The biology and non-chemical control of Field Pansy (*Viola arvensis* Murray)

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

Field pansy
Viola arvensis Murray

Occurrence

Field pansy is a native annual common throughout the UK on cultivated and waste ground (Stace, 1997). Multiple regression analysis of field distribution of field pansy indicates that it is favoured by a low clay content and by low potassium levels in soil (Andreasen *et al.*, 1991). There are indications that it prefers light sandy soils but will colonize heavier soils under dry conditions or where there is little competition from other weeds (Doohan & Monaco, 1992; Hanf, 1970). Field pansy is relatively drought resistant but is able to tolerate wet soil conditions too.

In a survey of weeds in conventional cereals in central southern England in 1982, field pansy was found in 11, 12 and 4% of winter wheat, winter barley and spring barley respectively (Chancellor & Froud-Williams, 1984). Field pansy was one of the main dicotyledonous weeds prior to herbicide application in cereals in NE Scotland in 1973 and was even more frequent in 1985 (Simpson & Carnegie, 1989). In Finland too field pansy was a frequent weed in conventional spring cereals and there was an increase in the frequency in the period 1980 to 1990 that may reflect a change in the rate or type of herbicides used (Hyvönen *et al.*, 2003). Field pansy was the most frequent weed species present in conventional sugar beet crops surveyed in East Anglia in autumn 1998 (Lainsbury *et al.*, 1999). It was common in the field margins also. In a comparison of the ranking of arable weed species in unsprayed crop edges in the Netherlands in 1956 and in 1993, field pansy had moved from 1st to 4th place (Joenje & Kleijn, 1994). In 1993, a survey of the most important weeds according to European weed scientists ranked field pansy among the most important weeds in winter cereals and winter rape (Schroeder *et al.*, 1993). In trials in Denmark from 1969-1988, field pansy was frequent in autumn-sown arable crops but was common in spring-sown crops too (Jensen, 1991). In a 3-year set-aside, field pansy frequency increased with increasing distance from the field edge (Rew *et al.*, 1992).

In a study of seedbanks in some arable soils in the English midlands sampled in 1972-3, field pansy was recorded in 88% of the fields sampled in Oxfordshire and 25% of those in Warwickshire (Roberts & Chancellor, 1986). In seedbank studies in arable fields in France, field pansy was well represented in the seedbank and in the emerged vegetation (Barralis & Chadoeuf, 1987).

Field pansy is very variable and the species now includes a range of violas previously designated as separate species including *V. agrestis, V. segetalis, V. obtusifolia, V. latifolia, V. ruralis, V. deseglisii, V. subtilis, V. anglica, V. arvatica, V. derelicta, V. contempta, V. monticola, V. vectenis, V. lejeunei, V. variata var sulphurea* (Clapham *et al.*, 1987). Some early publications refer only to heartease, *Viola tricolor*, and there may have been some confusion in distinguishing the two species. Hybrids between them also occur and usually resemble field pansy (Stace, 1997). Field pansy exhibits great phenotypic plasticity in response to environmental conditions (Doohan &

Monaco, 1992). In cereals it has an upright habit and few seed capsules. Under favourable conditions in the open, plants are decumbent and spreading with abundant capsules.

Field pansy is edible and has been used in cooking and in herbal remedies (Doohan & Monaco, 1992). Leaves and flowers are rich in vitamin A and C.

Biology

Field pansy flowers from April to October (Clapham *et al*., 1987). The flowers may be cross-pollinated by various insects but are self-fertile and largely autogamous. Average seed production per capsule of 75 seeds has been reported (Doohan & Monaco, 1992, Guyot *et al.*, 1962). Seed numbers per plant are given as 1,500 to 2,500. In spring cereals the average seed number per plant ranged from 89 to 117, in winter cereals from 126-198 and in root crops from 287 to 389 (Pawlowski, 1966). In red clover the average seed number per plant was 633 and in winter rape 567. Viable seed number per plant when grown in isolation was estimated at 8,944 (Wilson *et al.*, 1988). In competition with winter wheat the number of seeds per plant ranged from 967 to 354 depending on crop density. Seed numbers were well correlated with plant dry weight. Plants grown under optimum conditions to promote maximum seed generation produced 20,000 to 46,000 seeds per plant from summer through to early winter (Doohan & Monaco, 1992). Field pansy can be found in fruit 7 months of the year (Salisbury, 1962). The time from germination to fruiting is around 125 days (Guyot *et al.*, 1962).

Seed sown in pans of field soil showed a tendency for autumn emergence (Brenchley & Warington, 1930). Seedlings continued to emerge regularly for the next 2.5 years. Field emergence in plots cultivated at monthly, 3 monthly or yearly intervals or not at all, extended from March to November with peaks in March and in August-September (Chancellor, 1964b). Seed mixed into a 15 cm layer of soil in cylinders sunk in the field and stirred periodically, emerged from March to May and September to December (Roberts & Feast, 1970).

In Canada, field pansy germinates from May to early July and again from September to November (Doohan *et al.*, 1991). Seedling emergence occurred in both cultivated and uncultivated soil but was greater following disturbance. Germination was favoured by cool fluctuating temperatures. In laboratory studies germination was largely inhibited by light. Maximum germination occurred in the dark with alternating temperatures of 15/5^{o}C. However, in laboratory studies germination was substantially increased when seeds were transferred from darkness to daylight (Froud-Williams *et al.*, 1984b). There was complete germination of field pansy seeds during a 3-month period of moist storage at 5^{o}C (Grime *et al.*, 1981).

In Sweden field pansy 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. Very few seedlings emerged in the autumn after sowing.

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 72%, germination in darkness after a light flash. In complete darkness there was 34% germination and in the light 41% germination. In the USA, field pansy seed collected and buried under natural temperature conditions was dormant at maturity in May-June but non-dormant by autumn (Baskin & Baskin, 1995). During the winter, some seeds became dormant others only conditionally dormant and able to germinate at certain alternating temperatures (15/6^{o}C & 20/10^{o}C). Seeds followed an annual cycle of dormancy/non-dormancy but there was some variation in whether dormancy was conditional or not depending on when the seed was collected. This suggests a relationship between the environment during seed maturation and the form of annual dormancy. Seeds in both dormant and non-dormant states are likely to occur in the seedbank.

Seed sown in soil at different depths, cultivated or not, in pots and boxes outside in the field produced a few seedlings intermittently in spring, summer and autumn (Froud-Williams *et al*., 1984a). The optimum emergence depth was 5 to15 mm and the maximum was 20 mm. Field pansy seed mixed at different depths in soil and cultivated periodically, emerged mainly in the second year of a 5-year experiment (Roberts & Feast, 1972). In the field, 92-100% of seedlings emerged from the surface 30 mm of a sandy soil, with the odd seedling emerging from down to 50 mm (Chancellor, 1964a). In a sandy loam soil, field seedlings emerged from the upper 45 mm with the majority from the top 35 mm of soil (Unpublished information).

Persistence and Spread

Seed longevity in soil is greater than 4 years (Guyot *et al.*, 1962). Thompson *et al.* (1993) suggest that based on seed characters, field pansy seed should persist longer than 5 years in soil. Seeds mixed with soil and left undisturbed had declined by 62% after 6 years but in cultivated soil the decline was 93% (Roberts & Feast, 1973). Seeds recovered from excavations and dated at 30 and 300 years old are reported to have germinated (Ødum, 1974). 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 grown as commercial crops (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. Field pansy seed had a mean annual decline rate of 48% and an estimated time to 95% decline of 4-6 years. Seedbank decline was also studied in a succession of autumn-sown crops (winter wheat & winter OSR) in fields ploughed annually for 3-4 years and seed return prevented (Wilson & Lawson, 1992). The annual rate of loss was 36%, the estimated time to 99% decline was 10.2 years. The annual seedling emergence represented 2.5% of the seedbank. Field pansy 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.

Some seeds are dispersed explosively when the seed capsule splits open on drying (Doohan & Monaco, 1992). Seed may be propelled 2.1 m from the parent. Up to 55% of seeds remain on the plant at cereal harvest and may be collected up with the straw. Seed has been spread in cereal straw used as a mulch and for animal bedding. In the period 1978-1981, seed of *Viola* spp. was found in 2-6% of wheat and 6-10% of barley seed samples tested by the Official Seed Testing Station (Tonkin, 1982). Viable seeds are found in cattle droppings (Salisbury, 1961). In feeding tests with chaffinches, field pansy seeds were eaten readily and a small number of seeds

survived passage through the digestive system and germinated in faecal samples (Holmes & Froud-Williams, 2001).

Management

Cultivation, hoeing and harrowing destroy the seedlings (Morse & Palmer, 1925). Well-cleaned root crops keep the weed in check. Care should be taken that only pure samples of crop seed are sown (Long, 1938).

Field pansy was the least competitive weed in studies with winter oilseed rape (Lutman *et al.*, 1995). A competitive crop will suppress the growth of field pansy (Doohan & Monaco, 1992). There is a lower incidence of field pansy under reduced cultivation systems.

Small seedlings are susceptible to flame weeding (Ivens, 1966).

Acknowledgement

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

References

Andersson L, Milberg P, Noronha A (1997). Germination response of weed seeds to light of short duration and darkness after stratification in soil. *Swedish Journal of Agricultural Research*, **27**, 113-120.

Andreasen C, Jensen J E, Streiberg J C (1991). Soil properties and plant nutrients affecting the occurrence of *Poa annua*, *Stellaria media* and *Viola arvensis* on arable land. *Proceedings of the Brighton Crop Protection Conference – Weeds*, Brighton, UK, 395-402.

Barralis G & Chadoeuf R (1987). Weed seed banks of arable fields. *Weed Research* **27**, 417-424.

Barralis G, Chadoeuf R, Lonchamp J P (1988). (Longevity of annual weed seeds in cultivated soil. *Weed Research* **28**, 407-418.

Baskin J M & Baskin C C (1995). Variation in the annual dormancy cycle in buried seeds of the weedy winter annual *Viola arvensis*. *Weed Research* **35**, 353-362.

Brenchley W E & Warington K (1930). The weed seed population of arable soil. I. Numerical estimation of viable seeds and observations on their natural dormancy. *The Journal of Ecology* **18** (2), 235-272.

Chancellor R J (1964a). The depth of weed seed germination in the field. *Proceedings 7th British Weed Control Conference*, Brighton, UK, 607-613.

Chancellor R J (1964b). Emergence of weed seedlings in the field and the effects of different frequencies of cultivation. *Proceedings 7th British Weed Control Conference*, Brighton, UK, 599-606.

Chancellor R J & Froud-Williams R J (1984). A second survey of cereal weeds in central southern England. *Weed Research* **24**, 29-36.

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

Doohan D J & Monaco T J (1992). The biology of Canadian weeds. 99. *Viola arvensis* Murr., *Canadian Journal of Plant Science* **72**, 187-201.

Doohan D J, Monaco T J, Sheets T J (1991). Factors influencing germination of field violet (*Viola arvensis*). *Weed Science* **39**, 601-606.

Froud-Williams R J, Chancellor R J, Drennan D S H (1984a). The effects of seed burial and soil disturbance on emergence and survival of arable weeds in relation to minimal cultivation. *Journal of Applied Biology* **21**, 629-641.

Froud-Williams R J, Chancellor R J, Drennan D S H (1984b). The influence of burial and dry-storage upon cyclic changes in dormancy, germination and response to light in seeds of various arable weeds. *New Phytologist* **96**, 473-481.

Grime J P, Mason G, Curtis A V, Rodman J, Band S R, Mowforth M A G, Neal A M, Shaw S (1981). A comparative study of germination characteristics in a local flora. *Journal of Ecology* **69**, 1017-1059.

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.

Håkansson S (1979). Seasonal influence on germination of weed seeds. *Proceedings of the EWRS Symposium: The influence of different factors on the development and control of weeds,* 73-80.

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

Holmes R J & Froud-Williams R J (2001). The predation and dispersal of weed seeds by birds. *Proceedings of the BCPC Conference – Weeds*, Brighton, UK, 333-336.

Hyvönen T, Ketoja E, Salonen J (2003). Changes in the abundance of weeds in spring cereal fields in Finland. *Weed Research* **43**, 348-356.

Ivens G W (1966). Flame cultivation experiments 1965. *WRO Technical Report No.* **7**, Weed Research Organisation, Oxford, UK, 6pp.

Jensen P K (1991). Weed size hierarchies in Denmark. *Weed Research* **31**, 1-7.

Joenje W & Kleijn D (1994). Plant distribution across arable field ecotones in the Netherlands. *BCPC Monograph No. **58**: Field margins: integrating agriculture and conservation,* 323-328.

Lainsbury M A, Hilton J G, Burn A (1999). The incidence of weeds in UK sugar beet crops during autumn 1998. *Proceedings Brighton Crop Protection Conference - Weeds*, Brighton, UK, 817-820.

Long H C (1938). Weeds of arable land. *MAFF Bulletin* **108**, 2nd edition. HMSO, London, UK.

Lutman P J W, Bowerman P, Palmer G M, Whytock G P (1995). A comparison of the competitive effects of eleven weed species on the growth and yield of winter oilseed rape. *Proceedings Brighton Crop Protection Conference - Weeds*, Brighton, UK, 877-882.

Lutman P J W , Cussans G W, Wright K J, Wilson B J, McN Wright G, Lawson H M (2002). The persistence of seeds of 16 weed species over six years in two arable fields. *Weed Research* 42, 231-241.

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

Ødum S (1974). Seeds in ruderal soils, their longevity and contribution to the flora of disturbed ground in Denmark. *Proceedings of the 12th British Weed Control Conference*, Brighton, UK, 1131-1144.

Pawlowski F (1966). Prolificacy, height and ability of producing shoots on some weed species growing among crop plants. *Annales Universitatis Mariae Curie-Sklodowska Lublin-Polonia,* **21** (9), 175-189.

Rew L J, Wilson P J, Froud-Williams R J, Boatman N D (1992). Changes in vegetation composition and distribution within set-aside land. *BCPC Monograph No.* **50** *Set-Aside*, 79-84.

Roberts H A & Chancellor R J (1986). Seed banks of some arable soils in the English midlands. *Weed Research* **26**, 251-257.

Roberts H A & Feast P M (1970). Seasonal distribution of emergence in some annual weeds. *Experimental Horticulture* **21**, 36-41.

Roberts H A & Feast P M (1972). Fate of seeds of some annual weeds in different depths of cultivated and undisturbed soil. *Weed Research* **12** (4), 316-324.

Roberts H A & Feast P M (1973). Emergence and longevity of seeds of annual weeds in cultivated and undisturbed soil. *Journal of Ecology* **10**, 133-143.

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

Salisbury E (1962). The biology of garden weeds. Part I. *Journal of the Royal Horticultural Society* **87**, 338-350 & 390-404.

Schroeder D, Mueller-Schaerer H, Stinson C A S (1993). A European weed survey in 10 major crop systems to identify targets for biological control. *Weed Research* **33** (6), 449-458.

Simpson M J A & Carnegie H M (1989). Dicotyledonous weeds of spring cereal crops in north-east Scotland. *Weed Research* **29**, 39-43.

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

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

Tonkin J H B (1982). The presence of seed impurities in samples of cereal seed tested at the Official Seed Testing Station, Cambridge in the period 1978-1981. *Aspects of Applied Biology* **1**, *Broad-leaved weeds and their control in cereals*, 163-171.

Wilson B J & Lawson H M (1992). Seedbank persistence and seedling emergence of seven weed species in autumn-sown crops following a single year's seeding. *Annals of Applied Biology* **120**, 105-116.

Wilson B J, Peters N C B, Wright K J, Atkins H A (1988). The influence of crop competition on the seed production of *Lamium purpureum, Viola arvensis* and *Papaver rhoeas* in winter wheat. *Aspects of Applied Biology* **19**, *Weed control in cereals and the impact of legislation on pesticide application*, 71-80.