The biology and non-chemical control of Volunteer Cereals

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Barley ***Hordeum vulgare*** **L**
Oats ***Avena fatua*** **L**
Wheat ***Triticum vulgare*** **L**

Occurrence

Volunteer cereals arise primarily from seed shed at or before crop harvest. Seed can also be carried on and dispersed by farm machinery. Cereal seedlings can emerge from straw used as mulch or as animal bedding. Seedlings that reach maturity will produce a further generation of potential volunteer seedlings

The seedlings that develop from the shed cereal grains can be a hindrance and a problem in subsequent cereal crops (Hughes, 1974). If present in large numbers, volunteer cereals can result in too high a plant population leading to yield depression and other problems associated with too dense a plant stand. They will also compromise varietal purity. A survey of weeds in conventional cereals in central southern England in 1982, found volunteer cereals in 4.2, 4.0 and 2.0% of winter wheat, winter barley and spring barley fields respectively (Chancellor & Froud-Williams, 1984). In a study of varietal purity in samples of wheat and barley, the mean level of varietal impurity was around 3% (Wray, 1993). Barley, and in particular winter barley, was more contaminated by other cereal species than wheat. This may be because volunteer barley ripens and sheds its seed before wheat is harvested.

Volunteer cereals can be a particular problem in autumn sown or planted vegetable crops grown within an arable rotation. Volunteer barley can have a severe effect in the autumn on the growth of winter oilseed rape although the effect on yield may not be too severe. (Lutman & Dixon, 1991). It has been suggested that 28% of sugar beet fields and 88% of oilseed rape fields are infested with volunteer cereals (Orson, 1994).

In Scotland, soft fruit crops often follow cereals in the rotation and volunteer cereals are a problem in maiden fruit crops (Lawson, 1984). Even after the first year further flushes of cereal seedlings may occur following soil cultivation. Straw used as a mulch in strawberries and in raspberries is an additional source of cereal seeds.

In set-aside studies of different crop covers and natural regeneration, volunteer cereals made up 40% of the ground cover in the first year of the natural regeneration treatments (Cooke & Clarke, 1996). Even with sown covers, volunteer cereals made up to 30% of the ground cover.

In crops grown as a break from cereals the presence of cereal volunteers negates any pest and disease control benefits. They can act as a green bridge that perpetuates soil-borne and foliar diseases, and carries cereal pests through to the next cereal crop (Bray, 1976). Powdery mildew (*Erysiphe graminis*), leaf rusts (*Puccinia striiformis, P. hordei*), glume blotch (*Leptosphaeria nodorum*), leaf blotch (*Rhynchosporium* *secalis*) and net blotch (*Pyrenophora teres*) can be perpetuated in this way. Volunteer cereals can act as a primary source of the barley yellow dwarf virus (Orson, 1989). They can also lead to problems with frit fly (*Oscinella frit*) in late-drilled cereals.

Biology

Cereal grains may be shed in the standing crop and at harvest (Pickett, 1993). In barley the whole ear may break off while in wheat individual grains tend to fall from the spikelet. Some cultivars are more resistant to shedding and lose 5% of grains compared with an average of 16%.

Dormancy in freshly shed cereal seed can limit early germination and restricts post-shedding control measures (Pickett, 1993). Dormancy varies between cultivars and is normally a desirable characteristic that prevents pre-harvest sprouting. The temperature during seed ripening, particularly the dough stage, may influence dormancy levels (Chancellor, 1982). Seeds that ripen at higher temperatures and in dry conditions are less dormant. A cool wet period at or around harvest may encourage the retention of dormancy.

Seeds are indifferent to light and when seeds were put to germinate under a leaf canopy or in diffuse white light there was a similar level of germination under the canopy and in the light (Górski *et al.*, 1977).

After cereal harvest, shed cereal grains will not germinate until they absorb sufficient moisture (Orson, 1993). In a dry autumn this may be after the succeeding crop has been sown. Straw residues in soil may inhibit germination and seedling growth (Pickett, 1993).

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Persistence and Spread

Some reports suggest that cereal grains have a lifespan of up to 5 years in soil but lengthy persistence is thought to be unlikely even if seed is buried deeply (Pickett, 1993). Spring oat seed buried in a mineral or a peat soil at 130, 260 or 390 mm depth and left undisturbed was not viable after 1 year (Lewis, 1958). In granary and cold store conditions the seed retained 90% viability after a year. Winter oat seed gave up to 3% germination after 2 years at 390 mm depth in mineral but not in peat soil. Barley seed was not viable after 1 year buried at any depth in either soil. Spring and winter wheat seed retained less than 1% viability after burial in the mineral soil for up to 2 years but was not viable in the peat soil after 1 year. Wheat seed submerged in water remained viable for less than 3 months but oat seeds gave 23 and 6% germination after 3 and 6 months respectively (Comes *et al.*, 1978). After 5 years in dry storage wheat and oats gave 85 and 99% germination respectively.

Winter barley seed broadcast over the soil in autumn prior to ploughing to 15 or 20 cm, or tine cultivations at 5, 10 or 15 cm, emerged in the greatest numbers following the tine cultivations (Bowerman *et al.*, 1993). Between 60 and 90% of potential seedling emerged in the year after sowing following tine cultivation but less than 0.1% emerged in the following year. After ploughing, around 14% of possible seedlings emerged in year 1 but none afterwards.

Greater losses of seeds are likely from the soil surface than following burial by cultivation (Pickett, 1993). Ploughing and other cultivations soon after harvest are likely to encourage retention of dormancy. However, a late stubble cultivation could trigger germination under favourable conditions. Greater numbers of volunteer cereals may occur in crops grown under reduced tillage because of the retention of seeds near the soil surface (Christian, 1993).

In set-aside land in Scotland, some volunteer wheat, barley and oats were recorded in the first year but these gave way to other species in later years (Fisher, *et al.,* 1992).

In tests of cereal seed purity by the Official Seed Testing Station in the period 1978-1981, wheat was found in 25-28% of barley samples and barley was found in 25-28% of wheat seed samples (Tonkin, 1982). The highest number of seeds recorded in a 125 g sample was 300. Wheat seeds were found in up to 20% of certified barley seed samples and up to 26% of oat samples tested in the period 1986 to 1997 (Don, 1997). Oat seeds were found in up to 2% of barley and 1% of barley seed samples tested. Barley seeds were found in up to 50% of oat and 37% of wheat seed samples tested.

Management

Careful choice of varieties with some resistance to shedding can help to reduce the volunteer problem (Hughes, 1974). Shallow post harvest cultivations to 9 cm will incorporate shed cereal grains to a depth from which they can germinate after a short period of dormancy. Emerged seedlings can then be killed by further cultivations. The strategy is unsuccessful if the surface soil is dry at this time.

Volunteer barley can be a problem in autumn- and spring-sown beans (*Vicia* faba) (Babalola *et al.,* 1993). Early removal of volunteer winter barley in peas and spring beans sown in March prevented yield loss if carried out when peas and beans were at the 2-3 and 2-4 node stage respectively (Wilson, 1995). Allowing the cereal to remain for a further 4 weeks before removal resulted in some yield loss in beans but in peas the loss was as great as that of the unweeded crop. In row crops, the volunteer seedlings in the inter-rows can be controlled by cultivation (Bray, 1976). The dry-weight of volunteer barley at crop harvest gives a good estimate of seed production by the volunteer plants (Van Acker *et al.*, 1997).

In Scotland, ploughing down stubbles to bury barley seed deeply is considered the best management option (Davies & Wilson, 1993). However, some cultivars have somewhat higher dormancy levels and seed may persist and germinate after further ploughing in subsequent seasons. Post-harvest stubble cultivations usually encourage germination of shed cereal seed (Orson, 1994). Emerging volunteers can then be controlled by subsequent cultivations. However, the timing may conflict with the need to control wild oats (*Avena fatua*). Volunteer cereals are favoured by zero-tillage systems (Streit *et al.,* 2003).

In the first year of set-aside the number of volunteer cereals that emerged was similar whatever treatment was applied (Clarke & Cooper, 1992). Management in the first year had a significant effect on subsequent survival. Sowing a plant cover or cutting the vegetation more than once reduced the volunteers to a negligible level.

In Canada, the effect of different densities of volunteer barley on the yield of spring-sown rapeseed (*Brassica campestris*) was assessed to determine a threshold value at which it was economic to control the cereal (O'Donovan *et al.*, 1987). The cost of weed control set against the cash returns from the improved crop yield indicated that controlling a density of 15 or more barley seedlings could be justified economically.

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