C

Betulaceae—Birch family

Corylus L.

hazel

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Other common names. Filbert, hazelnut.

Growth habit, occurrence, and use. The hazels—*Corylus* L.—include about 15 species of large, deciduous shrubs (rarely small trees) that occur in the temperate parts of North America, Europe, and Asia. Some species are grown for their nuts or for ornament, and most species provide food for wildlife. In this country, 4 species have present or potential value for wildlife, shelterbelt, or environmental plantings (table 1). For many years, European hazel has been cultivated for the commercial production of its edible nutmeats, known as hazelnuts or filberts, mostly in Europe but to some extent in the United States, especially in the Willamette Valley of Oregon. Years of first cultivation for other species are as follows: American hazel (1798), beaked hazel (1745), and California hazel (1910).

Flowering and fruiting. Male and female flowers are borne separately on 1-year-old lateral twigs of the same plant. They are formed late in the summer and open the following spring before the leaves appear (table 2). The male flowers are borne in clusters of 2 to 5 pendulous catkins, consisting only of stamens. The female flower is budlike, each flower has a single ovary with 2 styles that are strikingly red at pollination (Hora 1981). By late summer or early fall, the fertilized female flowers develop into fruits. These are round or egg-shaped, brown or dark-tan, hard-shelled "nuts", each containing one embryo that is enclosed in a pericarp, or shell. These nuts are enclosed in an involucre (or husk) which consists of 2 more-or-less united hairy bracts (figures 1 and 2). The seeds are naturally dispersed by animals or birds. Large seedcrops are produced at irregular intervals, usually every 2 or 3 years (NBV 1946; Vines 1960).

Collection of fruits. Hazelnuts may be eaten by rodents, larger animals, or some birds even before they are fully mature. To reduce such losses, fruits should be picked as soon as the edges of the husks begin to turn brown, which may be as early as mid-August.

Extraction and storage of seeds. The fruits should be spread out in thin layers on wire-mesh screens to dry in a room with high humidity for about 1 month. A macerator can be used to separate the nut from the husk. The machine is operated without water, and the nuts and husks pour out of the spout (Horvath 1999). An aspirator or screen cleaning machine is then needed to separate the husk debris from the nut. Alternatively, a brush machine can be used to dehisce the nut in a square-wire cylinder and a vacuum to suck out the dust, with the seeds flowing out the opening in the door (Maloney 1999). Yields and number of seeds per weight vary even within the species (table 3).

Table 1—*Corylus*, hazel: nomenclature and occurrence

Scientific name & synonym(s)	Common name(s)	Occurrence
C. americana Walt.	**American hazel,** American filbert	Maine to Saskatchewan, S to Georgia; W to Missouri & Oklahoma
C. avellana L.	**European hazel,** European filbert, common filbert	Europe, to 1,824 m in central Alps
***C. cornuta* Marsh.** *C. rostrata* Ait.	**beaked hazel,** beaked filbert	Newfoundland to British Columbia, S to Georgia, Missouri, & E Colorado
***C. cornuta* var. *california* Marsh. (A.DC.) Sharp**	**California hazel,** California filbert	Coast ranges from Santa Cruz N to British Columbia

Source: Brinkman (1974).

Table 2—*Corylus*, hazel: phenology of flowering and fruiting

Species	Location	Flowering	Fruit ripening
C. americana	—	Mar–May	July–Sept
C. avellana	Europe	Feb–Apr	Sept–Oct
C. cornuta	Tennessee	Jan–Feb	Aug–Sept
var. *california*	California	Jan–Feb	Sept–Oct

Sources: Fernald (1950), Loiseau (1945), Munz and Keck (1959), NBV (1946), Rosendahl (1955), Sus (1925), Van Dersal (1938), Vines (1960), Wappes (1932), Zarger

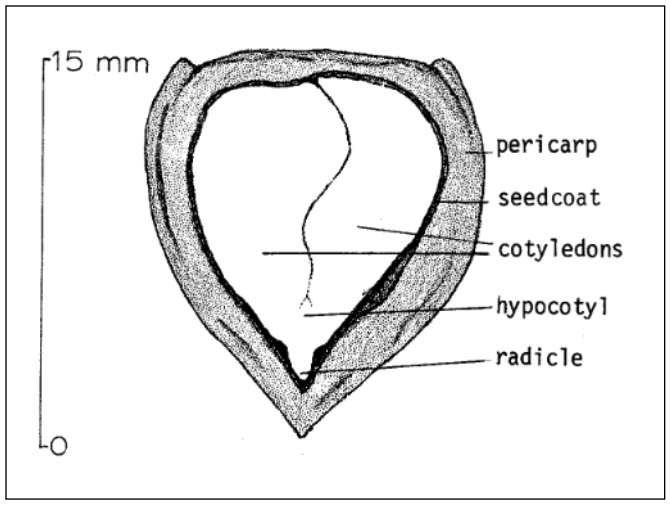
Table 3—*Corylus*, hazel: seed yield data

Species	Place of collection	Seed wt/fruit wt		Cleaned seeds/weight				Samples
				Range		Average		
		kg/45 kg	lb/100 lb	/kg	/lb	/kg	/lb	
C. americana	—	11–14	25–30	434–1,623	197–736	1,083	491	11
C. avellana	Europe	27	60	353–1,180	160–535	803	364	244
C. cornuta	—	—	—	937–1,490	425–676	549	249	3
var. *californica*	California	—	—	882–922	400–418	410	186	—

Sources: Brinkman (1974), Gorshenin (1941), NBV (1946), Rafn (1928), Swingle (1939), Vines (1960), Zarger (1968).

Figure 1—*Corylus cornuta* var. *californica*, California hazel: mature fruit including husk.

Figure 2—*Corylus cornuta* var. *californica*, California hazel: longitudinal section through a fruit.

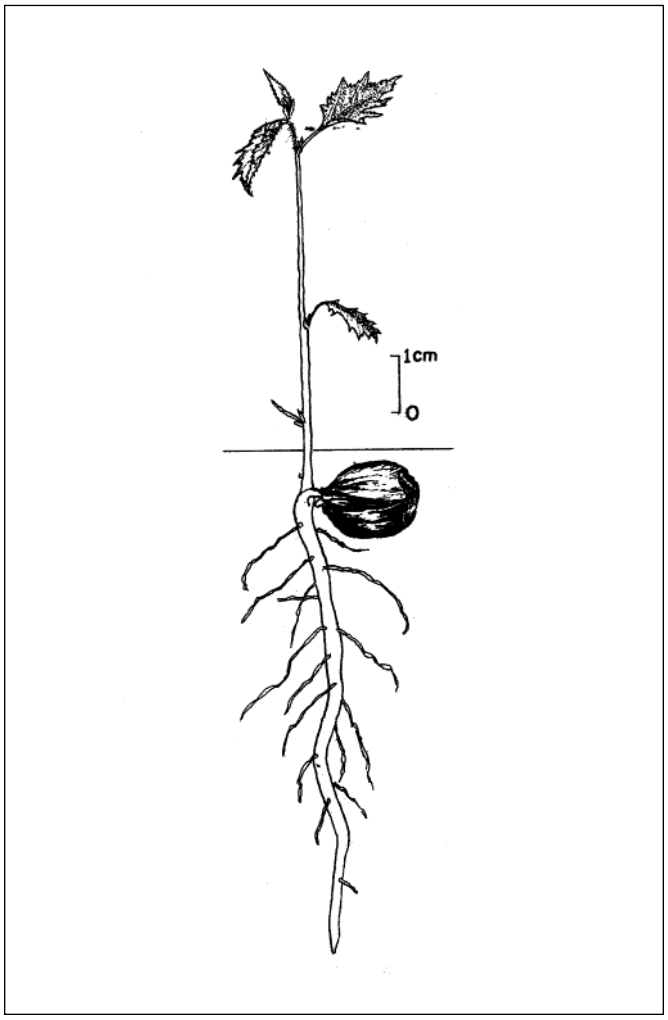


Because some dormancy is apparently induced by drying the nuts, seeds of hazel species were once thought to be recalcitrant and intolerant of any drying (Hong and Ellis 1996). Recommendations usually were to keep the hazelnuts moist after collection and store them moist over winter (stratification) before planting in the spring (Heit 1967; NBV 1946). Seeds of hazel species are now considered as orthodox in storage behavior, even though moist storage will prevent deep embryo dormancy for at least several months. Seeds of this genus will also remain viable for a year in unsealed containers at room temperature. Most of the viability of American hazelnut and some of beaked hazelnuts (Brinkman 1974) will be retained if seeds are stored in sealed containers at 5 °C. There are no long-term storage data for hazelnuts.

Pregermination treatments. Newly harvested hazelnuts are not dormant, but inhibitors present in the testa and pericarp are carried to the cotyledons and subsequently through the cotyledonary petioles into the embryonic axis (Bradbeer 1978; Jarvis 1975). Numerous studies have been

carried out on the nature of dormancy in European hazel, with most of them concerning the balance of gibberellins and inhibitors and starch synthesis (Arias and others 1976; Bradbeer and Pinnfield 1966; Jarvis 1975; Jarvis and Wilson 1978; Jeavons and Jarvis 1984; Li and Ross 1990). Stratification remains the method used to overcome dormancy, however. Hazel seeds require 2 to 6 months of prechilling before germination will occur (Heit 1968a&b). Three months of cold stratification has proven effective (Dirr and Heuser 1987). Stratification removes the block to gibberellin biosynthesis which begins when the seed is transferred to higher temperatures (Bradbeer and others 1978). In nurseries this can be accomplished by fall-sowing or by stratifying outdoors over winter before planting. Seeds may benefit from alternations of warm and cold stratification. Freshly harvested seeds of European hazel that were warm stratified for 3 weeks followed by 3 weeks at 4 °C germinated best (Dirr and Heuser 1987).

Figure 3—*Corylus cornuta* var. *californica*, California hazel: seedling development 30 days after germination.



Germination tests. Germination is hypogeal (figure 3). The seeds have a dormant embryo and germinate slowly without pretreatment. In one experiment, unstratified seeds of American hazel germinated throughout a year (Brinkman 1974). Giberillic acid (10^{-4} M) applied to European hazel seeds increased the germination from 64% for the control to 86% at 20 °C (Arias and others 1976). Seedlots of this species soaked in ethanol and then 0.1% (w/v) mercuric chloride, when put in a lighted chamber germinated 70% compared to seedlots germinated in total darkness, which germinated at only 9% (Jeavons and Jarvis 1996). Results of limited tests are listed in table 4.

Viability testing by staining the seeds with tetrazolium chloride (TZ) is the preferred method of ascertaining the seed's quality (ISTA 1993). Seeds should be cracked and soaked in water for 18 hours. After 1 to 2 mm of the cotyledons is cut off at the distal ends and the seeds are split longitudinally, the embryos should be incubated for 12 to 15 hours in 1% TZ, or 18 to 24 hours in a 0.5% solution. Some unstained tissue is allowed in viable seeds, but interpretation is difficult. Standard germination tests can also be performed once the pericarp is removed and the seeds are prechilled for 2 months at 3 to 5 °C (ISTA 1993).

Nursery practice. Although spring-sowing of stratified seeds is feasible, most nurseries plant hazel seeds in the fall (Sus 1925). In Holland, seeds of European hazel are mixed with moist sand for several months before sowing in the fall (NBV 1946). In Tennessee, good results with this species were obtained by storing fresh seed dry at 3 °C until planting in October; average tree percent was 98 based on 80% viability (Zarger 1968). Two seedlots of American hazel planted in November and December gave tree percents of 63 and 48, based on 70 and 60% viability. Seeds of both species were sown 2.5 cm (1 in) deep in drills and covered with 2.5 to 3.75 cm (1 to 1.5 in) of sawdust. In this report, the seedbeds had been fumigated with methyl bromide; other fumigants are now recommended. If seedling densities are kept low, from 43 to 65/m^2 (4 to 6/ft^2), hazel can be outplanted when 1 year old. European hazel and horticultural varieties are frequently propagated by cuttings, grafting, and tissue culture (Dirr and Heuser 1987).

Hazels are attacked by several fungi. The powdery mildew of hardwoods—*Phyllactinia guttata* (Wallr.:Fr.) Lév. (synonym *Phyllactinia corylea* (Pers.) P. Karst.)—will defoliate the plant. More serious attacks by the fungal parasite *Nematospora coryli* Peglion cause malformation of the nuts (Hora 1981). Hazelnuts are also attacked by the brown rot of pome and stone fruits—*Monilinia fructigena* Honey in Whetzel (synonym *Sclerotinia fructigena* Aderhold. ex Sacc.)—which enters through punctures caused by *Balaninus nuceum*, the nut weevil (Hora 1981).

Table 4—*Corylus,* hazel: germination test conditions and results

Species	Germination test conditions: Medium	Temp (°): Day	Temp (°): Night	Days	Germinative energy: Amt (%)	Germinative energy: Days	Germinative capacity: Average (%)	Germinative capacity: Purity: Samples	Germinative capacity: Purity (%)
C. americana	Sand	30	20	60	10	30	13	2	96
C. avellana	Sand or germinator	30	20	60	—	—	69	13	95
C. cornuta	Sand	30	20	60	1	26	1	1	99
var. *californica*	Sand	30	20	90	—	—	20	1	62

Sources: Brinkman (1974), NBV (1946), Rafn (1928), Shumilina (1949).

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