Anacardiaceae–Cashew family

Rhus L.

sumac

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Growth habit, occurrence, and use. The genus sumac—*Rhus* L.—consists of about 150 species of deciduous or evergreen shrubs, trees, and vines indigenous to temperate and subtropical regions of both hemispheres (LHBH 1976; Rehder 1990; RHS 1994). They occur frequently as pioneer species on disturbed sites and abandoned fields and along woodland borders. However, they are intolerant of shade and cannot compete with invading trees (Gill and Healy 1974). Sumacs are tolerant of poor, sandy, or rocky soils, and of soil moisture regimes ranging from dry to wet. For example, smooth sumac is adaptable to sites ranging from nearly bare rock to sand to heavy clay, and tolerates soil pH from acidic to slightly alkaline (Johnson and others 1966). Species native to North America are listed in table 1.

Three species of the genus *Toxicodendron*—poison-oak, *Toxicodendron diversilobum* (Torr. & Gray) Greene; poison-ivy, *T. radicans* (L.) Kuntze; and poison-sumac, *T. vernix* (L.) Kuntze—also are included because they are referred to frequently as *R. diversiloba* Torr. & Gray, *R. radicans* L., and *R. vernix* L., respectively. Laurel-sumac—*Malosma laurina* (Nutt.) Nutt. ex Abrams), until recently known as *Rhus laurina* Nutt.—is also included for the same reason.

Members of the sumac genus are shrubs, vines, or trees with alternate, simple, or featherlike (pinnate) compound leaves. Winter buds are minute, naked (without scales), and covered with dense hairs. Sumacs are fast growing and usually short-lived plants. Roots of sumac can spread more than 16 m in each direction, forming an extensive root network near the surface (Duncan 1935).

Sumacs are valuable for erosion control because of proliferation of rhizomes that results in an extensive root system. The species is ideally suited for roadside plantings, revegetation of areas of eroded or depleted soils, range reclamation and mine spoils restoration, and other conservation plantings (Brinkman 1974; Humphrey 1983). Some are grown as ornamentals for their pinnate foliage; persistent terminal showy fruits; and brilliant red, orange, or yellow fall color. This is especially true of the cutleaf staghorm sumac (*R. hirta* 'Laciniata' L. Sudworth), with its deeply cut, bright green leaves in summer; brilliant orange-red fall color; and twisted, exotic forms in winter (Cross 1988). Sumacs are recommended as ornamental shrubs for dry and open sites, but cultivation is easy in any garden soil.

Species of sumac also provide wildlife with habitat and an important source of food. Their thicket-forming growth provides excellent cover for birds and animals. The fruits, produced in large quantities each year, are eaten by over 30 species of birds, as well as rodents and other mammals. The twigs and leaves are browsed by deer (*Odocoileus* spp.), moose (*Alces americana*), and mountain sheep (*Ovis* spp.) (Elias 1989; Strauss 1988). The wood is soft, weak, and of no commercial value (Elias 1989). However, skunkbush sumac was once used by Native Americans for food, as a tobacco substitute, and for making baskets. In addition, some species can be processed to yield tannin and lacquer (LHBH 1976).

Geographic races and hybrids. There is some disagreement among taxonomists as to the classification of genera (*Rhus* vs. *Toxicodendron*) and particular species. For example, prairie sumac is often considered to be a variety or race of shining sumac (Elias 1989). In addition, natural hybridization occurs in the wild (Johnson and others 1966).

Flowering and fruiting. Plants are dioecious (flowers imperfect, one sex) or polygamous (flowers imperfect and perfect, both sexes). Flowers are small and rather inconspicuous and are borne in terminal or axillary clusters in the spring (table 2). They are pollinated by bees. Fruits are small, h00000.
airy, berry-like drupes, rounded to egg-shaped, containing a single nutlet or seed without endosperm (figures 1–3) (Brinkman 1974; Elias 1989). In most species, fruits form a dense cluster and ripen in the fall and may persist on the plant through winter. Seeds are spread primarily by birds and small mammals (Brinkman 1974). Sumacs generally produce copious

quantities of seeds with some seeds produced nearly every year.

Collection of fruits, seed extraction, and cleaning. Fruit clusters, which may be picked by hand as soon as they are ripe, are often available until late in the year. If collected early, fruits of smooth sumac and staghorn sumac, which occur in very dense clusters, may need additional drying and should be spread out in shallow layers for drying. However, fruits usually will be dry enough to process if they are collected in late fall or early winter (Brinkman 1974). Hybrid clumps often are found where smooth sumac and staghorn sumac occur near each other (Johnson and others 1966). These hybrid clumps may have seed-stalk heads that appear normal, but most seeds therein are generally empty, with the few full seeds usually infertile. Care must be taken to avoid such hybrid clumps. Even seeds of nonhybrid clumps should be checked carefully before collection to make certain that an excessive amount of empty seeds are not present. An estimate of the amount of empty seeds can be determined by crushing a small sample with a pair of pliers (Johnson and others 1966).

Dried fruit clusters can be separated into individual fruits by rubbing or beating the clusters in canvas sacks, followed by screening to remove debris (Brinkman 1974). Seeds can then be cleaned by running them through a macerator with water to remove remaining pieces of seedcoats and empty seeds. Such thorough cleaning is seldom practiced except for skunkbush sumac; seeds of other species are sown with pieces of the fruit wall still attached (Brinkman 1974). Trials have shown that about 99% of the empty seeds of smooth sumac can be removed by flotation, as empty seeds float and filled ones sink (Johnson and others 1966). However, the flotation method of separating empty seeds is not always successful with seeds of staghorn sumac (Brinkman 1974). Number of seeds per unit weight and seed yields vary among species (table 3).

Storage. Seeds of sumac are orthodox in storage behavior and can be stored over winter and possibly for years without special treatment (Dirr and Heuser 1987). Seeds of smooth sumac stored at room temperature for 10 years still exhibited over 60% germination, suggesting that controlled storage conditions are not required. Seeds of shining sumac have even survived 5 years of burial in the soil in Louisiana (Haywood 1994). However, Farmer and others (1982) recommend storing dried seeds of smooth sumac and shining sumac in sealed glass containers at 3 EC. Seeds of other species should be stored under a temperature range from 0 to 5 EC.

Pregermination treatments. Seeds of sumac need to be scarified in concentrated sulfuric acid for 1 to 6 hours, depending upon the species—then either fall-planted out-of-doors or stratified for approximately 2 months at about 4 EC before planting (Hartmann and others 1997). Fanner and others (1982) reported that without scarification, <5% of seeds of smooth sumac germinated, but 3 to 4 hours of scarification in concentrated sulfuric acid promoted an average of 58% germination. Even after 20 years, without scarification, 3% of the seeds receiving no acid treatment germinated. However, there was a gradual increase in the number of decayed seeds with increasing durations of scarification (Farmer and others 1982).

In other species such as fragrant sumac and skunkbush sumac, seed dormancy is caused by both a hard seedcoat and a dormant embryo, thus requiring both scarification and stratification for optimum germination (Heit 1967). These 2 treatments must be performed in proper sequence for spring-sown seeds, but the moist prechilling treatment is not necessary for fall-sown seeds. Scarification with sulfuric acid for about 1 hour followed by cold stratification at 1 to 4 EC for 1 to 3 months is recommended for seeds of fragrant sumac. Skunkbush sumac requires 1.5 to 2 hours of scarification and 1 month or slightly longer of moist prechilling for maximum germination (Heit 1967; Weber and others 1982). Seeds of evergreen sumac need to be acid-scarified with concentrated sulfuric acid for 50 minutes and then cold-stratified for 73 days (Hubbard 1986; Tipton, 1992).

High temperatures also are effective in removing seedcoat dormancy, a phenomenon that occurs naturally during wildfires. Germination of prairie sumac increases after seeds are exposed to fire (Rasmussen and Wright 1988). High temperatures scarified seeds of prairie sumac when temperatures reached 76 EC in wet environments or 82 EC in dry environments. Heat ruptures the seedcoats and waxy cuticle, enabling seeds to imbibe water. Heat generated on or near the soil surface by fire (82 EC) is sufficient to scarify seeds (Rasmussen and Wright 1988). In seeds of nutgall tree, or Chinese gall, or nutgall tree—*R. chinensis* Mill., a species native to China that is often referred to incorrectly as *R. javanica* L.—a temperature of 55 " 7.4 EC was successful in overcoming the impermeable seedcoat (Washitani 1988). With increasing temperature, shorter exposures became sufficient to render seeds permeable, but temperatures > 75 EC damaged seeds and resulted in lower germination. The most favorable regimes among those tested were temperatures of 65 to 75 EC for durations of 30 to 120 minutes, which frequently occur on denuded ground during the midday hours of clear spring and summer days (Washitani 1988).

Other scarification treatments include hot water and mechanical scarification. A 2-minute submersion in boiling water was the most effective of timed heat treatments for seeds of smooth sumac (Johnson and others 1966). Germination of seeds of prairie sumac scarified with sulfuric acid was greatest when they were soaked for 60 minutes but was less than that of seeds that were mechanically scarified or treated with wet heat at 94 or 97 EC (Rasmussen and Wright 1988).

The degree of seedcoat hardness and embryo dormancy varies within and among seedlots for most species (Hartmann and others 1997; Krugman and others 1974). Seed sources also must be considered when determining scarification and stratification pretreatments. This is true for sumacs, as individual seedlots and seed sources vary in their acid treatment requirements to remove seedcoat dormancy (Heit 1967). Test averages alone are not a good representation of germination potential because of wide family differences and a significant family by treatment interaction (Farmer and others 1982). For example, germination of individual clonal seedlots of smooth sumac ranged from 25 to 75% (Farmer and others 1982). Family differences in germination are apparently based on variable susceptibility of individual seeds to scarification (Farmer and others 1982). The duration of scarification and stratification should to be determined for each seedlot.

Germination tests. Light and temperature influence germination, which is epigeal (figure 4). When seeds were subjected to total darkness, the percentage germination of seedlots of smooth sumac (Brinkman 1974) and prairie sumac (Rasmussen and Wright 1988) were reduced. Heit (1967) also stressed the importance of germination in the presence of light. Likewise, temperature also is important. Evergreen sumac germinated at temperatures ranging from 21 to 30 EC (Tipton 1992), similar to that reported for other sumacs (Brinkman 1974). Final percentage germination declined with increasing temperature from a predicted maximum of 52% at 21 EC, whereas maximum germination rate increased with temperature to a predicted maximum of 69% germination at 31 EC. These results demonstrate that under low temperatures germination would be delayed and slow, but eventually yield more seedlings. Under high temperatures, germination would also be delayed, but relatively rapid, yet it would yield few seedlings (Tipton 1992). In studies with alternating day/night temperatures, percentage germination of smooth sumac and shining sumac seedlots was significantly greater when they were subjected to an alternating temperature (16/8 hours) of 20/10 EC than at 15/5 EC or 30/20 EC. Germination rate was also affected—germination was completed within 10 days at 20/10 EC and 30/20 EC but took 20 days at 15/5 EC (Farmer and others 1982). Maximum germination of prairie sumac occurred when seeds were subjected to alternating temperatures of 20/10 EC with a short-day light cycle of 8 hours of light and 16 hours of darkness (Rasmussen and Wright 1988).

Gibberellins and ethylene or ethephon (2-chloroethyl phosphonic acid) are known to overcome dormancy in seeds of some species by completely or partially substituting for the moist-prechilling requirement (Hartmann and others 1997; Norton 1985). This was true for seeds of staghorn sumac, as germination after 30 days was higher for seeds incubated for 24 hours in 100 mg/liter gibberellic acid (GA) (26% germination) than 0, 1, 10, or 1000 mg/liter GA (19, 22, 24, and 22% germination, respectively). When seeds were stratified at 4 EC for 0, 10, 20, or 30 days, percentage germination increased with the length of the stratification period to a maximum of 48%. However, combining infusion of GA into seeds with cold stratification did not further enhance germination if the stratification period exceeded 10 days (Norton 1986, 1987). In contrast, promotion of germination due to ethephon was demonstrated only after 20 or 30 days of stratification, whereas no effect was observed in the absence of a cold treatment (Norton 1985). A combination of ethephon treatment at 200 mg/liter for 24 hours followed by 30 days of cold treatment at 4 EC increased germination to 60%.

Soil pH has some influence on germination. Once prairie sumac seeds are scarified, germination occurred under a wide range of pH (4 to 10), but highest germination occurred at a pH of 10 (Rasmussen and Wright 1988). In nature, soil pH increases for a short time following fire. Increased pH is attributed to ash deposition on burned areas. Fire enhances these conditions, thus aiding establishment following burning. Furthermore, seedling emergence and root growth of staghorn sumac were inhibited by simulated acid rain (Lee and Weber 1979), which tended to lower soil pH.

In addition, exudates from leaves of sumac (identified as miasmins and saprolins) inhibit germination and seedling growth of a number of other plants (Matveev and others 1975). Water-soluble extracts from leaves of shining sumac had an adverse effect on germination and radicle growth of loblolly pine—*Pinus taeda* L.—which suggests that shining sumac, a common shrub on southern pine sites, may interfere with regeneration of loblolly pine from seed (Smith 1990).

Furthermore, extracts from seeds of skunkbush sumac inhibited growth of brome—*Bromus* L. spp.—either by killing newly germinated seeds or by reducing coleoptile growth by 30% compared to the control (Hampton and Singh 1979).

Nursery practice and seedling care. Sumacs can be propagated from seeds, by rooting stem cuttings (Hartmann and others 1997; Tipton 1990), or by field-planting root cuttings in early spring (Cross 1982, 1988; Jonsson and Zak 1975; Hartmann and others 1997). Although sumacs are heavy seed producers, commercially they are usually propagated vegetatively by root cuttings (Cross 1988, Jonsson and Zak 1975).

When propagating by seeds, the ideal sowing time depends on the species. Seeds that do not require stratification, such as those of shining, smooth, and staghorn sumacs, are sown best in the spring after a scarification treatment. Seeds scarified in sulfuric acid should be rinsed thoroughly with running water prior to sowing. Species that exhibit double dormancy, such as fragrant and skunkbush sumacs, can be either subjected to scarification and stratification and planted in spring or they can be scarified and sown in the fall, thus allowing winter temperatures to provide moist prechilling naturally (Dirr and Heuser 1987). In general, seeds should be sown at least 1.3 cm (½ in) deep at a rate of about 82 viable seeds/m (25/ft) (Brinkman 1974). However, depth of planting from 0 to 6 cm (0 to 2.4 in) did not affect percentage emergence of seeds of prairie sumac (Rasmussen and Wright 1988).

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Figure 1—*Rhus triblobata,* skunkbush sumac, and *R. typhina,* staghorn sumac: fruits, H 4.

Figure 2—*Rhus glabra,* smooth sumac; *R. integrifolia,* lemonade sumac; *R. laurina,* laurel sumac; *R. ovata,* sugar sumac; *Rhus triblobata,* skunkbush sumac; *R. typhina,,* staghorn sumac: nutlets (seeds), H 4.

Figure 3—*Rhus typhina,* staghorn sumac: longitudinal section through a seed, H 18.

Figure 4—*Rhus typhina,* staghorn sumac: seedling development at 2 (**A**), 4 (**B**), and 17 (**C**) days after germination, H 4.

Figure 5—*Rhus ovata,* sugar sumac: seedlings of 2 age classes.

Table 1—*Rhus,* sumac; *Toxicodendron,* poison ivy, etc.; *Malosma,* laurel-sumac: nomenclature and occurrence

Scientific names & synonyms	Common names	Occurrence
***R. aromatica* Ait.** *R. canadensis* Marsh.	**fragrant sumac,** lemon sumac, sweet-scented sumac	Vermont & Ontario to Minnesota, S to Florida & Louisiana
***R. choriophyllum* Woot. & Standl.**	**Mearns sumac**	S New Mexico & Arizona & adjacent Mexico
***R. copallina* L.**	**shining sumac,** winged sumac, mountain sumac, wing-rib sumac, dwarf sumac	Maine & Ontario to Minnesota, S to Florida & Texas
***R. glabra* L.** *Schmaltzia glabra* Small *R. borealis* Greene	**smooth sumac,** scarlet sumac	Maine to British Columbia, S to Florida & Arizona
***R. hirta* (L.) Sudworth** *R. typhina* L.	**staghorn sumac,** velvet sumac	Quebec to Ontario, S to Georgia, Indiana, & Iowa
***R. integrifolia* (Nutt.) Benth. & Hook. f. ex Brewer & S. Wats**.	**lemonade sumac,** sourberry, lemonade berry	S California & Baja Californa
***R. kearneyi* Barkl.**	**Kearney sumac**	Arizona & N Baja California
***R. lanceolata* (Gray) Britt.** *R. copallina* var. *lanceolata* Gray	**prairie sumac**	S Oklahoma & E Texas to S New Mexico & adjacent Mexico
R. michauxii* Sarg.** ***Schmaltzia M. Small	**false poison sumac**	North Carolina to Georgia
***R. microphylla* Engelm. ex Gray**	**desert sumac,** scrub sumac, small-leaf sumac	SW US & adjacent Mexico
***R. ovata* S. Wats.** *R. ovata* var. *traskiae* Barkl.	**sugarbush,** sugar sumac	Arizona, S California, N Baja Califomia
***R. trilobata* Nutt.** *Schmaltzia anisophylla* Greene *S. trilobata* var. *anisophylla* (Greene) Barkl.	**skunkbush,** ill-scented sumac	Illinois to Washington, California, & Texas
***R. virens* Lindheimer ex Gray**	**evergreen sumac,** tobacco sumac, lentisco	SW US
OTHER, RELATED TAXA		
***Toxicodendron diversilobum* (Torr. & Gray) Greene** *R. diversiloba* Torr. & Gray *R. toxicodendron* ssp. *diversilobum* Torr. & A. Gray) Engl.	**poison-oak**	British Columbia to Baja California

***T. radicans* ssp. *radicans* (L.) Kuntze** *R. radicans* L. *R. toxicodendron* L.	**poison-ivy**	Nova Scotia to Florida, W to Minnesota, Nebraska, & Arkansas
***T. vernix* (L.) Kuntze** *R. vernix* L.	**poison-sumac,** swamp sumac, poison elder	Swamps, Maine to Minnesota, S to Florida & Louisiana
***Malosma laurina* (Nutt.) Nutt. ex Abrams** *R. laurina* Nutt.	**laurel-sumac**	S California, Baja California

Sources: Elias (1989), LHBH (1976), Rehder (1990), RHS (1994).

Table 2—*Rhus,* sumac; *Toxicodendron,* poison ivy, etc.; *Malosma,* laurel-sumac: growth habit, flowers, and fruits

Species	Growth habit & max height	Flowers	Fruits	
R. aromatica	Shrub to 2.5 m	Yellowish, in clustered spikes 5–20 cm long, that appear before leaves	Red, hairy, 6 mm across; early summer,	forming s
R. choriophylla	Shrub or small tree to 5 m with an open irregular crown	Tiny, in dense branched clusters 5–6 cm long & wide from July–August	Red, hairy, 6-8 mm across	
R. copallina	Shrub or small tree to 6 m	Greenish, in dense	Red, hairy; late summer,	terminal
R. glabra	Shrub or tree to 6 m	Green, in dense panicles 10–25 cm long	Scarlet, hairy; summer	
R. hirta	Shrub or tree to 9 m, twigs densely pubescent	Greenish in dense, terminal panicles 10–20 cm long	Crimson, densely hairy; late summer, persist on plant into winter	
R. integrifolia	Evergreen shrub or tree to 9 m	White or pinkish in pubescent panicles	Dark red, hairy; spring	
R. kearneyi	Large shrub or tree to 5 m	White in short, crowded clusters at tips of branchlets	Reddish, hairy	
R. lanceolata	Thicket-forming shrub or small tree to 10 m	Yellowish-green to white in dense clusters at end August	Dark red, hairy; September or October	of branch
R. michauxii	Low stoloniferous shrub to 1 m	Greenish-yellow in panicles 10-20 cm long	Scarlet, densely hairy, in dense panicles	
R. microphylla	Shrub, to 2 m, rarely treelike to 5 m	White in heads or spikes	Globose, to 0.1 cm diameter, orange-red	
R. ovata	Evergreen shrub to 3 m, rarely a tree to 4.5 m	Light yellow, in short dense spikes	Dark red, hairy; spring	
R. trilobata	Shrub to 2 m	Greenish, in clustered spikes, appearing before leaves	Red, hairy; spring	
R. virens	Shrub	White to 4 cm long in terminal panicles	—	
OTHER RELATED TAXA				
T. diversilobum	Shrub to 2.5 m, sometimes climbing	Greenish, in axillary panicles	Whitish	
T. radicans ssp. *radicans*	Trailing or climbing vine, shrub, or rarely a tree	Greenish white in panicles 3–6 cm long	Whitish, berrylike 5–6 mm across, in axillary clusters; early	

T. vernix	Shrub or small tree to 9 m	Greenish, in slender panicles 8–20 cm long	Greenish white in pendent axillary panicles to 20 cm long; pedicles persist through winter
Malosma laurina	Shrub, 3–6 m	Greenish white, in dense panicles 5–10 cm long	Whitish; early summer

Sources: Elias (1989), LHBH (1976), Rehder (1990), RHS (1994).

Table 3—*Rhus,* sumac; *Toxicodendron,* poison ivy, etc.; *Malosma,* laurel-sumac: seed yield data

	Fruits H 1,000/wt		Cleaned seeds H 1,000/wt				
			Range		Average		
Species	/kg	/lb	/kg	/lb	/kg	/lb	Samples
R. copallina	—	—	81.4–173.8	37.0–79.0	125.4	57.0	4
R. glabra	50.6–105.6	23.0–48.0	52.8–277.2	24.0–126.0	107.8	49.0	28
*R. hirta*66.0	30.0	107.1–148.7	48.7–67.6	117.3	53.3	5	
R. integrifolia	6.6	3.0	15.0–17.6	6.8–8.0	16.7	7.6	2
R. ovata	37.4	17.0	41.1–57.2	18.7–26.0	—	—	2
R. trilobata	15.4–19.8	7.0–9.0	23.3–66.0	10.6–30.0	44.7	20.3	9
M. laurina	198.0	90.0	—	—	285.1	129.6	1

Source: Brinkman (1974).