The biology and non-chemical control of Thorn-apple (*Datura stramonium* L.)

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Thorn-apple

(jimsonweed, thornapple)
Datura stramonium L.
(*D. inermis, D. tatula)*

Occurrence

Thorn-apple is an introduced annual weed of cultivated fields, gardens and waste places with a large prickly fruit that gives the plant its name. It originates from America but is common in France (Bruneton, 1999). In the UK it is a casual weed introduced from several different sources including birdseed, wool and soybean waste (Stace, 1997; Hanson & Mason, 1985; Salisbury, 1961). It occurs sporadically throughout the UK particularly in hot summers. In a series of 4 national weed surveys made in Hungary between 1950 and 1997, thorn-apple moved from 177th to 8th place in the rankings (Tóth *et al.*, 1999; 1997).

The large trumpet-like flowers are usually white but var. *chalybaea* has purple flowers (Stace, 1997).

The plant is poisonous to humans, horses, cattle, sheep, pigs, mules and chickens (Weaver & Warwick, 1984; Forsyth, 1968). Livestock normally avoid it but may be poisoned by contaminated hay, silage or seed screenings. Toxicity varies with growing conditions. There have been many incidents of accidental and deliberate ingestion of seeds by humans (Bruneton, 1999). Thorn-apple has restricted medicinal uses (Barker, 2001). Its hallucinogenic properties have been known since the beginning of recorded history (Mitich, 1989). In Japan, it has been found that an extract of thorn-apple can halt the growth of certain types of brain tumour (Anon, 2003).

Biology

Thorn-apple flowers from July to October (Clapham *et al.*, 1987). Seeds mature 30 days after pollination and the capsule opens 20 days later (Weaver & Warwick, 1984). There may be 50 or more capsules per plant, 600-700 seeds per capsule and around 30,000 seeds per plant. On poor soil, however, there may be 1,300-1,500 seeds per plant. The average seed number per plant in ruderal situations is given as 14,964 (Pawlowski *et al.*, 1967). Flower and seed production are related to plant dry weight. Flowering can continue until the first frosts. The seeds will ripen within the capsules on cut down plants unless damaged by frost. Seeds from a partly green capsule that turn black on drying are fully viable (Gill, 1938).

Immature seeds are said to germinate more readily than fully mature seed. Dead ripe seed may germinate immediately after shedding but the majority soon become dormant (Gill, 1938). The low seed germination rates are put down to many factors including an impermeable seedcoat (Weaver & Warwick, 1984). The seed coat plays a major role in regulating germination due to its restricted permeability (Reisman-Berman *et al.*, 1989). A short soak or rinse in water causes the tissue within the hilum

to swell, restricting oxygen uptake and inhibiting subsequent germination. The effect is similar to that of blocking the aperture with lanolin. Cracking or chipping the seed coat allows germination to take place.

Seed mixed into the surface 25 mm of soil in boxes out of doors and stirred periodically emerged from May to August (Chancellor, 1979). The peak of emergence was in May. Seed burial increases the light requirement for germination (Benvenuti & Macchia, 1998). Light sensitivity and the effect of gaseous diffusion in soil around the seed allow it to perceive the proximity of the soil surface. Cultivation triggers seedling emergence by the removal of volatile dormancy-inducing metabolites and exposing seeds to light. Reburial of seed before germination occurs re-imposes dormancy.

Seedlings establish and grow rapidly to shade out surrounding vegetation (Weber, 2003). When thorn-apple itself is growing in the shade of other vegetation, plant biomass is reduced and there may be a 65% reduction in reproductive organs (Benevenuti *et al.,* 1994). Seed production declines by around 60% due to fewer fruits per plant rather than fewer seeds per fruit. Thorn-apple initiates flowering after the 6-8 leaf stage in or around July (Weaver, 1985). It has an indeterminate growth habit and produces a flower in the fork of each branch in the stem.

Thorn-apple is a C_3 plant in terms of carbon fixation during photosynthesis (Baskin & Baskin, 1978). Aqueous extracts of the seeds and the leaves depressed the germination and root development of linseed seeds (*Linum usitatissimum*) (Lovett *et al.,* 1981). The chemicals responsible are the tropane alkaloids, scopolamine and hyoscyamine.

Persistence and Spread

In Duvel's seed burial experiment, 91% of seeds germinated 39 years after burial at 34 cm deep (Weaver & Warwick, 1984). At 8 cm depth, viability remained high after 30 years but then appeared to decrease (Toole, 1946). Seed buried at 2.5 cm decayed faster than seed buried at 10.2 cm but viable seeds were still present at both depths after 3 years (Stoller & Wax, 1974). Thorn-apple seed survived for 9 years in cultivated soil and longer in uncultivated soil (Chancellor, 1982). In Beale's seed burial experiment there was 78% germination after 20 years in soil compared with a complete loss of viability after 15 years in dry storage (Crocker, 1938). Dry-stored seed gave 43% germination after 5 years (Comes *et al.,* 1978).

Mature seeds are dispersed 1-3 m from the parent plant by dehiscence of the seed capsule which can be stimulated by disturbance of the plant foliage. The capsule and seeds are buoyant in water and can remain floating for 10 or more days (Weaver & Warwick, 1984). Seed submerged in water gave 21% germination after 6 months, 2% after 2 years and zero after 5 years (Comes *et al.,* 1978). Seeds may also be dispersed on farm machinery or as an impurity in crop seed, birdseed and in wool and soybean waste.

In Canada, the progressive spread northwards of thorn-apple is related to the increased area devoted to maize and soybeans (Weaver, 1985). Weed control in these crops favours the relatively large-seeded thorn-apple but seed production is related to the length of the growing season and time of the first frosts. Early frost may eliminate

seed production and limit the northern spread of the weed but natural selection is encouraging the development of populations adapted to a shorter growing season.

Management

Small patches should be hand pulled before seed is set (Weber, 2003). Seedlings are readily killed by tillage (Weaver & Warwick, 1984). Mature plants may regenerate from cut down stumps.

Field applications of ammonium nitrate did not increase seedling emergence (Fawcett & Slife, 1978).

In the USA, the beetle *Lema trivittata* causes severe defoliation of thorn-apple and reduces seed production. The fungus *Alternaria crassa* has been tested as a potential biocontrol agent for thorn-apple (Fischl *et al.*, 1999). In field studies in the USA, both conidial and mycelial formulations have given around 90% control of thorn-apple seedlings at the 2- to 4-leaf growth stage (Boyette *et al.*, 1991).

Thorn-apple seed is moderately susceptible to soil solarization. Heating seeds in a loamy soil for 30 minutes at 80^{o}C significantly reduced seedling emergence (Rubin & Benjamin, 1984).

A model has been constructed that examines the population growth of thorn-apple in relation to seed production (Weaver, 1985). It takes into account seed survival, rates of seedling emergence and mortality, weed control efficacy and seed return. The model suggests that without adequate weed control thorn-apple will build up to a high level within 5-6 years of introduction.

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