

The biology and non-chemical control of Japanese knotweed (*Fallopia japonica* (Houtt))

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Japanese knotweed

***Fallopia japonica* (Houtt)**

Reynoutria japonica (Houtt); *Polygonum cuspidatum* Sieb. & Zucc.

Occurrence

Japanese knotweed is an invasive rhizomatous perennial introduced into the UK from Japan in 1825 as an ornamental garden plant and as cattle fodder (Clapham *et al.*, 1987; Salisbury, 1961). However, others suggest the actual date of introduction was 1841 (Beerling *et al.*, 1994). In its native habitat, Japanese knotweed is found on weathered volcanic lava, river gravels and managed pastures especially where high levels of nitrogen fertilizer have been applied. In Japan it often occurs near streams (Weber, 2003). It grows mainly on soils of pH 6.5 to 8.0 but may occur on more acid soils (Grime *et al.*, 1988).

Japanese knotweed was recorded as a garden escape in the late 19th century and as naturalised populations in the early 20th century. It was reported as becoming established in Shropshire in waste places and along roadsides in 1904 (Melvill, 1904). It was prevalent in South Wales at this time and has since become more widespread throughout the UK. In South Wales it is found in waste places and along riverbanks (Baker, 1988). Japanese knotweed became established alongside railways, canals, rivers and streams especially in the West of England, and is increasingly found along roadsides (Conolly, 1977). It now occurs on tips and in waste places (Stace, 1997). It is still most frequent in the south and west perhaps due to climatic factors.

In Japan, Japanese knotweed is regarded as an early-successional species that invades open habitats created by disturbance (Suzuki, 1994). Plants develop from seeds and spread by extension of the rhizomes that are formed by seedlings. Growth dynamics vary both with the genetics of the individual plants and with the mass of the clump as it spreads. In the UK, the spread is vegetative and it forms tall thickets that exclude other plants. The growing plant forms a dense leaf canopy and in the autumn the fallen leaves decompose slowly forming an impenetrable mulch that prevents anything else germinating (Kidd, 2000). Japanese knotweed is a serious pest when it occurs in nature reserves and SSSIs (Beerling *et al.*, 1994). It can even suppress bracken (Baker, 1988). Japanese knotweed is tolerant of soil acidity, heavy metal contamination and air pollution.

Japanese knotweed is found at altitudes of up to 3,800 m in Japan but in the UK it is generally restricted to relatively lowland habitats (Beerling *et al.*, 1994). This may be related to the greater wind damage that can occur at a higher altitude. In spring gales, the leaves can suffer severe wind damage as they unfurl. The foliage is also sensitive to late spring and early autumn frost. Evidence from the east of England and from the

Mediterranean region suggests that summer drought restricts the spread of the weed in warm conditions.

In the UK, both *F. japonica* var. *japonica* and the dwarf variant var. *compacta* are naturalized along with several hybrids (Beerling *et al.*, 1994). All of the plants of var. *japonica* found in the UK are functionally female and originate from the same clone (Kidd, 2000). The cross between *F. japonica* and the giant knotweed *F. sachalinensis*, (*F. x bohémica*), is the most commonly found hybrid (Child, 1996). In 1989 the hybrid was located at 20 sites in the UK. By 1995 126 locations had been identified.

In addition to being used as feed for stock, including goats, young shoots of Japanese knotweed have been used for human consumption. In September the flowers provide a valuable nectar source for beneficial insects and honey bees. There have been suggestions that Japanese knotweed could be grown as a renewable energy source planted on derelict land or land of low agricultural value (Callaghan *et al.*, 1984). The dried rhizomes are used in Chinese and Japanese medicine for treating a range of ailments (Beerling *et al.*, 1994).

Biology

Japanese knotweed flowers from August to October (Lousley & Kent, 1981). The compact variety may flower earlier in July and August. Japanese knotweed rarely sets seed being male sterile but some fruits were set in the October of the hot summer of 1996. It was not determined if the seeds were viable (Kidd, 2000). The flowers are insect pollinated (Grime *et al.*, 1988). Almost all seed that is set is hybrid, often from crosses with the Russian vine, *F. baldschuanica*, or the closely related giant knotweed as the pollen source. In countries where seed does develop, the seeds are dormant when shed. Dry storage for 5-12 months or stratification at 2 to 4°C for 8 weeks increases the germination of both normal and hybrid seed (Justice, 1941). There are no reports of any seedlings becoming established naturally in the UK. However, some seeds were reported to germinate in 1986 following a very cold winter in the UK. It may be that the thin walled seeds rot in the relatively mild winters in the UK. In addition, seedlings are susceptible to frost and are unlikely to survive in the wild.

The rhizomes form pinkish nodules in early spring from which shoots develop in April. The reddish shoots emerge in early spring and can reach 1.5 m tall by May and up to 3 m by June (NRA, 1994). The exact timing of emergence depends on soil temperature and other climatic factors. The stout rhizomes form a deep mat and can be more than 1 m deep and 15-20 m long (Weber, 2003). The roots can extend to a depth of 2 m. In autumn, when the shoots are killed by frost, food reserves are translocated down to the rhizomes. The dead aerial stems may persist for 12 months or more. The plants overwinter as dormant underground buds on the rhizome (Zimdahl, 1993).

Persistence and Spread

Well-established plants develop persistent woody stocks that increase in mass with age and continue to produce lateral creeping rhizomes (Beerling *et al.*, 1994). A significant proportion of the biomass of Japanese knotweed is below ground. Up to 35% of the dry weight of rhizomes consists of energy-storing compounds. The growing points overwinter as buds just below the soil surface.

In the UK, dispersal has been mainly through the dumping of plant material or cartage of soil containing plant fragments. Japanese knotweed can be transported long distances in soil. It usually forms large clumps wherever the roots are dumped (Lousley & Kent, 1981). Great care should be taken to prevent the spread of this weed as rhizome fragments and also as sections of stem material (Child *et al.*, 1993). Dispersal is facilitated by water (Baker, 1988). An example of its spread via seawater has been reported (Beerling *et al.*, 1994).

To determine the likely regeneration of plant stem material that had passed through a horticultural shredder, shoots of Japanese knotweed were collected in May, July and September (De Waal, 2001). The stem lengths were divided into upper, middle and lower sections and these different sections were cut into 40 mm segments to mimic the effect of a mechanical shredder. A proportion of the segments were also cut in half. The segments were spread over John Innes No 2 potting soil on the day of collection and watered regularly. Bud development occurred on node and split node segments one week after planting and shoot development began one week later. Internode segments developed adventitious roots but not buds, nor was there regeneration where the stem tissue had suffered desiccation. Desiccation occurred mainly in the shoot samples collected in May in which the stems had made only soft growth. The results demonstrate the enormous potential for regeneration if waste material from the clearance of Japanese knotweed is not disposed of properly by desiccation and burning, or by very deep burial. There are reports of regenerating shoots from buried plant material emerging through tarmac and concrete (Kidd, 2000).

Management

Sheep, donkeys, goats, cattle and horses will graze the young shoots and keep the weed in check (Soil Association, 2002). However, mature stems are not palatable and should be cut down to stimulate fresh young shoots. Japanese knotweed should be grazed from February to July (NRA, 1994). While the plant will be suppressed by grazing, it will not be eradicated.

Control by cutting alone is ineffective and may increase stem density and the lateral spread of clumps (Beerling *et al.*, 1994). Regrowth is very rapid. Pulling or digging out the weed has some effect if repeated regularly but all waste plant material must be burnt. Burning the plant in situ has not proved effective. Cutting or mowing every 4 weeks will reduce rhizome growth but will not eliminate the plant (Weber, 2003). Two cuts, the first in May-June, the second in late summer and repeated annually until no new shoots appear is said to work eventually. Mowing every 2 weeks effectively eliminated the weed in 2 years (Baker, 1988; Child *et al.*, 1993). Pulling by hand in July when plants were well grown took 3 years to eliminate just a small patch of the weed. In larger patches the weed had not been eliminated even after 10 years of annual pulling.

Root barrier fabrics made from reinforced polyethylene laminate have been successfully used to contain the spread of Japanese knotweed (Drury, 2003). The fabrics can be laid under new road surfaces and buildings to protect them from the emerging weed and avoid the need to transport contaminated soil off site.

Topsoil and other brought in soil should be checked for fragments of Japanese knotweed. If there is any doubt, the origin of the soil should be checked. Strict hygiene should be followed in dealing with living plant material of Japanese knotweed. All fragments should be destroyed by burning or by deep burial to at least 10 m deep. When control is limited to one problem area, re-infestation is likely from adjacent areas. It is necessary to deal with plants in those areas too and prevent the spread of plant fragments, especially near water or where loose soil is likely to become moved around. Geographical information services (GIS) can be used to monitor infested areas and co-ordinate control strategies. Information can be readily updated.

In future, biological control could become an option. Japanese knotweed would appear to be an appropriate candidate for biological control. This could be with insects or pathogens native to the UK or natural enemies introduced from Japan. However, few insects or plant diseases are known to attack the weed in Britain. An extensive programme of research would be needed to evaluate and develop biological control measures. A rust fungus from Japan, tentatively identified as *Puccinia polygonia-weyrichii* is a promising candidate biocontrol agent (Fowler *et al.*, 1991). A second rust species, *Puccinia polygonia-amphibia*, is recorded on Japanese knotweed in Japan and although it also occurs in the UK it has not been found on the weed here. More recently, a pathogenic leafspot, *Mycosphaerella* spp., has been found living on the weed in Japan (McEwan, 2007). A sap-sucking plant louse or psyllid, *Aphalara itadori*, has also given encouraging results and both are under assessment as biocontrol agents for Japanese knotweed.

Legislation

In the UK, it is an offence under Section 14, Schedule 9 of the Wildlife and Countryside Act 1981 to plant or cause Japanese knotweed to become established in the wild (Kidd, 2000; HMSO, 1994).

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