pests but is also a favoured source of nectar and pollen for many species of beneficial predator insects. The sap contains an antiviral agent that inhibits the growth of the polio and herpes viruses.

Biology
British populations of scentless mayweed normally flower from June to October. Other flowering periods given for scentless mayweed include July to September (Clapham *et al*., 1987) and May to October (Hanf, 1970). Plants from seeds collected in Scotland and southern England differed in flowering time when grown in the Midlands in spring (Kay, 1965). The Scottish plants flowered earlier and had a more erect growth habit. Seed is set from August to October (Grime *et al.,* 1988). Scentless mayweed is normally self-incompatible in Britain and isolated plants are unable to set seed (Kay, 1994). The heavy, sticky pollen is dispersed by insects (Woo *et al.,* 1991). Seeds become viable 12 days after flowering commences within a flower head and 2 days after it ceases. The seeds are fully ripe 4 weeks after the outer florets first open.

Each flower head or capitulum may contain 345 to 533 seeds (Woo *et al.,* 1991). Seed number per plant is given as 10,000 to 200,000 (Guyot *et al.,* 1962; Hanf, 1970) and 71,000 to 256,000 (Blackshaw & Harker, 1997). However, figures in excess of a million seeds per plant have been quoted (Kay, 1994). In spring cereals the average seed number per plant ranged from 990 to 1,112, in winter cereals from 1,482 to 1,790 and in root crops from 7,890 to 8,030 (Pawlowski, 1966). In winter rape the average seed number per plant was 1,710 and in red clover 2,283. The 1,000 seed weight ranged from 0.3 to 0.6 g in different parts of the UK (Kay, 1994). Seed rain from plants that emerged following cultivation in early April, occurred from mid-August to late November (Leguizamón & Roberts, 1982). Seed numbers in soil down to 10 cm depth increased from being undetectable up to 13,190 per m^2. Seed production by the weed growing alone and in various crops was studied to try and correlate seed number with plant dry weight (Lutman, 2002). There was a good correlation and this gave figures of 560 seeds for a plant of 1 g in dry weight, 6,300 seeds for a 10 g plant and 69,800 for a 100 g plant.

Seeds may germinate soon after shedding in the autumn or may do so the following spring (Grime *et al.,* 1988). Scentless mayweed seed germinates through most of the year with peaks in spring and autumn (Thurston, 1976). Seed sown in pans of field soil showed no definite periodicity of emergence but there was some preference for winter and spring germination (Brenchley & Warington, 1930). Seed sown in a 75 mm layer of soil in cylinders sunk in the field and stirred periodically, emerged from February to November with the main flush from February to May and a smaller peak in October (Roberts, 1964). Seed sown in soil at different depths cultivated or not in pots and boxes set in the field, emerged mainly in winter (Froud-Williams *et al.*, 1984). Seed sown at 25 mm without cultivation gave little emergence. Seed sown at 75 mm and cultivated in February emerged in spring, cultivation in June gave low emergence mainly in summer. In a second experiment, surface sown seed emerged mainly in spring. The optimum depth for emergence was 0 to 5 mm, the maximum depth was 10 mm. Seed sown in May emerged in 14 days (Long, 1938). In Canada, scentless mayweed emerged within 6 to 15 days of sowing (Blackshaw & Harker, 1997).

In Canada, the diploid and tetraploid populations exhibit similar temperature limits for germination (Thomas *et al.*, 1994). The upper limit is 40^{o}C and the lower is 5^{o}C but most germination occurs between 15 and 28^{o}C. Optimum germination occurs at alternating temperatures of 30/10^{o}C. Nevertheless the tetraploid seed germinates better at suboptimal constant temperatures of 5 to 20^{o}C, an adaptation that may account for the more northerly distribution of tetraploid cytotypes.

Germination is increased by a period of dry storage (Grime *et al.*, 1988). When seeds were put to germinate under a leaf canopy or diffuse white light there was 14% germination under the canopy and 50% in the light (Górski *et al.*, 1977). Diurnal fluctuations in temperature with an amplitude of 1.5^{o}C promote germination in the light (Thompson *et al.*, 1977). In Petri dish tests with seed maintained under high or low light intensity or in darkness, seed germinated to 89% in the light but there was no germination in the dark (Grime & Jarvis, 1976). An increase of temperature from 5/15 to 15/25^{o}C increased seed germination by 62% in darkness but did not affect germination in the light (Mekki & Leroux, 1991). A change to 25/35^{o}C did not affect seed germination further and at 35/45^{o}C no germination was recorded. Higher temperatures generally accelerated germination while light stimulated germination regardless of temperatures. Scentless mayweed is shallow germinating because it requires repeated diurnal exposure to light over a period of days to stimulate germination (Hartmann *et al.*, 1996). Nitrate enhances germination further so fertilizer application may stimulate additional germination. After a 50 week period of soil burial, seeds germinated only when the soil was disturbed in the light not in darkness (Wesson & Wareing, 1969). In pot experiments, seed exhumed from the soil in darkness and sown in the light germinated rapidly (Jensen, 1995). The same seed sown in the dark was much slower to germinate. The sowing depth had little effect in the light but in the dark seed sown at 4 mm germinated better than seed sown at 8 mm. Seed buried in the autumn and exhumed at monthly intervals germinated at anytime in full light (Andersson & Milberg, 1996). Seed given a 5-second light flash germinated better in spring and autumn. There was no germination in darkness. After a period of dry storage the seeds lose the light requirement and will germinate in darkness (Woo *et al.*, 1991). Germination studies under low water potentials suggest that wetting and drying of seed in the field may influence the light requirement of seeds and encourage germination in darkness.

In Sweden scentless mayweed is considered a winter 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 between April and November. Peaks of germination occurred in April/May and August/September. Many seedlings emerged in the autumn after sowing.

In a sandy loam soil, field seedlings emerged from the top 30 mm of soil with up to 99% in the upper 10 mm and over 80% in the surface 5 mm (Unpublished information). Seedling emergence declines with increasing depth of seed burial (Grundy *et al.*, 1996). When seeds were buried in discrete layers at 6, 19, 32, 57, 108 and 210 mm most seedlings emerged from the top 50 mm of soil. When the seeds were distributed through the soil profile down to the different depths, seedling emergence was spread further down the soil.

Seedlings that emerged from January to June took a progressively shorter time to reach flowering, the minimum was 40-50 days (Roberts & Feast, 1974). Plants that emerged after August overwintered as rosettes and flowered in early spring. Daylength was the controlling factor, plants required a long daylength to initiate flowering. At shorter daylengths flowering was delayed. In Canada, plants that emerged from mid-July onwards did not flower in that year but survived as winter annuals (Blackshaw & Harker, 1997). Plants that emerged in May and June had a greater biomass than those that emerged later. Seed production was also greater in plants that emerged early in the year.

After germination in autumn or spring, a rosette of leaves is produced (Kay, 1994). Plants develop a dense, extensively branched fibrous root system (Woo *et al.,* 1991). Isolated plants become spreading and branched forming a rounded mass 1 m^2. In dense vegetation the plants are erect and slender. Both seedlings and overwintering rosettes are frost tolerant but flowering shoots may be damaged (Kay, 1994). Plants are not drought resistant and in dry summers can suffer more than the crop plants.

Persistence and Spread

Seed recovered from excavations and dated at 20 and 25 years is reported to have germinated (Ødum, 1974). Dry-stored seed gave 92% germination after 1 year and 21% after 5 years storage (Kjaer, 1940). Seed buried in soil for 5 years retained 7% viability. Seed buried in mineral soil at 13, 26 or 39 cm depth and left undisturbed retained 52, 17 and 31% viability respectively after 4 years but none was viable after 20 years (Lewis, 1973). Seed buried in a peat soil at 26 cm for 1, 4 and 20 years retained 69, 12 and 8% viability respectively. Seed stored under granary conditions exhibited 59% viability after 1 year, trace viability after 4 years but was not viable after 20 years.

Seeds mixed with soil and left undisturbed had declined by 77% after 6 years but in cultivated soil the decline was 90% (Roberts & Feast, 1973). Scentless mayweed seed sown in the field and followed over a 5 year period in winter wheat or spring barley showed an annual decline of around 80% (Barralis *et al.*, 1988). Emerged seedlings represented 15% of the seedbank. Seedling emergence declined considerably after year 3.

There is no obvious dispersal mechanism and seeds may simply fall to the ground (Kay, 1994). In addition, seed may be carried in mud on tyres and footwear, in hay or straw and in manure. Seeds survive passage through ruminants and viable seeds have been recovered from cattle dung. Seeds floated for 2 days in seawater and retained 75% viability after submergence for 220 days. Seeds may float for 12 hours or more in fresh water (Woo *et al.,* 1991).

In cereal seed samples tested in 1961-68, scentless mayweed seed was a contaminant in up to 5.7% of rye, 1.7% of oats, 1.5% of barley and 1.0% of wheat samples (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 6% of samples (Tonkin & Phillipson, 1973). Most of this was home saved seed. In the period 1978-1981, it was found in 6-9% of wheat and 8-10% of barley seed samples tested (Tonkin, 1982). In clover and grass seed samples tested in Denmark for the period 1966-1969, scentless mayweed was one of the most frequent contaminant being found in around 20% of samples (Olesen & Jensen, 1969). In white clover seed there was an average of 49 mayweed seeds per kg of clover seed and a maximum of 2,050 seeds. In seed samples tested in the periods of 1955-57, 1939 and 1927-28, scentless mayweed seed was a contaminant in 28.6, 17.9 and 11.1% of samples respectively. In grass seed of English origin tested in 1960-61, scentless mayweed was found in 2.8 to 38.6% of samples of the different cultivated grasses (Gooch, 1963). In grass seed of Scandinavian origin scentless mayweed seed was found in 3.6 to 54.8% of samples tested. It was also found in 3% of carrot, 2% of brussel sprout and 1% of celery seed samples tested.

Management

Cultivation in the dark does not influence emergence of this weed as it requires more than a single flash of light to stimulate germination (Hartmann *et al.*, 1996). Seeds in the surface layer of soil will germinate anyway if conditions are favourable. Control is by surface cultivations in spring and summer and by the inclusion of root crops in the rotation (Long, 1938). The aim is to prevent seeding (Morse & Palmer, 1925). The application of lime may help on land that is deficient. Late autumn and early spring tillage is effective in controlling scentless mayweed before drilling (Woo *et al.*, 1991). Plants can re-establish if the roots are intact and the soil is moist. Regrowth can occur if ploughing does not bury plants completely. Regenerated shoots will flower and set seed in cereal stubble that has been left uncultivated.

In winter wheat, crop density is an important factor in limiting seed production by scentless mayweed through its effect on weed weight (Wright, 1993). Seed production may be halved if crop density is increased from 60 to 195 crop plants per m^2. Scentless mayweed is a common weed of winter cereals and the seeds are readily dispersed by the combine harvester at harvest (Åberg, 1956). More seeds are shed when the crop is combined that when cut, stacked and transported off site for threshing.

Scentless mayweed seedlings are relatively tolerant of flame-weeding (Vanhala & Rahkonen, 1996). In laboratory studies, naturally occurring seeds of scentless mayweed in soil were killed by steaming at 60^oC (Melander *et al.*, 2002).

Mowing can prevent seeding but only if carried out before flowering. However, both mowing and grazing may stimulate the production of vigorous laterals from the remaining stem bases (Kay, 1994).

Seed numbers in soil were reduced by 50% following a 1-year fallow, numbers were further reduced by a second year of fallowing (Brenchley & Warington, 1933). The land was ploughed, disked and harrowed during this time. Seed numbers increased under cropping with winter wheat for one year but numbers fell back again in a second year. This suggests that seedling survival varies from year to year. Fallowing could have a variable effect on seed numbers and scentless mayweed could also flower and set seed in the stubble after crop harvest (Brenchley & Warington, 1936).

A number of insects feed on scentless mayweed (Woo *et al.*, 1991; Kay, 1994). The larvae of some insects feed on and destroy seeds in the flower head, others mine the stems and leaves. Scentless mayweed is avoided by rabbits (Gillham, 1955).

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