The biology and non-chemical control of Common chickweed (*Stellaria media* L.)

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Common chickweed

(chickenweed, chickenwort, chuckenwort, craches, flewort, hen's inheritance, maruns, tongue grass, white bird's-eye, winterweed)
***Stellaria media* L.**
(*Alsine media*)

Occurrence

Common chickweed is a native summer or winter annual weed common on cultivated and open ground, waste places, farmyards and roadsides (Clapham *et al.*, 1987; Stace, 1997). It is a common garden weed (Copson & Roberts, 1991). It also occurs on river shingle banks, coastal banks and cliffs (Sobey, 1981). Common chickweed is recorded up to 2,500 ft, however it is rare at high altitude. It is found throughout the UK (Salisbury, 1961). In early surveys in Bedfordshire, Hertfordshire and Norfolk it was distributed over all soil types and was sometimes dominant on light and sandy soils (Brenchley, 1911; 1913). It was chiefly found on sand and light soils but recorded on chalk, clay and blackland. Multiple regression analysis of field distribution of common chickweed indicates that it is favoured by high potassium levels in soil (Andreasen *et al.*, 1991). Common chickweed is well adapted to making effective use of high levels of nitrogen (Mahn, 1988). The presence of the weed growing freely indicates an excess of nitrogen, and shortage of lime and phosphates in soil. It is absent from the most acidic soils. It prefers a pH of 5.2 to 8.2 and often suffers aluminium toxicity below pH 5.0 (Turkington *et al.*, 1980). Common chickweed is favoured by the partially shady conditions under row crops. It is more successful in cooler and more humid conditions but can occur in dry areas too (Sobey, 1981). However, it is sensitive to drought and is one of the first weeds to wilt. It will die back in hot dry summers. It occurs mostly in habitats where there is periodic soil disturbance. When disturbance ceases, common chickweed is replaced by perennial species.

In a survey of weeds in conventional cereals in central southern England in 1982, chickweed was found in 6, 7 and 8% of winter wheat, winter barley and spring barley fields respectively (Chancellor & Froud-Williams, 1984). In a survey of weeds in conventional winter oilseed rape in 1985, it was found in 4.5% of fields surveyed (Froud-Williams & Chancellor, 1987). In this survey it occurred mainly in the headland probably due to herbicide application within the field. Common chickweed has been shown to be a very competitive weed in winter oilseed rape (Lutman *et al.*, 1995). Common chickweed was one of the most frequent weed species present in conventional sugar beet crops surveyed in East Anglia in autumn 1998 (Lainsbury *et al.*, 1999). It was also a common species in the field margins. Common chickweed remained widespread in the period between 1978 and 1990 despite increased herbicide use (Firbank, 1999). In a survey of UK cereal field margins recorded as part of Countryside 2000, common chickweed was one of the most frequent species recorded (Firbank *et al.*, 2002). Common chickweed was the most frequent dicotyledonous weed prior to herbicide application in cereals in NE Scotland in 1973 and was still the most frequent in 1985 (Simpson & Carnegie, 1989). In a comparison

of the ranking of arable weed species in unsprayed crop edges in the Netherlands in 1956 and in 1993, common chickweed remained in 3-4th place (Joenje & Kleijn, 1994). In a survey of seeds in pasture soils in the Netherlands in 1966, while common chickweed was uncommon in the sward it was well represented in the soil seedbank (Van Altena & Minderhoud, 1972). In 1993 a survey of the most important weeds according to European weed scientists, ranked common chickweed as an important weed in all arable crops, vegetables and fruit (Schroeder *et al.,* 1993). In trials in Denmark from 1969-1988, common chickweed was frequent in spring-sown arable crops (Jensen, 1991). Common chickweed is more competitive in cooler conditions and is a problem in over-wintering crops like spring cabbage, flower bulbs and winter barley (Sobey, 1981).

In a study of seedbanks in some arable soils in the English midlands sampled in 1972-3, common chickweed was recorded in 97% of fields sampled in Oxfordshire and 84% in Warwickshire (Roberts & Chancellor, 1986). It was also the most abundant weed in a seedbank survey in swede turnip fields in Scotland in 1982 (Lawson *et al.*, 1982). It was found in 96% of fields sampled. Seed was found in 44% of arable soils in a seedbank survey in Scotland in 1972-1978 (Warwick, 1984). It accounted for 22% of the seeds in the soil seedbanks. Common chickweed is one of the most frequent arable weeds in Denmark and is well represented in the soil seedbank (Streibig, 1988). In a seedbank survey of arable fields in Denmark in 1964, common chickweed was on of the most frequent species recorded with an average of 2,667 viable seeds per m^2 (Jensen, 1969). In seedbank studies in arable fields in France too, common chickweed was well represented in the seedbank and in the emerged vegetation (Barralis & Chadoeuf, 1987).

Common chickweed is a very variable species, varying in size, habit and appearance even on a single site. Plant growth is sensitive to nitrogen levels and there is a marked reduction in plant weight with decreasing nitrogen supply (Turkington *et al.*, 1980). There may or may not be a genetic basis for variation in different characters. Genetic studies on common chickweed in a 150-year continuous wheat trial suggest that distinct biotypes have evolved on the low and high fertility treatments (Cavan *et al.,* 2000). In the USA, common chickweed populations have been found with resistance to sulfonylurea herbicides following five years use of the chemicals for weed control in consecutive wheat crops (Reed *et al.,* 1989). Elsewhere, populations have developed resistance to the phenoxy-herbicide mecoprop (Putwain & Mortimer, 1989).

Common chickweed is sometimes grouped with the closely related species *S. neglecta* and *S. pallida*. and these are treated as sub-species or varieties of *S. media* in several floras (Sobey, 1981). *Stellaria neglecta* is a strict winter annual that emerges in autumn and flowers in spring (Miura & Kusanagi, 2001). Early records of common chickweed may sometimes refer to the other species in the group. *Stellaria media* itself consists of three sub-species but only one of these, ssp. *media* is found in the UK. Summer and winter forms with different growth habits are thought to occur (Grime *et al.,* 1988). Ecotypes differ in the time from emergence to flowering (Miura & Kusanagi, 2001). Populations from vegetable fields and gardens often come into flower relatively quickly, as do strains from lower altitudes.

Common chickweed contains a relatively high level of oxalic acid and a low level of calcium which results in a high oxalic acid to calcium ratio that can have an adverse effect on dietary calcium bioavailability (Guil *et al.,* 1996). In feeding studies, common chickweed was not readily eaten by sheep (Derrick *et al.,* 1993). It is rich in magnesium, sodium, potassium and phosphate (Wilman & Riley, 1993; Wilman & Derrick, 1994). It can accumulate nitrate to levels that make it potentially toxic to sheep and goats (Grime *et al.,* 1988; Turkington *et al.,* 1980). The fibrosity index is consistently low compared with ryegrass (Wilman *et al.,* 1997). Common chickweed is an important constituent in the diet of several farmland birds including grey partridge, tree sparrow, linnet, bullfinch and reed bunting (Lainsbury *et al.,* 1999; Moorcroft *et al.,* 1997). It has medicinal and therapeutic uses, is rich in vitamin C and may be eaten as a salad vegetable (Barker, 2001). A ground cover of common chickweed has been used to suppress field and hedge bindweed (*Convolvulus arvensis, Calystegia sepium*) in vineyards (Turkington *et al.,* 1980).

Common chickweed is a host for many viruses that attack important crop species. It can become infected with cucumber mosaic virus, which is transmitted by the aphid *Myzus persicae* (Tomlinson & Carter, 1970a). Studies have shown that the virus can also be carried in the seed. In infected plants 4-29% of seeds may carry the virus (Tomlinson & Carter, 1970b). The virus persists for at least 5 months in seeds buried in soil. Common chickweed is an alternate host for the fungus causing carnation rust (Morse & Palmer, 1925). It can also carry various insect and nematode species that infect important crops (Thurston, 1970). The stem nematode, *Ditylenchus dipsaci*, can infest it as can the stem and bud nematode, *Aphelenchoides frageriae*, that damages strawberries (Franklin, 1970).

Biology

Flowering generally occurs from early spring to late autumn but chickweed may be found in flower every month of the year (Morse & Palmer, 1925). Plants have been observed in flower in early January. Daylength has little effect on flowering (Miura & Kusanagi, 2001). Flowers last just 1 day. Common chickweed can flower throughout the winter if temperatures remain above 2^{o}C (Turkington *et al.,* 1980). It has been known to flower and set seed when covered 10-20 cm deep under snow (Sobey, 1981). The flowers are normally self-pollinated but there is a short period when insects can effect cross-pollination (Grime *et al.,* 1988). In winter, chickweed may produce cleistogamous flowers that do not open, making self-pollination inevitable. Common chickweed matures rapidly and sheds an abundant supply of seeds (Long, 1938). It can complete its life cycle in 5-6 weeks with seeds being ripened and shed on plants that emerged just 5 weeks earlier. The time from germination to fruiting is given as 100 days by Guyot *et al.* (1962). There may be 1 or 2 generations in a year. Common chickweed can be found in fruit every month of the year (Salisbury, 1962). Flowers on cut down plants did not produce viable seed but green immature seeds ripened and were capable of germination after a period of dormancy overwinter (Gill, 1938).

The seed capsules may contain 1 to 20 seeds but the average is around 6 to 10 (Grime *et al.,* 1988; Turkington *et al.,* 1980). The average number of seeds per plant is 2,200-2,700 according to Salisbury (1961). Guyot *et al.* (1962) give the seed number per plant as 15,000 to 25,000. In winter cereals the average seed number per plant ranged

from 298 to 600, in spring cereals from 151-193 and in root crops and winter rape from 863 to 1,004 (Pawlowski, 1966). Seed production by the weed growing alone and in various crops was studied to try and relate seed numbers to plant dry weight (Lutman, 2002). There was a good correlation and this gave figures of 80 seeds for a plant of 1g dry weight, 920 seeds for a 10g plant and 13,100 for a 100g plant. Other studies have confirmed that plant dry-weight gives a good estimate of seed numbers (Van Acker *et al.,* 1997). Seed rain from plants that emerged following cultivation in early April extended from July to November (Leguizamón & Roberts, 1982). Seed numbers in soil to 10 cm depth increased from an initial 1,360 to a final 6,970 seeds per m^2.

Seeds will germinate at any time of year but particularly in spring and autumn (ADAS, 1977; Roberts & Feast, 1970). Seedling numbers tended to be higher following cultivations in early spring and in autumn than in summer (Roberts & Ricketts, 1979). In the field, seedling numbers usually represent less than 6% of the number of viable chickweed seeds present in the soil seedbank. Salisbury (1962) found that germination of freshly shed seeds could occur immediately. Seed collected on October 16 was divided into brown seed and yellow seed and sown on the day of collection. In the first flush of emergence, 66% of brown and 84% of yellow seed germinated within 20 days. Intermittent emergence continued throughout the winter. Chickweed is able to grow at relatively low temperatures and seedlings can survive all but the severest frosts. Plants from seeds that germinate in the autumn produce seeds in spring that germinate at once and produce a further generation in the same year (Hanf, 1970). Seedlings develop a slender taproot (Sobey, 1981).

Roberts & Lockett (1975) found that fresh seeds collected in May, June and October from plants in the field would only germinate when given alternating temperatures, light and nitrate. After dry storage or soil burial, seed gradually lost the requirement for one or more of these factors. The change was more rapid following soil burial than in dry storage as conditions were more favourable for after-ripening. Germination could occur between 2 and 30°C, but the optimum constant temperature was around 15°C. The germination of fresh seeds is not promoted by light but a short flash of light will stimulate the germination of buried seeds (Wesson & Wareing, 1969). Seed buried in mesh envelopes in the field at different depths and exhumed in darkness at 3-month intervals was tested for germination in darkness and after a short exposure to red light (Taylorson, 1972). After 6 months burial seed germinated completely after just 5 minutes of red light even when this was followed by 5 minutes of far-red. There was little or no germination of seed maintained in complete darkness. Seed stratified outdoors in soil overwinter was exhumed and tested for germination in the light, in the dark and in the dark with a 5 second flash of light (Andersson *et al.,* 1997). Seed gave 80-95% germination in the light, 94-99% germination in the dark with a short flash of light and 30-35% germination in darkness. Seeds naturally-occurring in field soil and concentrated down by washing/sieving and put into dishes did not germinate in subdued light when temperature fluctuations were small (Warington, 1936).

In laboratory tests, dry-stored seeds sown on moist paper or on soil in the light gave greater than 80% germination at a constant temperature of 18-20°C on soil or paper and at alternating temperatures of 20 / 30°C and 8 / 20 / 30°C on soil (Cross, 1930-33). Germination is inhibited when temperatures exceed 30°C (Turkington *et al.,*

1980). Germination on moist paper was around 60% at the alternating temperatures. When fresh and dry-stored seed from several sources was put to germinate at different temperatures and water potentials, fresh seed exhibited some dormancy (Grundy, 1997). Overall the number of seeds germinating decreased as the water potential decreased. At 5°C with a water potential of –1.4 Mpa there was no germination in any seed sample. In pure water at this temperature there was 44% germination. The optimum germination temperature for all water potentials was 15°C. In alternating temperatures, increasing the amplitude of temperature fluctuations increased germination in both light and dark up to an amplitude of 15°C (Thompson & Whatley, 1983). There was a decrease though when the change was 20 or 25°C.

Seeds develop a light requirement for germination following soil burial (Grime *et al.*, 1988). 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.

Populations may develop with different germination strategies according to when they emerge, set seed etc through their life cycle (van der Vegte, 1978). Seed reserves from the different populations may also vary according to the build-up and germination of the seed stock that itself depends on factors such as time of seed shed. Seed collected from different populations throughout the UK varied in seed size and germination characteristics. The germination reflected the pattern of autumn and spring flushes but some populations continued to emerge at much lower winter temperatures or had an extended or multiple peak of emergence (Christal *et al*., 1997).

In Sweden common chickweed 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 from April to November. There was a peak of germination in April/May. Many seedlings emerged in the autumn after sowing.

Chickweed seed was sown outside in pans and boxes at different depths in soil that was cultivated or left undisturbed (Froud-Williams *et al*., 1984). Seedlings emerged mainly in winter and spring when surface sown, and in winter when sown at 25 mm and not cultivated. In a further experiment surface germination was poor unless the soil was stirred. Germination then occurred in spring, summer and autumn. There was little emergence of seed sown at 50 mm and left uncultivated. Seed sown at 75 mm and cultivated in February emerged in spring. If cultivated in June sporadic emergence occurred through the year. Seed sown in a 75 mm layer of soil in cylinders sunk in the field and stirred periodically emerged from February to November with peaks in April and September (Roberts, 1964). The optimum depth for emergence was 0 to 10 mm, the maximum was 50 mm. Seedling emergence in Scotland recorded in field plots dug at monthly intervals began in April and continued through until October (Lawson *et al.*, 1974). Brenchley & Warrington (1930) found no periodicity of emergence in seed sown in pans of field soil. Most seed germinated at once, a few continued to emerge later but practically all had germinated after 18 months. Storage of the seed may have altered the germination characteristics. In plots dug into a grass sward and cultivated at monthly intervals, chickweed seedlings

emerged from March to November with a slight peak in April- May (Chancellor, 1986).

Data from parallel seedling emergence studies in several countries using seed from the same sources has been used to construct a simple model to predict the timing of chickweed emergence (Grundy *et al*., 2003). Modelling emergence against meteorological data suggests that temperature is the dominant factor in determining an emergence event (Grundy *et al*., 1999). Soil moisture is only important once the temperature requirement is met.

In the field, 98-100% of seedlings emerged from the surface 30 mm of soil, just the odd seedling emerged from 40 mm deep (Chancellor, 1964). In a sandy loam soil, seedlings in the field emerged from the top 40 mm of soil with the majority in the surface 25 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. There is some evidence that seedlings from deeper buried seeds take several days longer to emerge. Seedlings may emerge from deeper in the soil following cultivation in the light than when cultivation is carried out in darkness (Jensen, 1995). Total emergence may be less under fine soil conditions than in a coarse seedbed because of poorer light penetration (Cussans *et al.,* 1996).

Persistence and spread

Thompson *et al.* (1993) suggest that based on seed characters, common chickweed seed should persist for longer than 5 years in soil. Seed longevity in soil is given as 5 to 7 years by Guyot *et al.* (1962). Buried seeds are known to retain viability for at least 25 and probably over 40 years (Salisbury, 1962). Seeds mixed with soil and left undisturbed had declined by 78% after 6 years but in cultivated soil the decline was 96% (Roberts & Feast, 1973). A proportion of seeds will survive after 60 years under grass (Turkington *et al.,* 1980). Seed recovered from excavations and dated at 20, 30 92 and 600 years old was found to germinate (Ødum, 1974; Ødum, 1978). Viable seeds were still present in soil after 100 years under forest (Crocker, 1916). In Duvel's burial experiment, seed buried at 8, 22 and 42 inches gave 6, 3 and 22% germination respectively after 10 years but none germinated after 16 years burial (Toole, 1946; Goss, 1924). Seed buried in soil in subarctic conditions had 62, 26 and 5% viability after 2.7, 6.7 and 9.7 years respectively (Conn & Deck, 1995). After 30 months dry storage at low temperature seeds retained full viability but after burial in soil for that period viability was lost (Egley & Chandler, 1978; 1983).

The decline of seeds broadcast onto the soil surface and then ploughed to 20 cm or flexible-tine cultivated to 10-15 cm was followed over a 6-year period of cropping with winter or spring wheat grown as commercial crops. The experiment was made on a clay and a silty loam soil. Every effort was made to prevent further seed return to the soil. Common chickweed had a mean annual decline rate of 35% and an estimated time to 95% decline of 7-8 years (Lutman et al., 2002). Seedbank decline in a series of autumn-sown crops over 3-4 years with seed return prevented indicated a time to 99% decline of 11.1 years (Lawson et al., 1993). The mean annual decline was 30%. The decline of seeds under a grass sward was monitored after 1, 2, 3, 19

and 20 years (Chancellor, 1986). Common chickweed showed a mean annual decline of 26% and a half life of 2.5 years. The annual percent decline of seeds in cultivated soil was 41% (Popay et al., 1994).

In a study of post-dispersal seed predation in spring barley the main predators were invertebrates, birds were not important predators at this time of year (Mauchline *et al.*, 2005). Seed predation was greater earlier in the year when up to 90% of presented seeds were taken. Losses gradually declined over the summer and by late September few seeds were predated.

The seed capsule splits when mature and the seeds are shaken out onto the soil beneath the parent plant (Sobey, 1981). The seed is dispersed further in mud on footwear and tyres.

In cereal seed samples tested in 1961-68 chickweed was a contaminant in up to 1.7% of rye, 2.7% of oats, 3.1% of barley and 0.9% 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 10% of samples (Tonkin & Phillipson, 1973). Most of this was home saved seed. In the period 1978-1981, it was found in 4-8% of wheat and 11-14% of barley seed samples tested (Tonkin, 1982). In 1991-1997, common chickweed seed was found in up to 0.6% of certificated wheat and barley seed samples but was present in more than 11% of pre-certificated barley samples tested in 1996/7 (Don, 1997). In wild white clover seed of Dutch origin, common chickweed seed was found in 72% of samples analysed in 1960/61 (Gooch, 1963). In grass seeds of English origin tested in 1960/61, it was a contaminant in 6% of Italian and perennial ryegrass samples, 14% of Timothy, 9% of meadow fescue, 3% of tall fescue and around 1% of red fescue and cock's-foot. Common chickweed was also found in 1 to 17% of vegetable brassicas, 3% of carrot and 2% of celery seed samples tested. In clover and grass seed samples tested in Denmark for the period 1966-1969, common chickweed was one of the most frequent contaminant being found in around 30% of samples (Olesen & Jensen, 1969). In white clover seed there was an average of 584 chickweed seeds per kg of clover seed and a maximum of 11,850 seeds.

In feeding tests with chaffinches, chickweed seeds were readily eaten but a small number of seeds survived passage through the digestive system and germinated in faecal samples (Holmes & Froud-Williams, 2001). Seeds have been raised from the excreta of various other birds including sparrows. Seeds are also found in cattle, horse, deer and pig droppings (Salisbury, 1961). Apparently-viable seeds were found in samples of cow manure (Pleasant & Schlather, 1994). Seeds that had passed through a cow gave 49% germination (Horne, 1953). Seed has been found in worm cast soil in the field (McRill, 1974). It can also be transported by ants (Sobey, 1981). Seed has been found in irrigation water in the USA (Kelley & Bruns, 1975). The seeds can also withstand submergence in seawater (Sobey, 1981).

Management

In the past it was said that the hand and horse hoe should be used freely and frequently in root crops to control common chickweed (Long, 1938). Control was by continual surface tillage in hot, dry weather (Morse & Palmer, 1925). In gardens and among root crops, hoeing and hand pulling can be effective. However, in cool wet

conditions common chickweed forms a dense mat of spreading stems that root at the nodes making it difficult to hoe or pull up (ADAS, 1977). In moist conditions, hoed plants will root again.

Shoot fragments root readily following disturbance in moist soil (Grime *et al.,* 1988). Studies of the effect of physical damage on common chickweed seedlings showed that cutting at or below the soil surface was more effective than partial burial (Jones *et al*., 1995). Complete burial, alone and after uprooting the seedlings first, was the most consistently effective treatment. There was the potential for recovery if seedlings were left on the soil surface or if just the roots were buried. Shading after uprooting, as would occur under a crop canopy, improved the level of control (Jones *et al.,*1999). Normal mowing is not effective with this procumbent plant and may help the weed by removing taller species (Sobey, 1981). Close mowing may give some control. Common chickweed seedlings with 2-6 leaves are relatively susceptible to flame weeding (Ascard, 1998).

Chickweed often emerges in winter when ploughing will destroy it. The winter mortality of common chickweed is variable from year to year and site-to-site which can affect the predictions of the yield loss the weed will cause in winter cereals (Storkey *et al.,* 1997). It may be better to delay assessments to obtain more reliable predictions. Common chickweed is more vulnerable than cleavers (*Galium aparine*) to winter injury. Lutman *et al.* (2000) found it was not possible to predict yield loss precisely for winter oilseed rape in competition with common chickweed.

In a trial with spring wheat at two seed rates (140 and 180 kg/ha), and three row spacings (10, 20 and 30 cm), common chickweed 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 harrowings in the 30 cm row spacing. In competition studies in winter wheat it was noted that control of common chickweed could be deferred until mid-March without significant yield losses (Blair *et al.,* 1999).

Good cultivations including stubble cleaning are the usual method of cultural control. While stubble cleaning may not be appropriate for dealing with the shed seeds of some weed species it can be an effective way of controlling common chickweed. The surface soil should be cultivated to a depth of not more than 5 cm and this operation is repeated at 14-day intervals. In a study of the effect of straw disposal on the weed population there was an indication that shallowly incorporating straw reduced the emergence of common chickweed seedlings (Wilson *et al.,* 1989). This may have been due to toxins released by the decomposing straw.

Seed numbers in soil were reduced by 85% following a 1 year fallow and by almost 90% if this was extended to 2 years. The land was ploughed, disked and harrowed during each year (Brenchley & Warington, 1933). Weed numbers were reduced but to a lesser extent by cropping with winter wheat for the same period. Fallowing at 5 year intervals over a 15 year period did not reduce seed numbers in soil overall because during the cropped years this trailing weed was able to ripen seed before and after harvest and before ploughing (Brenchley & Warington, 1945). Some seeds were

able to remain dormant during the fallow period allowing seed numbers to increase again in the cereal crops. Even after an extended fallow period of 4 years that reduced seed numbers in soil substantially, seed numbers built up again rapidly in subsequent cereal crops (Brenchley & Warington, 1936).

In a market garden rotation, the number of common chickweed seedlings doubled following the addition of organic manures to the soil whether these were based on farmyard manure or sewage sludge (Mann, 1957). There was no further rise in numbers by increasing the rate of manure from 15 to 30 tons per acre. Common chickweed benefits from increased nitrogen levels by an increase in relative growth rate that is not affected by the lower light level beneath a crop canopy (Bastiaans & Drenth, 1999).

In laboratory tests, leachate from composted household waste decreased the germination of chickweed seed, and in pot tests covering the seeds with up to 3 cm depth of compost reduced seedling emergence (Ligneau & Watt, 1995). In field studies, mulching the soil with residues of hairy vetch (*Vicia villosa*) and of rye (*Secale cereale*) reduced the emergence of common chickweed (Mohler & Teasdale, 1993). Weed emergence declined with increasing rate of residue, however, the natural amount of residue that remained after a cover crop was killed off was insufficient for good weed control. A low rate of residue could even encourage greater weed emergence.

The germination of seeds in pots of moist soil heated with warm air for 6 hours was reduced by 50% at 47^{o}C and 80-100% at 49^{o}C (Laude, 1957). Chickweed seed is susceptible to soil solarization. In greenhouse tests of seedling susceptibility to ultraviolet-B radiation, common chickweed was the most sensitive of the species tested (Furness & Upadhyaya, 2002). Leaf area and biomass declined by 74%, root biomass was also affected. Small seedlings are susceptible to flame weeding (Ivens, 1966).

Chickweed is grazed by many wild and domestic animals including pigs and rabbits but this has little effect on management of the weed (Sobey, 1981). Rabbits are said to avoid it though (Tansley, 1949). On newly sown leys, chickweed may be grazed by sheep to help to suppress it. Geese are said to eat it selectively in certain crops (Quarles, 1999). Slugs also eat it (Grime *et al.*, 1988). Many insect species are associated with common chickweed some of which feed on it. The seeds of common chickweed are consumed by several species of ground beetle (Tooley *et al.*, 1999). The fungus *Peronospora media* may be an important agent in the natural control of common chickweed (Béres *et al.*, 1999).

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