# The biology and non-chemical control of Onion Couch (*Arrhenatherum elatius* ssp. *bulbosum* P.Beauv. ex J&C. Presl Var. bulbosum (Willd.) St-Amans)

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## Onion couch

(bulbous oatgrass, button grass, false oat grass, knot oat-grass, pearl grass, tall oatgrass)

***Arrhenatherum elatius* ssp. *bulbosum* P.Beauv. ex J&C. Presl Var. *bulbosum* (Willd.) St-Amans**

(*A. avenaceum, A. tuberosum, A. elatior*)

## Occurrence

Onion couch is a tall perennial grass that occurs throughout the UK both as an arable weed and as a component of semi-natural grassland (Cussans *et al.*, 1992). It is recorded up to 1,800 ft in Britain (Salisbury, 1961). Onion couch owes its name to the swollen stem internodes or 'bulbs' at or just beneath the soil surface. It is met with locally, particularly on lighter soils, and once established is difficult to get rid of (Long, 1938). It is a problem on open textured loams and is common on limestone brash and chalk downs (Rees & Sherrott, 1991). There is usually no obvious relationship between soil type and distribution but rainfall patterns may play a key role (Cussans *et al*., 1993). It is common on moderately fertile soils of pH 5.0 to 8.0 (Pfitzenmeyer, 1962). It cannot tolerate shade and is sensitive to low temperatures and exposure to wind. The bulbous form is more sensitive to frost than the non-bulbous one. Onion couch is not as drought tolerant as some grass species, although the roots penetrate deeply into the soil. It is said not to tolerate waterlogging in winter. Onion couch does not tolerate trampling and is absent from gateways (Pfitzenmeyer, 1962). It responds positively to applications of manure.

Onion couch occurs on unmown verges and lightly managed grassland (Grime *et al.*, 1988). It tends to be a late-successional grass that invades and takes over from pioneer species (Grubb, 1982). It is widespread on long-established hay-meadows but not pasture (Pfitzenmeyer, 1962). It is a troublesome weed in parts of Scotland. It is often found in the latrine areas of grassland grazed by horses (Gibson, 1996). The weed tends to become established in winter wheat as seedlings from seed shed in the hedgerow or in the previous crop (Ayres, 1981). A survey of bulbous forms showed that the arable weed form occurred mainly in the Midlands and Central Southern England (Cussans *et al*., 1992) and the west (Clapham *et al*., 1987). The grassland bulbous forms were found mainly in Wales and the South West. In a survey of weeds in conventional cereals in central southern England in 1982, onion couch was found in 4, 3 and 1% of winter wheat, winter barley and spring barley respectively (Chancellor & Froud-Williams, 1984). In a survey of UK cereal field margins recorded as part of Countryside 2000, it was one of the most frequent species recorded (Firbank *et al.*, 2002). In a 3-year set-aside, frequency gradually declined with increasing distance from the field edge (Rew *et al.*, 1992).

The species exists in several sexually compatible forms differing mainly in the amount of swelling of one or more basal internodes (Cussans *et al.*, 1993). In semi-natural grassland both bulbous and non-bulbous forms occur together but here the bulbous forms are not as extreme as the arable weed. In the form that occurs as the arable weed, onion couch, a chain of 4 to 7 swollen basal internodes 7-12 mm in diameter is present. The non-weedy form, ssp. *elatius*, is more commonly known as tall oatgrass. Weedy populations do not breed true, a proportion of offspring being the non-weedy form (Cussans *et al.*, 1993). 'Bulb' formation is hereditary and independent of habitat (Tanphiphat & Appleby, 1990). Soil type only modifies the degree of 'bulb' development. Crosses between the bulbous and non-bulbous forms result in a hybrid that is bulbous but less so than the bulbous parent.

The 'bulbs' were used for food in the Bronze Age (Pfitzenmeyer, 1962).

**Biology**

Onion couch flowers from June to July and beyond (Long, 1938). The flowers are wind pollinated and self-incompatible (Grime *et al.*, 1988). An abundance of seed is produced. Seeds are shed from July, before or soon after maturing and are generally non-dormant (Tanphiphat & Appleby, 1990; Grime *et al.*, 1988).

Seed germinates better at 8-15$^{o}$C and somewhat poorer at 25$^{o}$C. In Petri-dish tests with seed maintained under high or low light intensity or in darkness, the seed germinated virtually completely in all conditions (Grime & Jarvis, 1976). Germination of fresh seed was enhanced by exposure to red light but seeds lost any light requirement following burial (Froud-Williams *et al.*, 1984b). Seeds had a high level of germination at alternating or constant temperatures in darkness or under a 'safe' green light (Grime *et al.*, 1981). The seeds do not have a light requirement for germination and will germinate with the autumn rain (Cresswell & Grime, 1981).

Like many common grasses, onion couch seeds tend to germinate in the cool moist conditions of the autumn after shedding (Grime, 1981). Seeds germinate mainly in August or September (Salisbury, 1961). Seed sown outside at different depths in pots of soil, cultivated or not, emerged mostly in August-September with further seedlings emerging through to December (Chancellor, 19--). In a further experiment, seedlings emerged in winter when surface sown or sown at 25 mm without cultivation (Froud-Williams *et al.*, 1984a). When sown deeper and cultivated in February or June, seeds still emerged over the winter. The optimum depth of emergence was 5 to 40 mm, the maximum was 130 mm.

In the bulbous form the lowest stem internodes swell and form 'bulbs' 5-11 mm in diameter (Tanphiphat & Appleby, 1990). Each 'bulb' is a thickened internode of the vertical underground stem. The 'bulbs' are formed in order one on top of the other. Young 'bulbs' are small and white but become larger and turn brown as they mature. A shoot generally has 3-5 'bulbs'. 'Bulbs' usually form under the soil surface but if the crown is shallow the 'bulbs' may project above the surface and they then become green. Plants under long days form 'bulbs' faster than those under short days. Higher temperatures also hasten bulbing but only in short days. Each 'bulb' has a regenerative bud. The sprouting bud forms adventitious roots and a short rhizome which becomes an aerial shoot as it nears the soil surface. A crown develops where the rhizome becomes an aerial shoot. Shoot buds and roots are initiated from the

crown which usually forms within 15 cm of the soil surface. The length of the initial rhizome depends on the depth of the 'bulb' in soil. A shallow 'bulb' will have a short rhizome with the crown near the 'bulb'. A deep 'bulb' will have a long rhizome and the crown is formed near the soil surface. New 'bulbs' are formed above the crown. 'Bulbs' located near the soil surface are likely to produce the earliest shoots but there is prolonged emergence through the autumn period (Ayres, 1981). Aerial shoots develop from March onwards (Grime *et al.*, 1988). Leaves continue to form until December (Pfitzenmeyer, 1962).

In the USA, aerial shoots emerge in early autumn. Between October and February plants produce new secondary shoots (Tanphiphat & Appleby, 1990). Moderate frosts do not harm the shoots. Stem elongation begins in March and peaks in July. 'Bulbs' begin to form in November. By April each shoot has one or more 'bulbs' that form rapidly between February and June and by the end of June shoots have 4-5 'bulbs'. 'Bulb' dry weight increases from March to May. In July the plants senesce. The new 'bulbs' are able to sprout 2-4 weeks after maturing.

Elevated levels of $CO_2$ increased plant biomass in the presence of high nitrogen levels, increasing the mass of the leaves and flowers in particular (Arp *et al.*, 1998). High nitrogen and $CO_2$ levels increased the efficiency of water use allowing plants to conserve water better.

**Persistence and Spread**

Seed viability in soil is thought to be relatively short, seeds may be attacked by fungus (Tanphiphat & Appleby, 1990). Onion couch does not form a persistent seedbank (Grime *et al.*, 1988). Thompson *et al.* (1993) suggest that based on seed characters, onion couch seed is likely to persist for less than 5 years. Seeds stored under cool dry conditions retain viability for a few years (Pfitzenmeyer, 1962). Seed sown in a 75 mm layer of soil in cylinders sunk in the field and stirred periodically, emerged mainly in the year of sowing (34.5%) with less than 1% of seedlings emerging in years 2 and 3 (Roberts, 1986).

Onion couch plants in grassland tend to be very persistent but are not particularly competitive or invasive and remain very local (Cussans *et al.*, 1993). The swollen 'bulb'-like internodes make effective propagules in arable land (Stace, 1997). The 'bulbs' are easily detached and spread by tillage and each possesses a bud that can develop into a new plant (Long, 1938; Cussans *et al.*, 1993). The 'bulbs' are capable of withstanding drought. Buried 'bulbs' remain viable for 2 years (Tanphiphat & Appleby, 1990). 'Bulbs' that have sprouted once are unable to sprout again. Onion couch can perennate vegetatively by forming new tillers, and short rhizomes may be formed occasionally (Pfitzenmeyer, 1962). Proliferated spikelets have been reported.

The abundant seeds are spread by the wind (Long, 1938). Cultivations spread the bulbs throughout the soil profile.

**Management**

The 'bulbs' are very resistant to drought and can survive long periods of exposure and desiccation at the soil surface (Salisbury, 1961). The resistance to drying out means that onion couch is less affected by rotary cultivations than common couch (*Elytrigia repens*) (Cussans *et al.*, 1993). Traditional methods of control have been based on

deep autumn ploughing, fallowing or by sowing grass and maintaining a programme of grazing and mowing. Past suggestions for control have included hand picking of the bulbs and skimming off and burning the surface soil (Morse & Palmer, 1925). In arable crops, the non-bulbous form is kept under control by persistent hoeing, surface cultivations and dragging out the roots with harrows (Morse & Palmer, 1925).

The growth of onion couch from seed or bulbs in spring barley was studied under 4 basic cultivation regimes (Ayres, 1977). The regimes were early autumn cultivation plus chisel ploughing or plus mouldboard ploughing, no early cultivations just mouldboard ploughing and an uncultivated control. Mouldboard ploughing gave the greatest reduction in tiller and bulb number but was better without the early cultivations. The tine cultivations increased the number of tillers and bulbs but not as much as leaving the soil uncultivated. All the cultivation treatments prevented seedling establishment.

An increase in advisory requests concerning control of onion couch on heavy land in the north of England was associated with a switch from ploughing to minimum tillage (Attwood, 1981). Over a three-year period, a large reduction in onion couch numbers was observed due to a change from winter to spring cropping (Samuel, 1985). The land was winter ploughed.

Onion couch may be a dominant grass that produces a high level of biomass in productive pasture (Campbell & Grime, 1992). Flowering is unaffected by competition. In pot and field studies, onion couch was less competitive than tall oatgrass or wheat under moist conditions and when nutrient levels were low. But, under drier conditions onion couch was more competitive than tall oatgrass (Cussans *et al*., 1993). There was some evidence that the bulbous form was at a disadvantage in grassland especially when regularly defoliated. It regrows readily following the first defoliation but after subsequent defoliations it rapidly declines. It cannot endure grazing (Tansley, 1949). In rough grassland, onion couch succumbs readily to repeated cutting (Salisbury, 1961). Applications of lime eradicate some grasses but not onion couch (Williams, 1976). In roadside verges, increased cutting frequency reduced the incidence of tall oatgrass (Parr & Way, 1988). In pasture it was favoured by undergrazing (Kydd, 1964). Recovery after grazing and mowing is limited due to the small number of basal axillary buds available to regenerate new shoots (Pfitzenmeyer, 1962). While it is generally susceptible to grazing, semi-prostrate forms are known to occur that are more resilient to defoliation (Grime *et al.*, 1988).

Cultural control involves the use of short-term leys with associated mowing or grazing and deep ploughing to bury ‘bulbs’ to a depth from which they cannot emerge (Rees & Sherrott, 1991). Preventing seeding, and sowing only clean crop seed aids control (Long, 1938). Hedgerows should be kept free of the weed to prevent seeds being shed into the field or ‘bulbs’ being carried in by cultivation. A short rotation with extra root or hoed crops will help in combating the weed. Bare fallowing may be needed on heavy land. Smother crops can help to out-compete the weed. Isolated patches may be dug out and burnt. Once the weed is established, repeated ploughing, grubbing and harrowing must be practiced. As much of the weed as possible should be collected up by harrowing. Care should be taken not to break up the strings of ‘bulbs’. The weed should be burnt and the ashes spread on the land.

Onion couch is grazed by rabbits and populations increased when rabbits were decimated by myxomatosis in the 1950's (Thomas, 1963).

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