The biology and non-chemical control of black-grass (*Alopecurus myosuroides* Huds)

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***Alopecurus myosuroides* Huds**
Alopecurus agrestis L.
Black-grass
Black Twitch, Hungerweed, Rat-tail, Mousetail Grass, Slender Foxtail

Occurrence

A native annual grass weed of arable land especially cornfields on heavy soil (Long, 1938). Black-grass is scattered throughout the UK, abundant in SE England, a casual in the North (Clapham et al., 1987). In early surveys of Bedfordshire, Hertfordshire and Norfolk, black-grass was universally distributed over different soil types but was rare on chalk and was typically found on heavy clay (Brenchley, 1911; 1913). It occurs in the main cereal growing area of Britain south and east of the Trent, Severn and Exe (MAFF, 1975). It remains chiefly confined to heavy land, occurring only occasionally on sandy or gravely soil but has begun to appear on chalk. In a survey of weeds in conventional cereals in central southern England in 1982, black-grass was found in 33, 15 and 7% of winter wheat, winter barley and spring barley respectively (Chancellor & Froud-Williams, 1984). The species is often found spreading into arable fields from the hedge bottom (Marshall, 1989). It has not been recorded on land above 1000 ft (Salisbury, 1961). Albino seedlings occur at a frequency of 1 in 4000 (Brenchley & Warington, 1936).

Black-grass suffers from ergot (*Claviceps purpurea*) and this can result in contamination of the grain at harvest leading to rejection of the crop (MAFF, 1975).

Biology

Black-grass flowers from May to August sometimes into October (Long, 1938). It is both self fertile and cross pollinated. Seed production may range from just 50 up to 6,000 seeds per plant, the greatest number on plants germinating in early autumn (MAFF, 1975). The seed ripens quickly and is shed before the harvest of most of the crops in which it grows. Shedding occurs from late June to late August (Moss, 1983). All the seed has been shed by the time of winter wheat harvest but only 50% by winter barley harvest. The viability of seed shed at the start and end of shedding is lower than that of seed shed at the peak time.

Some seeds are able to germinate soon after shedding, others remain dormant for a few months. Seed sown in pans of field soil germinated almost immediately, 97% in first year, indicating little natural dormancy (Brenchley & Warington, 1930). Usually the majority of seeds germinate within 1 year of shedding but some become dormant when buried deeply or in waterlogged soil (Thurston, 1964). However, large differences have been found in the germinability of seed from different populations of black-grass (Naylor & Abdalla, 1982). A germination value for one population may not be representative of other populations. Light and fluctuating temperatures stimulate germination.

Germination occurs mainly in autumn (Salisbury, 1961). Seeds normally germinate best near the soil surface and burial can result in some degree of dormancy. Seeds emerge from depths of 2-5 cm, which in a ploughed soil means that the seedlings are not from freshly shed seeds. If conditions are favourable most seed germinates in late October and early November (Thurston, 1964). There is then a small flush of seedlings in spring, which is increased if autumn germination has been prevented by waterlogging, for example (Thurston, 1976).

Seed sown outside in pots and boxes of soil germinated throughout the year, but mainly in autumn and winter when sown on the soil surface (Froud-Williams *et al.*, 1984). Emergence was much less when seed was sown at 25 mm with no further cultivation. Seed sown at 75 mm and cultivated in February germinated mainly in spring and autumn. If cultivated in June, emergence was mainly in summer and autumn.

Emergence of black-grass seedlings decreased with increasing depth of burial in soil soils of different aggregate size (Cussans et al., 1996). Total emergence was lowest in fine soil conditions. Light penetration is likely to be less in fine particle soils. In preliminary tests, black-grass seed germination was six times greater when exposed to light. In laboratory tests, irradiation with red light enhanced germination (Froud-Williams, 1981). The overall optimum germination temperature was 8 ^{o}C.

Persistence and spread

The decline of seed in soil is reported to be highest in the first year after shedding but appreciable numbers remained after 4 years whether in cultivated or uncultivated soil (Froud-Williams, 1987). If seeds are ploughed down deeply they appear to retain viability for some time (Long, 1938). Black-grass patches remained relatively stable in their positions in arable fields over a 10 year period (Wilson & Brain, 1991). The grass exhibited little ability to spread to new areas but persisted in the established areas of infestation.

In the period between 1961 and 1968 black-grass seed was found as a contaminant in around 2% of seed samples of wheat, barley, oats and rye tested for purity by the Official seed Testing Station, Cambridge (Tonkin, 1968). Most of the contaminated samples contained very low numbers of seeds but some had several hundred in an 8 ounce sample of grain. In a survey of weed seed contamination in cereal seed in drills ready for sowing on farm in spring 1970, black-grass seed was found in 3% of samples (Tonkin & Phillipson, 1973). All of these were home saved seed. The relatively early shedding of black-grass seed reduces the likelihood of contamination of most cereals except winter barley (Froud-Williams, 1987). Black-grass has sometimes occurred as a contaminant of clover seed but is rarely found in seed of cultivated grasses.

Seed has been found in cattle droppings (Salisbury, 1961).

Management

It is a difficult weed to control because so many black-grass seeds are shed at or prior to crop harvest. In the past, straw burning caused high losses of the freshly shed seed in stubble but this is no longer allowed (Froud-Williams, 1987; Moss, 1979). Shallow

ploughing and surface tillage after harvest will encourage seeds to germinate freely. Large numbers of seedlings can then be destroyed by ploughing. In any subsequent root crop thorough cultivations will destroy many young plants. In wheat, small seedlings are killed by harrowing when the soil is dry.

Early drilling of winter cereals leads to severe infestations both because it coincides with peak emergence, and because the weed has time to become fully tillered before winter (MAFF, 1975). Infestations are often worse on badly drained heavy soils where there is a high proportion of winter cropping. In a 4-year experiment with winter wheat crops, black-grass populations were favoured more by direct-drilling and tine cultivations than by ploughing (Moss, 1981). Ploughing did not prevent some increase in the weed population but the infestation remained at a relatively low level. Black-grass emergence tended to be shallower on the direct-drilled plots than on the ploughed or tined plots, but even on the ploughed land most seedlings emerged from within the surface 5 cm of soil.

When there is only a small reserve of seeds in the soil ploughing generally reduces the level of infestation while tine cultivations leave many seeds in the surface layers of soil (Moss, 1979; 1984). Where seed had been shed in the previous crop, it was calculated that 80-90% of black-grass plants in a direct-drilled winter wheat crop came from recently shed seeds (Moss, 1980). However, on a field that had suffered black-grass infestations for many years, ploughing brought up buried seeds that germinated in large numbers.

Improving land drainage may lead to a reduction in the severity of infestations but the weed will remain a problem for some time and the cost may not be justified. Sowing cereals before 25 October has been shown to increase black-grass infestations, sowing after 5 November has led to a decrease (MAFF, 1975). However, there may be a substantial loss in yield if winter wheat is drilled after mid-November. With winter beans the optimum drilling dates are similar to those of cereals but winter oilseed rape needs to be sown at the end of September.

Since black-grass builds up in autumn sown cereals, an autumn fallow is ideal for ridding the soil of the seeds (Brenchley & Warington, 1930). Seed numbers in soil were reduced by over 75% following a 1 year fallowing and by 95% following a 2 year fallowing (Brenchley & Warington, 1933). The land was ploughed, disked and harrowed during the fallow period. Under cropping with winter wheat for the same period, seed numbers gradually increased. Successive fallowing every five years over a 15 year period did not reduce seed numbers overall (Brenchley & Warington, 1945). Although numbers dropped after fallowing, the survivors germinated in the following winter wheat crop and seed numbers built up rapidly before the next fallow year. Apart from in the first crop after fallowing, there is little benefit unless subsequent seeding can be reduced or prevented. An extended fallow period of 4 years reduced seed numbers in soil initially but numbers rapidly built up again in subsequent cereal crops (Brenchley & Warington, 1936).

In spring cereals early sowings suffer worse black-grass problems but delaying sowing reduces the yield potential of the crop. Black-grass is less competitive in the spring crop but it can be a significant source of fresh seed. The weed is also important in winter beans, winter oilseed rape, and seed crops of brassicas, sugar beet

and grass. Infestations in grass seed crops are very difficult to control. Mowing or grazing in the first year may be required to prevent the black-grass seeding and reduce the infestation in the second year.

There have been attempts at devising methods for determining the extent of likely black-grass infestations ahead of cropping and for devising the best control strategy. It has been shown that there is a significant relationship between the number of black-grass seedlings emerging in soil samples in the glasshouse and the level of infestation that developed in the field (Naylor, 1970). Over 90% of seedlings emerged from the top 2.5 cm of soil in the field and samples should be taken from this layer to get reliable results prior to drilling a crop. A population model has been developed to determine the effect of soil tillage and other factors on the level of black-grass infestations in winter cereals (Cussans & Moss, 198-). The model suggests that to prevent a likely build-up of black-grass under minimum tillage systems the land should be ploughed every 5 years. Strategies to deal with herbicide resistant black-grass may be relevant to non-chemical management systems. They consist of ploughing at least once every 4-5 years, including spring-sown crops in the rotation, and delaying autumn sowing to allow a higher proportion of seedlings to emerge and be hoed off prior to sowing winter cereals (Clarke & Moss, 1991).

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