The biology and non-chemical control of Winter Wild-oat (*Avena sterilis ssp. ludoviciana*)

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Winter wild-oat

***Avena sterilis* L. *ssp. ludoviciana* (Durieu) Gillet & Magne**
(*Avena ludoviciana*)

Occurrence

Winter wild-oat is an introduced annual grass weed of arable, waste and rough land usually on heavy soils (Clapham et al., 1987; Stace, 1997). In the UK, the winter wild-oat has a more local distribution than wild-oat (*A. fatua* L.) and, as the name suggests, is mainly a problem in winter cereals (MAFF, 1974).

The date of the first record in the UK is given as 1917. One of earliest records of the species was in 1926 from Abingdon near Oxford and according to a 1951 survey, winter wild-oat occurred predominantly in an area within a radius of 80 miles of Oxfordshire (Thurston, 1953). It became a major weed of heavy land in central, southern and eastern England possibly reflecting the distribution of winter wheat (Thurston, 1963) but is now more scattered. In a survey of UK arable weeds in 1971-1973 it was recorded in only 2% of the tetrads surveyed (Chancellor, 1977). In a survey of weeds in conventional cereals in central southern England in 1982, winter wild-oat was found in 7, 3 and 1% of winter wheat, winter barley and spring barley respectively (Chancellor & Froud-Williams, 1984). Winter wild-oat is more of a problem in southern Europe and was considered to be the most troublesome weed of cereals in Spain (Torner *et al.*, 1991).

In Italy, winter wild-oat is represented by 2 subspecies, ssp. *ludoviciana* and ssp. *macrocarpa* (Vecchio *et al.*, 1982). However, some individuals are difficult to classify and biochemical tests suggest that some may originate from natural hybrids with wild-oat (*A. fatua*).

Biology

Seeds of winter wild-oat may be fully developed and dormant 15 days after anthesis (Thurston, 1963). Unripe seeds are viable but non-dormant. Destruction of hand-pulled winter wild-oat, even with green panicles, is therefore important. There may be 1,700 seeds per plant but this reduced to 700 in a winter cereal (Clarke *et al.*, 1995).

The seeds possess a hygroscopic awn that twists and straightens with changes in humidity pushing the seeds down into cracks and crevices in the soil (Thurston, 1953). It germinates predominantly in winter or early spring (Salisbury, 1961). The most favourable temperatures for germination are between 7 and 13^{o}C (Thurston, 1963). In Petri-dish tests under a range of temperatures and osmotic potentials, winter wild-oat germinated slower and was more affected by osmotic stress than wild-oat seed (Fernandez-Quinantilla *et al.*, 1990). At temperatures below 10^{o}C, a greater

proportion of winter wild-oat emerged than wild-oat. At temperatures above 20°C the opposite was true. Between these temperatures the germination process was similar.

In northern Italy, where winter wild-oat is more common than wild-oat, seeds collected from fields with different cropping histories exhibited 3 types of dormancy behaviour (Marzolo & Speranza, 1993). High germination with little seed dormancy (0-10%) was associated with a greater frequency of wheat cropping. Moderate germination levels with higher dormancy levels (35-62% was found in seeds from fields with a high frequency of alfalfa cropping. Low germination with high dormancy (74-100%) was from fields where no ploughing had been carried out.

Field and glasshouse studies have shown have shown that the post-harvest residues of wheat stimulate the germination of winter wild oat seed (Purvis & Jessop, 1985). However, germination was inhibited by leachate from the roots of young wheat seedlings. The same chemical may be responsible but at different concentrations.

The main period of seedling emergence is from October to March with a peak around November-December (Thurston, 1976). Seed mixed in a 75 mm layer of soil in cylinders sunk in the field and stirred at intervals emerged mainly between October and February (Roberts, 1986). Most seedlings emerged in year 2 of the 5-year experiment with fewer seedlings in years 1 and 3. In Spain, emergence in winter cereals begins soon after drilling in late-October and continues for 23 weeks (Aibar *et al.*, 1991). Around 75% of seedlings appeared in the first 9 weeks. In Spain, both winter wild-oat and wild-oat (*Avena fatua* L.) emerge at the same time.

Seedlings will emerge from seed buried at 23 cm deep in soil (Thurston, 1963). The seeds have greater food reserves than seeds of wild-oat and a higher percentage are able to emerge from this depth.

Persistence and spread

A proportion of winter wild-oat seed is relatively non-dormant and germinates within a few weeks of shedding. Once mixed into the soil, the remaining seeds can persist for around four years (Thurston, 1963). No seeds remained after 7 years in a cultivated soil but seeds were still viable after 33 months (Thurston, 1961). Winter wild-oat has a faster recruitment rate but a faster depletion rate than wild-oat (Navarette & Fernandez-Quintanilla, 1996). Different tillage systems, including ploughing versus shallow cultivation, result in different distributions of seed and hence different patterns of seedling recruitment. Shallow cultivation leaves seeds in the surface layers while ploughing distributes seeds throughout the soil profile. Birds may eat more of the seeds following shallow cultivation (Thurston, 1961).

In winter wheat in Greece, more that 50% of winter wild-oat seeds shed naturally before crop harvest (Skorda *et al.*, 1991). Less of the seed is found in the grain and the least in the straw. Seeds can be spread in straw or animal fodder but do not seem to survive in well-rotted manure (Thurston, 1963). Less than 1% of winter wild-oat seeds fed to a calf passed through the digestive system and germinated in the dung.

Management

Winter wild-oat seed will only germinate in cool conditions. It does not germinate in summer therefore a summer fallow will not deplete the seedbank (Thurston, 1963).

However, fallowing for a full year reduced seed numbers in soil by 65% according to Navarette & Fernandez-Quintanilla (1996). Nine years of intensive hand-roguing did not prevent the continued emergence of winter wild-oat (Roebuck & Field, 1978).

Cultivations prior to spring cropping will effectively control winter wild-oat seedlings (MAFF, 1974). Where winter wild-oat is a problem, growing a series of 3-4 spring sown crops allows the weed to be destroyed by thorough cultivations. Seedlings of winter wild-oat are smaller than those of cereals initially but soon catch up and exceed the crop (Thurston, 1963). Therefore the crop needs to be most competitive at an early stage.

In Spain, winter barley yield losses due to winter wild-oat increase with the density of the weed but are greater when the growing conditions are relatively dry (Torner *et al.*, 1991). Losses are due to a reduction in the number of fertile tillers. Increasing the seed rate of the barley is of limited yield benefit but increasing crop density progressively reduces winter wild-oat seed production. In Greece, increasing the sowing rate of winter wheat reduced the biomass of winter wild oat (Skorda & Efthimiadis, 1985). With a higher wheat population the growth of the weed was suppressed and the crop was less affected by weed competition but grain yield was still reduced. In India, an evaluation of the competitive ability of winter wheat cultivars against winter wild-oat showed that greater straw height and dry matter accumulation were better characters for predicting competitive ability than the number of tillers (Balyan *et al.*, 1991). In Spain, wild-oat competition was lower in wheat cultivars with a shorter growing cycle (González Ponce, 1988). In cultivars with a longer growing cycle, stem extension and heading coincide with the extension of the winter wild-oat panicles. In Greece, studies of the competitive ability of winter barley cultivars, of both *Hordeum distichum* and *H. vulgare*, varied from year to year (Dhima *et al.*, 2000). In general, yield was reduced by 8 to 57% depending on the cultivar. The presence of the weed up until March had little effect on the crop but if it remained after early April crop biomass was reduced.

In a study of the effect of the residues from harvested crops on winter wild oat, wheat and field pea residues promoted wild-oat germination and subsequent growth (Purvis *et al.*, 1985). There was more rapid emergence of the weed in the presence of wheat, pea, oilseed rape, sunflower or sorghum residues.

Frit flies (*Oscinella frit*) will attack and damage winter wild-oat as well as cultivated oats (Van Emden, 1970).

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