Rutaceae—Rue family

Phellodendron amurense Rupr.

Amur corktree

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Growth habit, occurrence, and use. Amur corktree—*Phellodendron amurense* Rupr.—is native to northern China, Manchuria, Korea, and Japan. This small to medium deciduous tree—25 to 50 feet tall—has been cultivated in the Far East and eastern Europe. It was introduced into the United States around 1865, and its thick, corky bark and massive, irregular branches have made it of special interest for landscape and environmental plantings in the northern and western United States (Blackburn 1952; Everett 1964; Hoag 1965; Lewis 1957). In tests in Kansas, however, the tree did not perform well and was not recommended for general use (Hensley and others 1991). It is a potential source of industrial cork (Izmodenov 1972; Ota and others 1965), important as a nectar-bearing species in bee-keeping areas of the Soviet Far East (Necaev and Pelemenev 1965), and of possible importance for the insecticidal properties of the fruit oils (Schechter 1943). In Byelorussia it is considered a soil builder when mixed with Scots pine—*Pinus sylvestris* L. (Letkovskij 1960). It tolerates a wide range of soil conditions, pH, drought, and pollution; it is easily transplanted and generally free of pests.

Flowering and fruiting. The species is dioecious, and female plants develop tend to have a bushier form than males (Hensley and others 1991). Small, yellowish green flowers, in large clusters of terminal panicles, appear in May and June (Krecetova 1960; Rehder 1940; Schechter 1943). Climate affects the time of day when flowers open, pollination, and the longevity of flowers (Starshova 1972).

Fruits are subglobose drupes about 1 cm in diameter (figure 1), green to yellowish green, turning black when ripe in September and October (Read 1974). They remain on the terminal panicles long after the leaves have dropped. Fruits are borne singly on short stalks (figure 1) and are very oily and aromatic. Each fruit usually contains 2 or 3 full-sized seeds and 3 or 4 aborted seeds (Read 1974). Seeds are brown to black, 5 mm long, 2 mm wide, and about 1 mm thick (figures 2 and 3); they have a moderately hard, stony coat (Gorokhova 1981; Read 1974).

Minimum seed-bearing age is 7 to 13 years, both within the natural range and where the species has been introduced (Atkimockin 1960; Gorokhova 1981; Maljcev 1950; Read 1974; Starshova 1972). No data are available on the frequency of seed crops. Severe drought had no marked effect on the morphology of fruits and seeds, but appeared to reduce seed quality (Gorokhova 1986).

Collection, extraction, and storage. The terminal panicles of fruit may be harvested with pruning shears in late September through October after leaf fall. After that, although many fruits remain tightly on the tree, some will have fallen. Fruits should be spread out in shallow layers to prevent heating and mildew during air drying. Fruits may be soaked in water and seeds

squeezed from the fleshy matter by hand; large lots can be run through a macerator and separated from the pulp by flotation. Fresh fruits weigh about 57 kg/hl (44 lb/bu) and yield about 0.9 kg (2 lb) of cleaned seeds (Read 1974). Based on seeds from 2 different lots, 1 kg contained 58,960 to 80,000 (26,800 to 36,363/lb) and 96,800 to 105,600 (44,000 to 48,000/lb) cleaned seeds (Read 1974; Swingle 1939). Seeds collected from plants growing in the natural range had similar seed weights (Gorokhova 1981).

Germination. Fresh seeds germinate well without pretreatment (Dirr 1990; Read 1974). However, there are a number of reports of greatly improved germination following stratification. Stratification is recommended for seeds stored any length of time (Dirr and Heuser 1987). Germination for a seedlot (for which the handling and storage history was not described) was best following cold moist, underground stratification for 166 days (Timm 1989). In another study, seeds stratified for 8 weeks had a higher germination rate and the same germination percentage as seeds stratified 4 weeks; germination of unstratified seeds was less than half that of stratified seeds (Mukai and Yokoyama 1985). Based on the information available, it is recommended that seeds be stratified if the history of collection, handling, and storage is not documented. Seeds of other *Phellodendron* spp. vary in their requirements for stratification (Dirr and Heuser 1987; Lin and others 1994).

Seeds germinate best at alternating temperatures. Both Lin and others (1979) and Mukai and Yokoyama (1985) reported germination of 3% or less at constant temperatures and 75 to 90% at alternating temperatures. The best temperature regimes were 35/5 EC and 35/15 EC (day length and high temperature for 8 hours).

Nursery practice and natural regeneration. In its natural range, natural regeneration sometimes occurs in dense groups. Although the corktree has been reported to sucker from its roots (Dirr and Heuser 1987), this dense regeneration is believed to be from seeds present in the forest floor (Soludukin 1977). Light fire or disturbances that result in drying and warming of the forest floor are believed to promote this development. There was no indication regarding the longevity of the seeds in the forest floor environment, however the endocarp is moderately hard and might facilitate longevity under these conditions (Soludukin 1977).

In the nursery, untreated seeds may be sown in the fall (Read 1974) or stratified through winter for spring seeding (Yerkes 1945). It is suggested that the best time for spring sowing is when the mean daily soil temperature has reached 8 to 10 EC (Antonyuk 1987). Trees may also be propagated vegetatively by root cuttings or shoot cuttings (Bailey 1947; Dirr and Heuser 1987).

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Figure 1—*Phellodendron amurense,* Amur corktree: fruit cluster, H 1.

Figure 2—*Phellodendron amurense,* Amur corktree: seed, H 4.

Figure 3—*Phellodendron amurense,* Amur corktree: longitudinal section through 2 planes of a seed, 8H.