HamamelidaceaeCWitch-hazel family

Liquidambar styraciflua L.

sweetgum

Franklin T. Bonner

Dr. Bonner retired from the USDA Forest Service-s, Southern Research Station, Mississippi State, Mississippi.

Other common names. redgum, American sweetgum, sapgum, bilsted.

Growth habit, occurrence, and use. SweetgumC*Liquidambar styraciflua* L.Cis found on a variety of sites from Connecticut and southeastern Missouri, south to central Florida and southeastern Texas. It also occurs in scattered locations from Mexico south to Nicaragua (Kormanik 1990) and is considered by some to be a very promising species for the American tropics (McCarter and Hughes 1984). This large deciduous tree reaches heights of over 45 m and diameters of 1.2 m at maturity (Brown and Kirkman 1990). Sweetgum has some value for pulp, lumber, and veneer. The seeds are eaten by many species of birds (Van Dersal 1938), and the tree is planted as an ornamental. It was first cultivated in 1681 (Bonner 1974).

Sweetgum exhibits quite a bit of variation over its wide natural range (McCarter and Hughes 1984; McMillan and Winstead 1976; Wells and others 1991; Williams and McMillan 1971). Minor differences in germination and seedling growth and morphology have been reported, but there is no strong evidence for distinct geographic races in the species.

Flowering and fruiting. The small, greenish, monoecious flowers bloom in March to May. The pistillate flowers are borne in axillary, globose heads that form the 22- to 35-mm-diameter multiple heads of small 2-celled capsules (figure 1). The lustrous green color of the fruiting head fades to yellowish green or yellow as maturity is reached in September to November (Bonner 1974; Vines 1960). At the point of color change, moisture content of the fruit head should have dropped below 70% (Bonner 1972). The beaklike capsules open at this time, and the small, winged seeds (figures 2 and 3), 1 or 2 per capsule, are dispersed. Empty fruiting heads often remain on the trees over winter. Fair seed crops occur every year and bumper crops about every 3 years. The flowers are susceptible to late spring freezes that can greatly reduce seed crops. Crop reductions of up to 44% have also been reported from damage by seed bugsC*Leptoglossus oppositus* SayCin North Carolina (Ebel and Summerville 1983). Some trees have been known to flower and bear fruit 4 and 5 years after planting (Mohn and Randall 1970), but good crops are not common until the tress reach 20 to 30 years of age (Bonner 1974).

Collection and extraction. Mature fruit heads must be picked from standing trees or logging slash before seed dispersal. The best indicator of maturity is the fading of their green color. Fruit heads should be dried to completely open the capsules so that the seeds can be extracted by shaking or tumbling. Drying may be done indoors on well-ventilated screen racks or outdoors on plastic or canvas sheets in the sun (Bonner 1987). Indoor drying takes approximately 7 to 10 days, whereas outdoor drying in typical fall weather in the South should require only 3 to 5 days. The

fruit heads should be stirred daily, and those dried outdoors should be covered at night and during rain (Bonner 1987). Canvas sheets are preferred over plastic, as plastic tears easily and also tends to promote condensation of moisture (Robbins 1984).

Fruit heads picked prematurely may be ripened in moist storage at 5 °C for about a month (Bonner 1970). The fruit heads should then be spread to dry until they open and release the seeds. This operation may take longer than drying fruits that were picked when mature, and the seed yields may be less.

Leaves, twigs, and the sawdust-like aborted seeds can be removed most easily with hand screens and laboratory blowers or with air-screen cleaners, depending on the size of the lot (Bonner 1974). Round-hole screens are best for this job, but variations in seed size due to geographic origin or weather during maturation may require a variety of hole sizes (Bonner 1987). Two passes through an air-screen cleaner should produce lot purities of 98%. Seed lots may then be upgraded by removing empty seeds with laboratory blowers or by flotation in water (Bonner 1987). From mostly southern collections, the following yield data were obtained (Bonner 1974):

- Weight per volume of air-dried fruiting heads (1 sample) was 11 kg/hl (or 8.5 lb/bu).
- Weight of cleaned seeds per volume of fruiting heads (3 samples) was 1.0 kg/hl (0.8 lb/bu).
- Number of seeds per fruiting head (144 samples) was 56.
- Range in number of seeds per weight (40 samples) was 143,300 to 217,000/kg (65,000 to 98,400/lb) with an average of 180,000/kg (82,000/lb).

In Mississippi, there were significantly more seeds per fruiting head on trees in the Mississippi River flood plain than on trees from other parts of the state (Kearney and Bonner 1968).

Storage. Sweetgum fits in the storage category of orthodox seeds, that is, its seeds can be stored for a number of years at low temperatures and moisture contents (Bonner 1994). Seed moisture should be maintained in the 5 to 10% range. For storage periods of 5 years or less, temperatures should be kept at 0 to 5 °C; for longer storage, subfreezing temperatures (- 18 °C) should be used (Bonner 1987). The ultimate storage potential of the species is not known, but seeds stored at - 18 °C for 14 years at the USDA Forest Services=s Forestry Sciences Laboratory, in Mississippi State, Mississippi, have lost no viability.

Pregermination treatments. Sweetgum seeds exhibit what can be described as only a shallow dormancy (Nikolaeva 1967). Studies of geographic variation in sweetgum have shown that stratification requirement increases from south to north (Wilcox 1968; Winstead 1971), but even the southernmost sources will respond to stratification with increased germination rates (Bonner and Farmer 1966; Rink and others 1979). Moist stratification at 3 to 5 °C for 2 to 4 weeks should produce timely germination both in the laboratory and in nursery beds (Bonner 1987). Satisfactory treatment has also been achieved by soaking the seeds for 14 to 20 days in water at 3 to 5 °C (Bonner 1974). Older seeds from storage may not require as much stratification, especially if they have been stored above freezing. Stratification of lots stored longer than 7 years under such conditions should be cut in half (1 to 2 weeks) (Bonner 1987).

Germination tests. Satisfactory tests may be obtained with either constant or alternating temperature regimes, but alternating temperatures of 20 °C at night for 8 hours, and 30 °C in the day for 16 hours are recommended for official testing (AOSA 1993). Light is not absolutely

necessary for germination of stratified seeds (Bonner 1967), but it is normally used in all testing. Tetrazolium staining (Bonner and Gammage 1967), radiography (Belcher and Vozzo 1979), and the excised embryo method (Bonner and Gammage 1967; Flemion 1948) also provide reliable tests of viability. Germination is epigeal (figure 4). For moisture testing, duplicate samples of 4 to 6 g each should be dried for 17 ± 1 hour at 103 ± 2 °C (ISTA 1993), or electric meters can be used for rapid measurements (Bonner 1981).

Nursery practice. Stratified seeds should be broadcast or drilled in the spring to achieve an initial seedling density of 100 to 160/m^2 (9 to 15/ft^2) (Barham 1980). Aluminum powder may be mixed with wet stratified seed at a rate of 15 ml/45 kg of seed (4 tablespoons/100 lb) to achieve easy flow in seeders (Bonner 1974). The seeds should be sown on the surface and lightly into the soil with a roller. A 6- to 12-mm (3- to 2-in) mulch of sawdust, sand, or chopped pine straw should be applied (Bonner 1974; Coleman 1965; Vande Linde 1964), although some nurseries have reported better results with wood fiber mulches at rates of 1,400 to 2,900 kg/ha (1,250 to 2,600 lb/ac) (Barham 1980).

Ornamental cultivars of sweetgum are usually propagated vegetatively. Cuttings taken in early June will root, and budding is common also (Dirr and Heuser 1987).

Literature cited

AOSA [Association of Official Seed Analysts]. 1993. Rules for testing seeds. Journal of Seed Technology 16(3): 1B113.

Barham RO. 1980. Nursery-grown sweetgum production improved by hydromulching. Tree Planters= Notes 31(2): 28B30.

Belcher E, Vozzo J. 1979. Radiographic analysis of agricultural and forest tree seeds. Association of Official Seed Analysts Handbk. No. 31. 27 p.

Bonner FT. 1967. Germination of sweetgum seed in response to light. Journal of Forestry 65: 339.

Bonner FT. 1970. Artificial ripening of sweetgum seeds. Tree Planters= Notes 21(3): 23B25.

Bonner FT. 1972. Maturation of sweetgum and American sycamore seeds. Forest Science 18: 223B231.

Bonner FT. 1974. *Liquidambar styraciflua* L., sweetgum In: Schopmeyer CS, tech. coord. Seeds of woody plants in the United States. Agric. Handbk. 450. Washington, DC: USDA Forest Service: 505B507.

Bonner FT. 1981. Measurement and management of tree seed moisture. Res. Paper SO-177. New Orleans: USDA Forest Service, Southern Forest Experiment Station. 11 p.

Bonner FT. 1987. Collection and care of sweetgum seed. New Forests 3: 207B214.

Bonner FT. 1994. Predicting seed longevity for four forest tree species with orthodox seeds. Seed Science and Technology 22: 361B370.

Bonner FT, Farmer RE. 1966. Germination of sweetgum in response to temperature, moisture stress, and length of stratification. Forest Science 12: 40B43.

Bonner FT, Gammage JL. 1967. Comparison of germination and viability tests for southern hardwood seed. Tree Planters= Notes 18(3): 21B23.

Brown CK, Kirkman LK. 1990. Trees of Georgia and adjacent states. Portland, OR: Timber

Press. 292 p.
Coleman MC. 1965. Georgia=s experience in hardwood seedling production. In: Proceedings, Region 8 Forest Nurserymen's Conferences; 1964 August 19B20; Morganton, NC; and September 16B17; Oklahoma City, OK. Atlanta: USDA Forest Service, State and Private Forestry: 25B32.
Dirr MA, Heuser CW Jr. 1987. The reference manual of woody plant propagation. Athens, GA: Varsity Press. 239 p.
Ebel BH, Summerville KO. 1983. An evaluation of feeding by a seed bug, *Leptoglossus oppositus* (Say), on seed yield of sweetgum, *Liquidambar styraciflua* L. Journal of the Georgia Entomological Society 18: 316B320.
Flemion F. 1948. Reliability of the excised embryo method as a rapid test for determining the germinative capacity of dormant seeds. Contributions of the Boyce Thompson Institute 15: 229B241.
ISTA [International Seed Testing Association]. 1993. International rules for seed testing. Rules 1993. Seed Science and Technology 21 (Suppl.): 1B259.
Kearney NW, Bonner FT. 1968. Sweetgum seed production on soils in central Mississippi. Res. Note 50-75. New Orleans: USDA Forest Service, Southern Forest Experiment Station. 2 p.
Kormanik PP. 1990. *Liquidambar styraciflua* L., sweetgum. In: Burns RM, Honkala BH, tech. coords. Silvics of North America. Volume 2, Hardwoods. Agric. Handbk. 654. Washington, DC: USDA Forest Service: 400B405.
McCarter PS, Hughes CE. 1984. *Liquidambar styraciflua* L.Ca species of potential for the tropics. Commonwealth Forestry Review 63: 207B216.
McMillan C, Winstead JE. 1976. Adaptive differentiation in *Liquidambar styraciflua* L. from eastern United States and northeastern Mexico under uniform environmental conditions. Botanical Gazette 137: 361B367.
Mohn CA, Randall WK. 1970. Flowering in young sweetgum plantations. Forest Science 16: 70B71.
Nikolaeva MG. 1967. Physiology of deep dormancy in seeds. Komarovskie Chteniya Botanicheskogo Instituta Akademii Nauk SSR [translated by National Technical Information Service. TT 68-50463. 1969. 220 p.].
Rink G, Dell TR, Switzer G, Bonner FT. 1979. Use of the Weibull function to quantify sweetgum germination data. Silvae Genetica 28: 9B12.
Robbins AMJ. 1984. Seed extraction: 1. The tarpaulin method of sun drying pine cones and seed extraction. Tech. Note 9. Humlebaek, Denmark: DANIDA Forest Seed Centre.
Van Dersal WR. 1938. Native woody plants of the United States: their erosion-control and wildlife values. Misc. Publ. 303. Washington, DC: US Department of Agriculture. 362 p.
Vande Linde F. 1964. Nursery practices for southern oaks and gums. Tree Planters= Notes 65: 24B26.
Vines RA. 1960. Trees, shrubs, and woody vines of the Southwest. Austin: University of Texas Press. 1104 p.
Wells OO, Switzer GL, Schmidtling RC. 1991. Geographic variation in Mississippi loblolly pine and sweetgum. Silvae Genetica 40: 105B119.
Wilcox JR. 1968. Sweetgum seed stratification requirements related to winter climate at seed

source. Forest Science 14: 16B19.
Williams GJ III, McMillan C. 1971. Phenology of six United States provenances of *Liquidambar styraciflua* under controlled conditions. American Journal of Botany 58: 24B31.
Winstead JE. 1971. Populational difference in seed germination and stratification requirements of sweetgum. Forest Science 17: 34B36.

Table 1C*Liquidambar styraciflua,* sweetgum: germination test conditions and results

Stratif-ication* (days)	Daily light period (hrs)	Germination test conditions: Medium	Temp (°C): Day	Temp (°C): Night	Germination rate: Days	Germination rate: %	Germination rate: Days	Germination: Ave. (%)	Germination: Samples
0	8	Blotter paper	30	20	28	76	21	85	14
30	8	Kimpak	30	20	25	86	14	95	23
15B45	0	Blotter paper	30	30	30	C	C	85	13

Sources: AOSA (1993), Bonner (1974).
* Stratification at 3 °C.