The biology and non-chemical control of Weed Beet (*Beta vulgaris* L.)

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Weed beet
Beta vulgaris L.

Occurrence

Beet was first grown for sugar around 75 years ago. Although normally a biennial, a proportion of beet plants flower prematurely in their first year (Longden, 1980). Weed beet was first noted as a problem in the early 1970's (Longden, 1993). Weed beet has increased as hand labour to remove bolters in the crop row has declined (Lea, 2000). It can originate from wild beet, from hybrids between wild and cultivated beet, and from bolters in open pollinated cultivars and their resulting seedlings. It was observed that the seeds shed by bolters could persist in the soil, germinating and emerging as volunteer weeds in subsequent crops. Roots left in the ground after harvest can also flower and set seed in following crops. The resulting seed may produce seedlings with the potential to become annual rather than biennial plants. Weed beet can therefore evolve from seed of any beet left to flower in the field such as contaminated sugar beet seed, seed shed by weed beet, seed shed by normal sugar beet bolters or seed shed by sugar beet groundkeepers (Gunn, 1982). Wild plants of the *Beta vulgaris* ssp. *vulgaris* occur sporadically with ssp. *maritima* (Clapham *et al.*, 1987). All variants appear to be inter-fertile and to cross freely. In the native annual beet the gene for annual bolting is dominant and the one for bolting resistance is recessive.

The first monogerm sugar beet cultivars that were introduced were more susceptible to bolting until this was bred out. Cool conditions during early growth contribute to bolting. Early sowing of the crop can expose seedlings to cooler conditions that promote bolting (Longden, 1974).

Weed beet occurs as a weed in sugar beet and a range of other crops (Hornsey & Arnold, 1979). It is also found on wasteland and on the verges of newly constructed roads. Weed beet was one of the main weed species present in conventional sugar beet crops surveyed in East Anglia in autumn 1998 (Lainsbury *et al.*, 1999). It was recorded in 13% of crops and was common in the field margins too. Weed beet is most obvious when growing in sugar beet but can occur in other crops. It commonly occurs in potatoes and in peas but the incidence in winter cereals is low. In a survey of 274 fields between 1976 and 1982, weed beet was more of a problem when sugar beet crops were grown in close rotation. In 1981, more than 25% of the English sugar beet crop was infested with weed beet (Longden, 1982). There is a strong correlation between sugar yield and weed beet density (Longden, 1989). One weed beet per m^2 can reduce yield by 9-15%. The hardened roots of bolted beet cause processing problems if harvested with the normal roots. In pot tests with weeds and sugar beet grown together, wild beet was found to be one of the most competitive weeds (Fayed *et al.*, 1997a).

The beet cyst eelworm (*Heterodera schachtii*) can be perpetuated by weed beet (Bray, 1976).

Biology

Bolting or premature flowering is partly inherent and partly under climatic control (Longden, 1993). Bolters become visible in late May and flower in July, the average date of flowering is 12th July (Longden, 1982). The sugar beet inflorescence develops as an indeterminate raceme and individual flowers open over a period of 3-4 weeks (Longden, 1980). The flowers of weed beet produce large amounts of wind blown pollen and are more self-fertile than normal sugar beet (Longden, 1976). Sugar beet is visited by pollen bearing insects that may also contribute to pollination (Free *et al.*, 1975). Some individual insects were found to carry over 5,000 pollen grains of which beet pollen made up the majority. There is the potential to carry pollen from wild beet on seashores and from weed beet onto sugar beet flowers. This can be a problem in beet being grown as a seed crop particularly in the production of hybrid seed where contamination must be avoided. Diploid wild beet tends to release pollen earlier in the day than modern triploid cultivars so stray pollen can lead to contamination of the seed line. This has happened with commercial seed crops in the past (Longden, 1980). The annual character is dominant (Longden, 1974). Genetic studies have shown that gene exchange between cultivated and wild beets is common and many weed beets appear to be derivatives of cultivated beet through accidental pollination (O'Hanlon, *et al.,* 2000).

The proportion of bolters decreases with increasing weed beet density, probably due to decreasing light intensity (Sester *et al.,* 2004). The same happens in competition with crop plants. The time taken to reach flowering increases with plant density but the number of flowers and hence seeds per plant decreases. Seeds start to become viable in mid-August, 28 days after flowering begins. The flower stalks of bolters cut or pulled out in early August and left in the field may produce on average 12 seeds per stalk. Weed beet begins to shed seed in September. Intact bolters left to grow to maturity produce an average of 1,000 to1,919 seeds per plant (Longden, 1980; 1982). Seed number per plant decreases with weed beet density but seed production per unit area increases to a maximum of over 50,000 seeds/m^2 (Sester *et al.,* 2004). There is no evidence of inherent dormancy in beet seed.

Residues of the decayed roots of weed beet reduce the germination and growth of sugar beet (Fayed *et al.,* 1997b). In Petri-dish tests, water extracts from plant residues of sugar beet inhibited the germination of clover, lettuce, radish and wheat seed (Carley & Watson, 1968). The root growth of any surviving seedlings was also considerably reduced.

Persistence and Spread

Weed beet seeds appear able to remain viable in soil for at least 7 years (Gunn, 1982; Longden, 1993). Burial to ploughing depth seems to prolong the life of the seed (Longden, 1974). It is said that seed can remain dormant in soil for at least 18 years.

In Duvel's burial experiment, sugar beet seed buried at 8, 22 and 42 inches gave 8, 35 and 9% germination respectively after 6 years and less than 1% after 21 years (Toole, 1946; Goss, 1924).

Management

Weed beet populations are likely to increase rapidly where beet are grown one year in three rather than one year in five. A serious infestation can build up over three cycles of sugar beet cropping. Longer rotations dramatically cut weed seed returns. It is difficult to distinguish weed beet seedlings from sugar beet seedlings unless they are out of line with the drilled crop row (Longden, 1974). Annual bolters tend to have seedlings with red petioles but so do a proportion of cultivated beet seedlings.

To avoid weed beet infestations, sugar beet should be grown on clean land, using bolting resistant cultivars sown after mid-March (Longden, 1980). Any bolters must be destroyed in July-August. To reduce infestations, fresh seed must be prevented from entering the soil seedbank (Hornsey & Arnold, 1979). An inter-row tractor hoe can be used to destroy bolters before flowering. Seeds shed by missed plants should be left on the soil surface to germinate, die or suffer predation (Longden, 1980). Shallow cultivation will enhance germination. Ploughing encourages the emergence of weed beet from deeply buried seeds.

The tall flower spikes allow height selective control by pulling and cutting (Longden, 1993). Good control is achieved by cutting down bolters 3 times at 2 week intervals, starting 14-28 days after flowering (Longden, 1980; 1982). Two cuts will give reasonable control (60-70%) but a single cut does not. Cutting 42 days after flowering is not satisfactory as viable seed has already formed. Early July appears to be the best time to cut down bolters and prevent seeding (Longden, 1974). Hand pulling is very effective but not practical (Longden, 1980). A season with few frosts after sugar beet drilling is likely to lessen crop bolting allowing the flower spikes of annual beet to stand out and be targeted for control (Gibson, 2004). Low infestations up to 1 weed beet per m^2 can be hand rogued or cut at ground level and removed before seed set. Where infestations exceed this density, machine topping is the best option. Starting at 20 cm above the crop, cuts should be made progressively lower until the final cut is just above the crop canopy. A rotary cutter has been developed to remove the flower heads of bolted weed beet growing in sugar beet crops (Anon, 2000). A 12 m wide topper fitted with 36 hydraulically powered spinning blades is also available to cut bolters and other tall weeds in sugar beet.

Weed beet do not thrive in cereals or in less competitive crops such as peas that are harvested early enough to prevent weed beet flowering and developing seeds (Sester *et al.*, 2004). Inter-row tractor hoeing removes around 70% of weed beet seedlings but not those within the crop row.

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