The biology and non-chemical control of Black Nightshade (*Solanum nigrum* L.)

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Black nightshade

(duscle, garden nightshade, hound's-berry, mixplenton, morel, petty morel)
***Solanum nigrum* L.**

Occurrence

Black nightshade is a native annual found throughout most of England, becoming rarer northwards and local in Wales (Clapham *et al*, 1987; Stace 1997). Black nightshade is a plentiful and troublesome weed of agricultural and horticultural fields, disturbed land, waste ground and gardens (Copson & Roberts, 1991). In urban situations it often occurs in shaded areas (Benvenuti, 2004). It occurs on a wide range of soils but prefers soil rich in nitrogen, of which it is considered an indicator (Hanf, 1970). It has been found in prehistoric deposits and is recorded up to 1,000 ft in the UK (Salisbury, 1961).

In seedbank studies in arable fields in France, black nightshade was well represented in the seedbank but was less frequent in the emerged vegetation (Barralis & Chadoeuf, 1987). In a survey of seeds in pasture soils in the Netherlands in 1966, while black nightshade was uncommon in the sward it was well represented in the soil seedbank (Van Altena & Minderhoud, 1972). In 1993, a survey of the most important weeds according to European weed scientists ranked black nightshade as an important weed in fruit crops, grapevines, potatoes, sugar beet, vegetables and sunflowers (Schroeder *et al.,* 1993). It was not considered important in winter and spring cereals and winter rape.

The species exhibits a high level of morphological plasticity and several sub-species have been identified (Weller & Phipps, 1978/79). Black nightshade has been introduced into North America where it can grow as a short-lived perennial in warmer regions (Ogg *et al.,* 1981). Some populations of black nightshade in forage maize crops in South Wales and South-west England have developed resistance to the triazine herbicide atrazine (Clay, 1989). Two introduced green nightshades also occur locally in some areas. *Solanum physalifolium* and *S. sarrachoides* have a similar growth habit to black nightshade but the berries remain green even when ripe. They cause similar problems in crops grown for processing. Natural hybrids between black nightshade and *S. sarrachoides* have been recorded in Britain (Leslie, 1978).

The plant and berries can form a sticky mass during harvesting operations. The berries contaminate processing crops, particularly vining peas. There is conflicting evidence about the toxicity of the berries (Bassett & Munro, 1985; Rogers & Ogg, 1981). Black nightshade has caused varying degrees of poisoning in humans, cattle, pigs, goats, ducks and chickens due to the glycoalkaloid, solanine (Weller & Phipps, 1978/79). The leaves and unripe fruits are richest in the alkaloid (Bruneton, 1999). The consumption of black nightshade berries does not always cause ill effects and they are eaten as a food in various countries (Rogers & Ogg, 1981). In some communities the shoot tips are also eaten. It is possible that under certain conditions the plant develops toxic levels of alkaloid (Forsyth, 1968). The berries are thought to

become less toxic as they ripen (Fawcett & Jennings, 1979). The alkaloid has been shown to gradually disappear during maturation (Bruneton, 1999). In France, black nightshade is reported as a frequent contaminant in ensiled corn but hydrolysis during ensilage is thought to lessen the solanine concentration. The plants also contain a high level (2.5%) of nitrate which may cause nitrate toxicity in livestock. It has been used medicinally in the past as a sedative (Barker, 2001).

Black nightshade can carry the pathogen *Verticillium albo-strum* that infects hops (Thurston, 1970). It also carries blackleg disease that infects potato (Zimdahl, 1993). Black nightshade is the host of several types of aphid that affect important crops and can carry several virus diseases (Heathcote, 1970). Transmission of tobacco mosaic virus (TMV) by seeds from infected black nightshade plants was 0.3% (Horváth *et al.*, 2002).

Biology

Black nightshade flowers from July to September (Clapham *et al*, 1987; Stace 1997). The time from emergence to flowering was 60 days in May and 50 days in July. Individual plants produce up to 400 berries each containing about 40 seeds (Clapham *et al*, 1987; Stace 1997). In the USA, seed numbers per berry ranged from 43 to 75 with an average of 60 (Keeley & Thullen, 1983). While an average plant produces around 9,000 seeds, a large plant may have 153,000 seeds (Salisbury, 1962). Stevens (1957) quotes seed numbers per plant of between 8,000 and 40,000 from several authors, while Guyot *et al.* (1962) give the seed number per plant as 40,000 to 50,000. Hanf (1970), however, suggests there are just 500 seeds per plant. The average seed number per plant in ruderal situations is given as 53,524 (Pawlowski *et al.*, 1967).

Seeds from green berries tested 22 days after flower opening did not germinate but seed tested at 27 days gave 100% germination (Roberts & Lockett, 1978). Seed collected from plants at different periods after flowering was stored for 7 months and germination was then tested (Chakravarti & Pershad, 1953). Seed collected 15, 25, 35 and 45 days after flowering gave 20, 24, 84 and 94% germination respectively,

In the laboratory, stored seed did not germinate under constant temperatures with or without light (Wagenvoort & Van Opstal, 1979; Roberts & Lockett, 1978). Under alternating temperatures there was 80% germination. There was some indication that stratification for 2 days at 5^{o}C increased the level of germination. The seed may suffer reduced viability at very low temperatures. In Israel, seeds showed no dormancy after harvest (Givelberg *et al.*, 1984). Seed germinated at a constant temperature of 20 to 35^{o}C in the light but not in the dark.

Black nightshade grows rapidly after germination in spring and continues to emerge throughout the summer (Long, 1938). In studies with seeds sown in the field, seedling emergence began in early May, reached a peak in late-May or June, declined in July-August and ceased in September (Roberts & Lockett, 1978; Roberts 1986). No seeds germinated in the autumn after sowing and a reducing number of seedlings emerged each successive year of the 5-year study. Black nightshade seedlings are susceptible to frost and late-germinating seedlings are unlikely to reach maturity. In the USA, black nightshade begins to emerge from late May to early April and emergence increases to late May (Ogg & Dawson, 1984). Emergence continues at a lower level through the growing season. The seedlings began to emerge when the soil

temperature at 50 mm depth reached 17°C (Keeley & Thullen, 1983). Few seedlings emerge from seed sown deeper than 25 mm in soil.

Persistence and Spread

Seeds that are buried by ploughing can remain dormant for 39 years (Weller & Phipps, 1978/79). Seed recovered from excavations and dated at 20, 50 and 80 years was found to germinate (Ødum, 1974). Seed retained 90% viability after 5 years in soil but this reduced progressively over the following 3 years down to 2% (Bassett & Munro, 1985). In Duvel's burial experiment, seed buried at 20, 55 and 105 cm gave 3, 81 and 90% germination after 10 years, 82, 42 and 63% after 30 years and (-), 83 and 79% after 39 years (Toole, 1946; Goss, 1924). The annual percent decline of seeds in cultivated soil was 37% (Popay et al., 1994). An average of 11% of seeds remained dormant and viable after 5 years in cultivated soil (Roberts, 1986).

Berries are readily eaten by birds and seeds present in their droppings are viable (Roberts & Lockett, 1978). Seeds can be spread in cattle droppings and retain high viability (Bassett & Munro, 1985). Black nightshade seeds that had passed through a cow gave 52% germination (Horne, 1953). The seeds are also dispersed by small mammals (Weber, 2003). In a survey of seed contamination in 1960-61, black nightshade seed was found in 10% of carrot, 5% of lettuce and 2% of sugar beet samples tested (Gooch, 1963).

Work in Denmark has shown that the seeds can survive in silage made from sugar beet tops (Weller & Phipps, 1978/79). To determine the survival in slurry that is dried and pelleted to aid transport, black nightshade seeds were imbibed in pig manure for 24 hrs then heated in an oven at different temperatures for different periods (Bloemhard *et al*., 1992). Seeds survived heating at 50°C for up to 15 minutes but were killed by 3 minutes at 75 or 100°C.

Management

Black nightshade was considered to be mainly a garden weed and one that could be exterminated by constant hoeing (Morse & Palmer, 1925). Control is by surface cultivations in spring and the growing of root crops (Long, 1938). Seeding should be prevented by mowing and tillage (Bassett & Munro, 1985). Seedlings and small plants can be hand pulled (Weber, 2003).

In south-east France black nightshade has increased through the use of selective herbicides in direct-seeded tomatoes (Maillet & Abdel-Fatah, 1983). Even a low population of the weed can cause a drastic reduction in crop yield.

Black nightshade is not eaten by rabbits (Tansley, 1949).

Infection of black nightshade with tobacco mosaic virus (TMV) reduces seed viability (Horváth *et al.,* 2002).

In greenhouse tests, corn gluten meal (CGM) applied as a surface and incorporated treatment to soil sown with black nightshade seed has been shown to reduce plant development (Bingaman & Christians, 1995). Application rates of 324, 649 and 973 g per m^2 reduced nightshade survival by 82, 88 and 99% respectively. Shoot length was reduced by up to 100%.

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