The biology and non-chemical control of Yarrow (*Achillea millefolium* L.)

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

Yarrow

(Arrow-root, bloodwort, greenarrow, milfoil, nosebleed, sneezewort, thousand-leaf, yallow, yarroway)
***Achillea millefolium* L.**
(*Achillea lanulosa*).

Occurrence

Yarrow is a polycarpic perennial, native in meadows and pasture, lawns, banks, hedgerows and waysides, very common in Britain (Stace, 1997; Clapham *et al.*, 1987). It is recorded up to 3,980 ft (Salisbury, 1961). Yarrow is a persistent weed of grassy banks and roadsides but not on acid or waterlogged soils (Barker, 2001). It has a preference for coarse, well-drained soils, low in organic matter and with a pH of 4.6 to 6.4 (Dale *et al.*, 1965). However, it is also said to grow on soils with pH levels ranging from 4.7 to 8.0 (Grime *et al.*, 1988; Warwick & Black, 1982). Yarrow has roots that penetrate to 20 cm allowing it to withstand drought and it will thrive even on a poor dry soil (Tansley, 1949). Yarrow is considered to be an indicator of loam (Hanf, 1970). It prefers an open habitat and grows less well in the shade (Warwick & Black, 1982). It is a natural component of chalk grassland but is absent from woodland (Grime *et al.*, 1988). Yarrow thrives in most climates but is more of a weed problem in cool temperate conditions (Mitich, 1990).

There is considerable variation both within and between yarrow populations in plant morphology (Warwick & Briggs, 1979). Races have been recorded that are able to tolerate heavy metal contamination in soil (Grime *et al.*, 1988). Diploid, tetraploid, hexaploid and octoploid races are known to occur (Warwick & Briggs, 1979). Yarrow exhibits considerable morphological plasticity in response to external factors. Cultivars with coloured flowers have been bred as ornamentals (Mitich, 1990).

Sheep eat yarrow when it is young and for this reason it is sometimes included in grass mixtures (Morse & Palmer, 1925; Tansley, 1949). It is also said to control diarrhoea in sheep. It is much valued in permanent pasture both as stock food and for the soil improvement the roots induce (Elliot, 1943). The plant is rich in magnesium. The young shoots are rich in calcium and phosphate (Warwick & Black, 1982). Deer feed on yarrow in the autumn. Yarrow has an aromatic odour and can taint dairy products if it is grazed by cows (Frankton & Mulligan, 1970).

Yarrow has many herbal uses (Barker, 2001). The Anglo-Saxons used it to coagulate the blood of wounds (Haig, 2005; Mitich, 1990). Roman centurions carried dried leaves into battle. More recently, it has been used to treat digestive problems and piles. It is used as a face and hair wash to improve the complexion. Aromatic oils in the foliage have an anti-bacterial action. However, the plant can also cause skin irritation and rashes (Warwick & Black, 1982). Yarrow repels insects.

Biology

Yarrow flowers from June to August (Clapham *et al.*, 1987) sometimes into October (Hanf, 1970). Plants have been found in flower in late May. The flowers are insect pollinated and self-incompatible (Warwick & Briggs, 1979). Not all plants flower and yarrow may need to reach a minimum size before flowering (Bostock & Benton, 1979). Grime *et al.* (1988) state that seeds are set from July onwards but elsewhere seeds are said to be produced from May to October or August to September or November (Mitich, 1990). A single plant may have from 3,000 to 6,000 seeds (Stevens, 1957; Guyot *et al.*, 1962). The average seed number per stem given by Stevens (1932) is 210 while Grime *et al.* (1988) state it is 1,500, and Warwick & Black (1982) give it as 1,660. The mean number of seeds per capitulum is 11. The average seed number per plant in ruderal situations is given as 5,207 (Pawlowski *et al.*, 1967). The 1,000 seed weight is given as 0.40 g by Stevens (1932) and 0.158 g by Bostock (1978). Seed production decreases with increasing plant density (Warwick & Black, 1982). Plants may remain vegetative or may flower but not set seed.

Fresh seed requires a period of after-ripening (Bostock, 1978). In Petri-dish tests, germination of fresh seed was low initially but after a short period of dry-storage the germination level reached over 90% (Rodbocker, 1977). Germination was greater in the light and at alternating temperatures. When seeds were put to germinate under a leaf canopy or in diffuse white light there was 32% germination under the canopy and 90% in the diffuse light (Górski *et al.*, 1977). However, Grime & Jarvis (1976), in Petri dish tests with seed maintained under high or low light intensity or in darkness, found seed germinated to around 70% in all conditions. While light will break seed dormancy, seeds will germinate in the dark after chilling, coat pricking, and exposure to high nitrate concentrations or to alternating temperatures (Kannangara & Field, 1985b).

In the field, seedlings require an open site in which to become established. A few of the seeds sown in a 75 mm layer of soil in open cylinders in the field and stirred periodically emerged in the autumn and winter after sowing in October (Roberts, 1986). In the following year the seedlings emerged from January to October with the main peak of emergence period from March to April. A reducing number of seedlings emerged in subsequent years but some viable seeds still remained after 5 years. Seeds germinate better at the soil surface (Warwick & Black, 1982).

Yarrow has far creeping stolons and prostrate stems that root at the nodes (Salisbury, 1961). The plant has a well-developed fibrous root system (Bostock & Benton, 1979). The branched rhizomes generally remain in the top 10 cm of soil (Bourdôt, 1984). A high degree of apical dominance is present and branching normally occurs only from buds near the rhizome apex (Bourdôt & Butler, 1985). When the rhizomes are fragmented, a higher proportion of the buds develop on smaller fragments than on the longer pieces where apical dominance is soon re-imposed and bud development is inhibited. Yarrow overwinters as leaf rosettes that give rise to leafy flowering shoots in spring (Grime *et al.*, 1988). A few plants flower in their first year but flowering usually begins in year two (Warwick & Black, 1982).

Yarrow plants can stimulate the growth of neighbouring plants but inhibit the germination of seeds (Mitich, 1990).

Persistence and spread

Yarrow is not thought to form a persistent seedbank (Hutchings & Booth, 1996). Thompson *et al.* (1993) suggest that based on the seed characters, yarrow seed should persist less than 5 years in soil. Nevertheless, in cultivated soil yarrow seeds remained viable for at least 5 years (Roberts, 1986). Seed buried at 32 cm in undisturbed soil lost viability slowly over 4 years while seed in the upper 8 cm lost viability almost completely within 2 years (Kannangara & Field, 1985b). Seed longevity in dry-storage is 7-8 years (Guyot *et al.*, 1962). Seed in dry-storage for 10 years had around 30% viability (Rodbocker, 1977). In other studies, seeds gave 41% germination after 9 years dry-storage (Warwick & Black, 1982).

Yarrow seeds may be dispersed by wind (Grime *et al.*, 1988). The seed has been found in horse droppings, and seedlings have been raised from the excreta of various birds (Salisbury, 1961).

In lawns, yarrow occurs in clonal patches and rarely flowers or sets seed (Warwick & Briggs, 1979). In pasture, the shallow rhizomes simply spread out from the parent plant at a rate of 7-20 cm per year. However, rhizomes up to 70 cm long may be produced in 1 year but they generally remain attached to the parent (Bourdôt & Butler, 1985). On cultivated land the rhizomes are easily broken up by tillage and the fragments become spread around. Regeneration can occur from single node fragments but the shorter the fragment the greater the mortality with depth of burial (Bourdôt, 1984). Fragments 4 cm long failed to emerge from below 15 cm.

Management

As a natural component of chalk grassland, yarrow has been included in seed mixtures to restore arable land back to grassland (Hutchings & Booth, 1996). It germinates best when the vegetation is cleared, somewhat less well in if the vegetation is cut short, and poorly if the vegetation is left uncut. Good germination was achieved when the seed was sown on chalk grassland grazed by rabbits. Field germination was often much less than laboratory tests of germination indicated. In long-term grassland studies the application of lime did not favour yarrow (Williams, 1976).

In pasture, yarrow decreases under lenient spring grazing and increases under tight spring and autumn grazing by sheep (NERC, 2006). It is often associated with heavily-grazed grassland (Gibson, 1996). To keep yarrow in check pastures should be close grazed with sheep in spring and early summer (Morse & Palmer, 1925). Sheep eat the plant when the leaves are young, they will also eat the exposed rhizomes. Although deliberately sown in grass mixtures it can become a problem if grazing in spring is too excessive (Elliot, 1943). Allowing the yarrow to flower and set seed will increase the problem. Applications of nitrogenous manures will reduce yarrow growth as will liming.

Deep burial may be effective if rhizomes are sufficiently fragmented, otherwise shoot emergence will only be delayed relative to crop emergence (Bourdôt, 1984). In dry conditions rhizome fragments left on the soil surface desiccate rapidly. Yarrow does not regenerate readily when fragmented repeatedly (Warwick & Black, 1982).

In roadside verges, increased cutting frequency had no effect on or slightly increased the frequency of yarrow (Parr & Way, 1984; 1988). Infrequent cutting allows yarrow to flower after a spring mowing and to set seed before an autumn cut (Haig, 2005).

In arable crops in New Zealand, yarrow was traditionally controlled by repeated summer cultivations to first induce and then destroy shoot regrowth (Bourdôt & Butler, 1985). A first rotary cultivation to 12 cm followed by a second cultivation 8 weeks later and just 1 week prior to a further cultivation for seedbed preparation reduced yarrow regrowth in barley. In arable fields, the growth of yarrow seedlings was suppressed by competitive crops including peas (Kannangara & Field, 1985a).

A wide range of insects feed on yarrow and many other pest and diseases attack or occur on it (Warwick & Black, 1982).

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

References

Barker J (2001). *The medicinal flora of Britain and Northwestern Europe,* Winter Press, West Wickham, Kent, UK.

Bostock S J (1978). Seed germination strategies of five perennial weeds. *Oecologia* (Berl) **36**, 113-126.

Bostock S J & Benton R A (1979). The reproductive strategies of five perennial Compositae. *Journal of Ecology* **67**, 91-107.

Bourdôt G W (1984). Regeneration of yarrow (*Achillea millefolium* L.) rhizome fragments of different length from various depths in the soil. *Weed Research* **24**, 421-429.

Bourdôt G W & Butler J H B (1985). Control of *Achillea millefolium* L. (yarrow) by rotary cultivation and glyphosate. *Weed Research* **25**, 251-258.

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

Dale H M, Harrison P J, Thomson G W (1965). Weeds as indicators of physical characteristics in abandoned pastures. *Canadian Journal of Botany* **43**, 1319-1327.

Elliot R H (1943). *The Clifton Park System of farming and laying down land to grass*. 5th Edition, Faber and Faber Limited, London.

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

Gibson C W D (1996). The effects of horse grazing on species-rich grassland. *English Nature Research Report* No. **164**, English Nature, Peterborough.

Górski T, Górska K, Nowicki J (1977). Germination of seeds of various herbaceous species under leaf canopy. *Flora Bd* **166**, 249-259.

Grime J P, Hodgson J G, Hunt R (1988). *Comparative Plant Ecology*, Unwin Hyman Ltd, London, UK.

Grime J P & Jarvis B C (1976). Shade avoidance and shade tolerance in flowering plants II. Effects of light on the germination of species of contrasted ecology. Reprinted from: *Light as an Ecological Factor :II, The 16th Symposium of the*

British Ecological Society, 1974, Blackwell Scientific Publications, Oxford, 525-532.

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.

Haig G (2005). The healing garden. *Devon Life* **10** (4), 123.

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

Hutchings M J & Booth K D (1996). Studies of the feasibility of re-creating chalk grassland vegetation on ex-arable land. II. Germination and early survivorship of seedlings under different management regimes. *Journal of Applied Ecology* **33**, 1182-1190.

Kannangara H W & Field R J (1985a). Growth of seedling *Achillea millefolium* L. (yarrow) in association with pea (*Pisum sativum* L.). *Weed Research* **25**, 355-361.

Kannangara H W & Field R J (1985b). Environmental and physiological factors affecting the fate of seeds of yarrow (*Achillea millefolium* L.) in arable land in New Zealand. *Weed Research* **25**, 87-92.

Mitich L W (1990). Intriguing world of weeds – Yarrow – The herb of Achilles. *Weed Technology* **4**, 451-453.

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

NERC (2006). Sustainable management strategies for creeping thistle. *Defra Project BD1449 Final Report*, NERC Centre for Ecology and Hydrology, 28 pp.

Parr T W & Way J M (1984). The effects of management on the occurrence of agricultural weeds in roadside verges. *Aspects of Applied Biology* **5**, *Weed control and vegetation management in forests and amenity areas*, 9-18.

Parr T W & Way J M (1988). Management of roadside vegetation: The long-term effects of cutting. *Journal of Applied Ecology* **25**, 1073-1087.

Pawlowski F, Kapeluszny J, Kolasa A, Lecyk Z (1967). Fertility of some species of ruderal weeds. *Annales Universitatis Mariae Curie-Sklodowska Lublin-Polonia* **22** (15), 221-231.

Roberts H A (1986). Seed persistence in soil and seasonal emergence in plant species from different habitats. *Journal of Applied Ecology* **23**, 639-656.

Rodbocker W C (1977). Germination of seeds of common yarrow (*Achillea millefolium)* and its herbicidal control. *Weed Science* **25** (5), 456-459.

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

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

Stevens O A (1932). The number and weight of seeds produced by weeds. *American Journal of Botany* **19**, 784-794.

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

Tansley A G (1949). The British Islands and their vegetation. Volume II, 2nd Edition, Cambridge University Press.

Thompson K, Band S R, Hodgson J G (1993). Seed size and shape predict persistence in soil. *Functional Ecology* **7**, 236-241.

Warwick S I & Black L (1982). The biology of Canadian weeds. 52. *Achillea millefolium* L. s.l. *Canadian Journal of Plant Science* **62**, 163-182.

Warwick S I & Briggs D (1979). The genecology of lawn weeds. III. Cultivation experiments with *Achillea millefolium* L., *Bellis perennis* L., *Plantago*

lanceolata L., *Plantago major* L. and *Prunella vulgaris* L. collected from lawns and contrasting grassland habitats. *New Phytologist* **85**, 275-288.

Williams E D (1976). Components of the vegetation of permanent grassland in relation to fertilizers and lime. *Annals of Applied Biology* **83**, 342-345.