

Comprehensive Crop Reports

Salvia: An Old Standby and Promising Newcomer

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Salvia L. is a large genus comprised of about 900 species of annual, biennial, or perennial herbs, subshrubs, or shrubs (Griffiths, 1994). Over 140 species are used as garden plants, culinary and medicinal herbs, cut flowers, and for habitat gardening (Griffiths, 1994). *Salvia*, the Latin name for this group of plants, also functions as a common name and is presumably derived from *salvus* meaning well, safe, or sound; referring to the plant's medicinal uses. The common name for most species in the genus *Salvia* is sage and is usually preceded by at least one modifier, such as common sage (*S. officinalis* L.), or

mexican bush sage (*S. leucantha* Cav.). A few salvia species are known as clary (*S. sclarea* L.), meadow clary (*S. pratensis* L.), and wild clary (*S. verbenaca* L.) and at least two have neither clary nor sage in the common name: jupiter's-distaff (*S. glutinosa* L.), and cancerweed (*S. lyrata* L.) (Liberty Hyde Bailey Hortorium, 1976). Clary also has its linguistic roots in the plant's usage; *S. sclarea* was used for afflictions of the eye and therefore called clear-eye or clary (Stearn, 1992).

Salvia is the largest genus in the family Labiatae (Lamiaceae), the mint family (Clebsch, 1997; Griffiths, 1994). Like many members of the mint family, salvias are characterized by square stems (cross section), opposite leaves, flowers formed in false whorls (verticillasters), and aromatic foliage. *Salvia* flowers are disposed in terminal or axillary racemes, spikes, panicles, or cymes. The calyx has two lips, the lower deeply two-toothed, the upper three-toothed. The corolla is also two-lipped, the upper hooded, erect or plane and the lower spreading with three lobes. *Salvia* is also characterized by having two stamens, included or exerted, and fruit containing four ovoid, three-angled nutlets (Griffiths, 1994; Liberty Hyde Bailey Hortorium, 1976). Hummingbirds, bees, bumblebees, and bee-flies harvest nectar from salvias and thereby act as pollinators (Boring et al., 1995).

Some species, such as scarlet sage (*S. splendens* Sell ex Roem. & Schult.), are perennial herbs in their native habitat but are used as annuals in temperate climates. Additionally, mealycup sage (*S. farinacea* Benth.) is a perennial herb in its native Mexico and southern Texas but is grown as an annual throughout the more temperate regions of the United States. Such plants

are sometimes referred to as tender perennials or as half hardy perennials (Armitage, 1989).

Although of cosmopolitan distribution, salvias are generally characterized as growing in dry or stony soils (Liberty Hyde Bailey Hortorium, 1976). One notable exception is bog sage (*S. uliginosa* Benth.), which is native to wet soils in Brazil, Uruguay, and Argentina (Griffiths, 1994).

Although about 140 species are in cultivation, only a few salvias are commonly found in commerce and gardens. Common sage is a culinary herb grown for commercial herb production, home kitchen use, and as decorative foliage in the garden. The chromosome number for this species is $2n = 14$ (Goldblatt and Johnson, 1998). There is an extensive literature, mostly from Europe, on the chemical composition, production, and extraction of essential oils from common sage and related species (Serrato-Valenti et al., 1997) but these topics will not be covered in this review.

Scarlet sage, is one of the leading 25 bedding plants. Much of the literature on ornamental production of salvia focuses on scarlet sage ($2n = 44$, Goldblatt and Johnson, 1996) and thus many references discuss salvia without distinguishing between species. Mealycup sage ($2n = 18$, Goldblatt and Johnson, 1990), a native of the southwestern United States, is used for bedding or in a mixed border. As native plant gardening increases in popularity, the number of salvia species found in commerce increases but most of the scientific literature has focused on the species mentioned above.

CULTIVAR DEVELOPMENT

Of the ornamental salvias, cultivar development has been most extensive for scarlet sage. Novartis Seeds (Downers Grove, Ill.) and PanAmerican Seed Co. (West Chicago, Ill.) have contributed to cultivar development for this species. Dwarf cultivars, such as those in the Sizzler series, flower in the pack yet tend to develop leaf scorch and pigment bleaching during high summer temperatures. Cultivars like 'Vista' and 'Empire' may not flower in time for spring sales but are superior garden plants showing greater tolerance of summer heat and sun. Color also affects leaf scorch: purple, burgundy, rose, and red cultivars are scorch resis-

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Table 1. Salvia species and their landscape characteristics (Boring et al., 1995; Clausen and Ekstrom, 1989; Clebsch, 1997; Griffiths, 1994; Still, 1994; Wasowski and Wasowski, 1997).

Common name	Scientific name	Ht ft (m)	Native habitat	Propagation mode	Flower color
Texas salvia, tropical sage Culture and landscape use Annual Part to full sun Tolerant of a wide range of soils Self-seeds readily Sow seeds in fall or spring Used for massing or as a tall groundcover	<i>Salvia coccinea</i>	2-3 (0.6-0.9)	South Carolina to Mexico	Seed or cuttings	Red, pink, or rarely white
Dorri sage, purple sage, desert sage Culture and landscape use Semievergreen shrub Well-drained soil Drought tolerant Attracts hummingbirds	<i>Salvia dorrii</i>	2-3 (0.6-0.9)	Desert-southwest U.S.	Seed or cuttings	Tubular blue flowers nestled in pink to violet bracts.
Mealycup sage Culture and landscape use Perennial herb used as an annual Full sun Well-drained soil Hardy to Zone 8, evergreen perennial in Zone 9 Common bedding plant Good container plant or cut flower	<i>Salvia farinacea</i>	1-2 (0.3-0.6)	Texas and Mexico	Seed or cuttings	Lavender-blue or white flowers
Gregg sage, autumn sage, cherry sage Culture and landscape use Perennial herb or shrub Part to full sun Well-drained soil Blooms from spring to frost	<i>Salvia greggii</i>	2-3 (0.6-0.9)	Texas and Mexico	Cuttings	Red, pink, white, or coral

tant, while white (white cultivars of scarlet sage tend to be cream-colored), salmon, and bicolor cultivars tend to develop leaf scorch (Armitage, 1994; J. Nau, personal communication).

CROP PRODUCTION

Production of scarlet sage requires high light. Supplemental photosynthetic lighting of seedlings accelerates development and limits excessively leggy growth (Armitage, 1994), but photoperiod requirements for flowering are cultivar dependent. Carlson (1978) suggested three categories for the photoperiod response of scarlet sage cultivars: 1) cultivars that flower faster under short days (facultative short day plants), 2) cultivars that flower in the same length of time under either long or short days (day neutral plants), and 3) cultivars that flower faster under long days (facultative long day plants). Of 44 cultivars studied, Carlson

found 18 to be quantitative short day, 11 to be day neutral, and 14 to be quantitative long day plants (one cultivar did not flower at all). Recommended photoperiod length for optimum production can vary by cultivar and with temperature: Weiler (1972) and Weiler and Lai (1973) reported 'St. John's Fire' to be day neutral when grown at either 75 °F (24 °C) or 60 °F (16 °C) while Carlson (1978) listed it as a long day plant when grown at 70 to 75 °F (21 to 24 °C). 'St. John's Fire' had an increased response to daylength at 75 °F (24 °C) over 60 °F (16 °C) indicating that temperature may account for differences in reported photoperiod requirements (Weiler, 1972).

Mexican bush sage is a short day plant that flowers in autumn (Armitage, 1993). This perennial herb, native to Mexico and tropical America, requires long days and warm temperatures for vegetative growth and short days and warm temperatures for flower initia-

tion and development. Mexican bush sage can be grown as a cut flower in 11 to 15 weeks by providing 3 to 5 weeks of long days followed by 8 to 10 weeks of short days (Armitage, 1993).

Scarlet sage, texas salvia (*S. coccinea* Juss. ex Murray.), and mealycup sage should be grown at 57 to 59 °F (14 to 15 °C) (Nau, 1993), while scarlet sage grows best with night temperatures of 55 to 59 °F (13 to 15 °C) and day temperatures of 70 to 75 °F (21 to 24 °C) (Armitage, 1994). Scarlet sage responded strongly to a difference between day and night temperatures (DIF), a response that can be used to regulate plant height (Barrett and Erwin, 1994). Internode length was greatest for scarlet sage with a cooler night than day temperature (DIF = +6 °F [+3.3 °C]), was intermediate with a constant temperature, and shortest with a higher night than day temperature (DIF = -5 °F [-2.8 °C]). Using temperature to reduce intern-

Table 1. Continued.

Common name	Scientific name	Ht ft (m)	Native habitat	Propagation mode	Flower color
Mexican bush sage	<i>Salvia leucantha</i>	4 (1.2)	Mexico	Cuttings or division	White or purple flowers surrounded by purple to lavender-blue calyces
Culture and landscape use					
Perennial herb or shrub used as an annual					
Full sun					
Well-drained					
Drought tolerant					
Good cut flower					
Common sage, garden sage	<i>Salvia officinalis</i>	1-2 (0.3-0.6)	Mediterranean region	Cuttings or division	Lilac-blue
Culture and landscape use					
Perennial subshrub					
Full sun					
Well-drained					
Hardy to Zone 4					
Tricolor, purple, and variegated cultivars					
Scarlet sage, red salvia	<i>Salvia splendens</i>	0.5-2.5 (0.2-0.8)	Brazil	Seed	Scarlet, purple, lavender, red, cream, or
Culture and landscape use					
Perennial or annual herb used as an annual					
Full sun					
Well-drained soil					
Common bedding plant					
Perennial salvia	<i>Salvia ×superba</i>	2-3 (0.6-0.9)	Of garden origin	Cuttings and division	Violet or purple
Culture and landscape use					
Perennial herb					
Clump forming					
Full sun					
Well-drained soil					
Drought tolerant					
Hardy to Zone 5					

ode length is most effective if the temperature drop (DROP) is rapid, occurs at sunrise, and during high light intensity.

Although scarlet sage cannot withstand freezing temperatures, optimum temperature for storage and transport of plugs ranges from 45 to 55 °F (7 to 13 °C) (Heins et al., 1994); however, Armitage (1994) cautions that reddening of foliage may occur below 50 °F (10 °C). Perennial salvia (*Salvia ×superba* Stapf.), an herbaceous perennial of garden origin, is a cold hardy plant able to withstand root medium temperatures to -14 °F (-10 °C); however, regrowth was limited when root medium temperatures were reduced to -10 °F (-12 °C) indicating a well-defined low-temperature threshold for this species (Iles and Agnew, 1993).

PROPAGATION

Scarlet sage is produced from seed

(Armitage, 1994), while perennial species may be produced from either seed or cuttings. Autumn sage (*S. greggii* A. Gray.) does not remain true to type when grown from seed, thus named cultivars should be propagated from cuttings. Certain cultivars of mealycup sage come true from seed and therefore may be propagated by either method (Clebsch, 1997). *Salvia* seeds should not be stored for greater than one year since they lose not only viability but seedlings may have reduced vigor (Dole and Wilkins, 1999).

Germination of scarlet sage 'Red Hot Sally' seed was 0% at pH 4.5 and 5.0, 44% at 5.5, and 70% at 7.0 and 7.5 when germinated on filter paper (Shoemaker and Carlson, 1990). However, when seed were placed in perlite of varying pH, germination ranged from 60 to 83% with no significant differences among the treatments indicating that pH may not be an important factor when germinating salvia seeds

in a growing media. Germination also failed after scarlet sage 'Red Hot Sally' seeds were stored at 77 °F (25 °C) and 75% relative humidity for 12 months (Carpenter et al., 1995). Optimal germination occurred when seed was stored at a relative humidity between 11 and 32% regardless of temperature (41, 59, or 77 °F [5, 15, or 25 °C]) but seed storage is recommended below 59 °F (15 °C) (Carpenter et al., 1995).

Temperature optima for germination are 75 to 77 °F (24 to 25 °C) for scarlet sage and mealycup sage, 70 to 79 °F (21 to 26 °C) for texas salvia, 70 °F (21 °C) for common sage, and 72 °F (22 °C) for perennial salvia (Nau, 1993). Texas salvia, scarlet sage, and mealycup sage require light for germination while common sage germinates best when covered and perennial salvia may be grown under either condition (Nau, 1993).

Postgermination night temperatures for the above species range from

55 to 61 °F (13 to 16 °C) (Nau, 1993) and Armitage (1994) recommended day temperatures of 70 to 72 °F (21 to 22 °C). Scarlet sage requires 5 to 6 months from sowing to flowering in a 4-inch (10-cm) pot (Armitage, 1994) and mealycup sage reaches a marketable size in 5 months from seed in a 1-gal (3.8-L) container (Knowles et al., 1993).

In vitro propagation has been used successfully for mexican bush sage (Hosoki and Tahara, 1993). Shoots 1 inch (2.5 cm) long rooted well when transferred to a basal medium with or without IBA and shoot counts increased with increasing BA concentration. Since high BA concentrations [1 ppm (mg·L⁻¹)] decreased shoot length and caused vitrification, Hosoki and Tamara (1993) recommended 0.1 ppm BA be added to obtain the maximum number of normal shoots. Plantlets were successfully transferred to a sandy loam and bark mix under greenhouse conditions.

NUTRITION

Plug production of scarlet sage is common. Plugs should be fertilized with 50 to 75 ppm N (potassium nitrate) at plug stages two and three and fertilized with 100 to 150 ppm N complete fertilizer once transplanted (Armitage, 1994). Medium electrical conductivity should be maintained at 0.5 dS·m⁻¹ during stages 1 and 2 and can be raised to 1.5 dS·m⁻¹ in stage 4 (Koranski et al., 1996). When ammonium levels exceed 10 ppm, a dark green cast occurs on immature leaves with thick, protruded veins. Therefore, it is important to use fertilizers low in ammonium during early stages of plug production. Similarly, additions of sodium chloride (NaCl) caused leaf abscission, slowed growth, lowered leaf K concentration, and increased leaf thickness in seedlings of scarlet sage 'Flare Path' (Ibrahim et al., 1991). Root and shoot weights were significantly lower at 30 mM NaCl and total leaf abscission occurred at 60 mM.

A positive linear relationship between shoot nitrogen concentration and shoot dry mass occurred for scarlet sage 'Top Red' but no significant effect was indicated for phosphorous or potassium (van Iersel et al., 1998). Nor were significant differences in shoot growth observed at differing P and K fertilizer rates; however, P and K concentrations increased in leaf tissue

as fertilizer levels increased suggesting luxury consumption of these nutrients. Over watering, low calcium, high calcium-inhibiting magnesium, low phosphorus, or low magnesium can all lead to poor root and root hair development in scarlet sage (Koranski et al., 1996). For high-quality salvia plants, the optimum leaf tissue nutrient levels are (in percent) N, 3.0 to 4.5; P, 0.3 to 0.7; K, 3.5 to 5.0; Ca, 1.5 to 2.5; and Mg, 0.3 to 0.6 (values based on most recent fully developed leaf) (Nelson, 1994).

Mealycup sage had greater shoot growth in a bark/sand mixture after 21 weeks than in a perlite/vermiculite mixture (Knowles et al., 1993). Shoot growth was maximal in the bark/sand mixture with either weekly fertigation at 100 ppm N (as ammonium nitrate, 34N-0P-0K) or preplant incorporation of 3 lb/yard³ (2 kg·m⁻³) N (as Osmocote, 39N-0P-0K, The Scotts Company, Columbus, Ohio). Dry weights did not significantly increase when these levels were exceeded and higher rates of N resulted in leggy plants with excessive plant succulence.

Although K concentration does not appear to be important for the production of scarlet sage, increased K concentrations may aid in the postproduction quality of plants. Moisture stress conditioning, lowering greenhouse temperatures, and increasing K fertilization rates were shown to reduce transpirational water loss while allowing plants to maintain photosynthesis at lower leaf water potentials (Eakes et al., 1991a, 1991b). These treatments may maintain plant appearance during the moisture stress often associated with transport and display of plants in a retail setting; however, fertilizing with K at 600 ppm also resulted in small plant size compared with 300 ppm.

HEIGHT CONTROL

Plant size can be controlled during production with the use of growth regulators, DIF, soil volume, and cultivar selection (van Iersel, 1997; Armitage, 1994; Incrocci et al., 1994; Higuchi et al., 1987). Scarlet sage cultivars are generally divided into three groups: dwarf (8 to 12 inch [20 to 30 cm]), medium (12 to 16 inch [30 to 40 cm]), and tall (>16 inch [40cm]) (Armitage, 1994). Early flower production is related to size with the dwarf cultivars tending to flower earlier (J. Nau, personal communica-

tion). Increasing container size increased plant size, lateral growth, and plant quality and decreased time to flowering (van Iersel, 1997). Thus transplanting plugs early may reduce the production duration of salvia.

Increasing greenhouse temperatures 11 to 14 °F (6 to 8 °C) above ambient (86 to 100 °F [30 to 38 °C]) retarded primary shoot growth, increased lateral shoot growth, percentage of flowering shoots, and mean length of inflorescence (Higuchi et al., 1987). Filtering light through copper sulfate (CuSO₄) has also been tested as a means of reducing growth. Incrocci et al. (1994) compared the height of scarlet sage grown under water-filled polycarbonate panels (control) and panels filled with a CuSO₄ solution. They reported no reduction in height for scarlet sage but reported a 2-week delay in flowering for plants grown under the CuSO₄ filters.

Chemical control of height has proven effective for scarlet sage and mealycup sage. Dole and Wilkins (1999) listed amcymidol, chlormequat chloride, daminozide, and ethephon as effective on salvia and paclobutrazol and uniconazole as most effective. Armitage (1994) recommended two applications of 5000 ppm daminozide or two to four applications of 750 to 1000 ppm chlormequat for height control of scarlet sage.

Uniconazole was more effective than either paclobutrazol or daminozide in reducing the height growth of indigo spires salvia (S. 'Indigo Spires') (Rodriguez et al., 1993). Unrooted cuttings were either soaked for 24 h, dipped for 3 s, sprayed, or sprayed and then resprayed 18 d later with various levels of growth regulators. The 24 h soak and two sprays with 50 ppm uniconazole were most effective at reducing plant height. These treatments also reduced the number of flower spikes from 11 (control) to 5 but the authors suggested that the plants were still commercially viable. The treatment effects were short lived (less than 3 weeks) indicating that application of growth regulators during production would not affect garden performance or that repeated applications would be necessary if continued growth retardation were desired for plants in the landscape.

PESTS AND DISEASES

In the greenhouse, salvia is susceptible to many common disease and in-

sect problems, including aphids (*Myzus persicae* Sulzer and other species), whiteflies (*Trialeurodes vaporariorum* Westwood and *Bemisia argentifolii* Bellows & Perring), spider mites (*Tetranychus urticae* Koch.), common gray mold (*Botrytis cinerea* P. Micheli ex Pers.), and damping off (*Pythium* Pringsh., *Rhizoctonia* DC., and *Fusarium* Link) (Armitage, 1994). Two cultivars of scarlet sage, 'Carabiniere Red' and 'Hot Line Red', were slightly susceptible to root-knot nematodes (*Meloidogyne incognita* [Kofoid & White] Chitwood, race 3) when inoculated with 200 eggs/cell while mealycup sage 'Rhea' and 'Victoria Blue' were resistant; however, dry weight was not affected for any cultivar nor was dry weight of common sage affected when inoculated (Walker, 1995). A similar study by McSorley and Frederick (1994) indicated no galling on scarlet sage 'Bonfire' by root-knot nematodes (*M. incognita* race 1) but did find eggs on a few individual plants inoculated with another species of root-knot nematodes (*M. javanica* [Treub] Chitwood). Downy mildew (*Peronospora lamii* A. Braun.) and rust (*Puccinia salviicola* Dietel & Holw.) have each been reported on various salvia species but salvia is generally free of pest problems in the landscape (McMillan and Graves, 1994; Holcomb and Valverde, 1995).

CUT FLOWERS

Mexican bush sage may be grown in the greenhouse or the field for the specialty cut flower market. Plants should be spaced at least 15 inch (37.5 cm) apart but closer than 3 ft (90 cm) apart since the large plants will use surrounding plants for support (Armitage, 1993; 1987). Inflorescences should be harvested when white flower petals appear on the lower three to four individual flowers. Cut stems last about 7 d when floral preservatives are used. Individual flowers will shatter if allowed to wilt (Armitage, 1993). Mexican bush sage also makes good dried flowers.

CONCLUSION

Scarlet sage is by far the most widely cultivated species of salvia (Liberty Hyde Bailey Hortorium, 1976) but has sometimes been maligned by horticulturists. It has been described as having limp, grass green foliage that is ordinary with flowers that are strident in color (Clausen and Ekstrom, 1989). In contrast, native perennial species of salvia, such as

mealycup sage, have been praised for their drought tolerance and nutrient efficiency making them well adapted for low maintenance landscapes in the south (Knowles et al., 1993). Native perennial species are also prized for their wildlife value; hummingbirds and bees seek the flowers while birds eat the seeds (Boring et al., 1995).

As interest in native plants increases, so too will the number of salvia species in cultivation and the need for production information, environmental requirements, and postharvest research on those species (Knowles et al., 1993). Even the most basic information, such as hardiness, has not been investigated for many of the native salvia species as is evidenced by the conflicting hardiness ratings given by gardening books. Since many salvia species are native to arid and resource poor environments, the need is apparent for further research within this genus. New introductions will require evaluation in different soil types, regions of the country, and in the cultivated landscape.

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The drug salvia is readily available in stores and online. It can cause severe hallucinations and lack of body control. But it's still legal in Canada. Today, salvia is marketed as providing a "natural high" and sold in head shops and online in highly concentrated doses. When smoked it is 10, 20 or even 100 times more potent than the leaves themselves. According to Health Canada's most recent, 2011 Canadian Alcohol and Drug Use Monitoring Survey, 5.4 per cent of people aged 15 to 24 had used salvia. According to numerous studies, salvia users can experience time distortion and, at higher doses, terrifying hallucinations. There is a risk of injury because the drug can leave users unable to control their physical movements. You might be interested. Although scarlet sage cannot withstand freezing temperatures, optimum temperature for storage and transport of plugs ranges from 45 to 55 °F (7 to 13 °C) (Heins et al., 1994); however, Armitage (1994) cautions that reddening of foliage may occur below 50 °F (10 °C). Perennial salvia (*Salvia* *—**superba* Stapf.), an herbaceous perennial of garden origin, is a cold hardy plant able to withstand root medium temperatures to -14 °F (-10 °C); however, regrowth was limited when root medium temperatures were reduced to -10 °F (-12 °C) indicating a well-defined low-temperature threshold for *Salvia officinalis* is part of the *Salvia* genus in the Labiatae family, containing over 700 species of plants. It has been used over several millennia across a number of different cultures including Ayurvedic medicine, as well as early Greek and Chinese civilisations as a treatment for the amelioration. The proposed mechanisms of action for *S. officinalis* include acetylcholinesterase inhibition (ChEI), butyrylcholinesterase inhibition (BuChe), antioxidant, anti-inflammatory and oestrogenic effects (Perry et al., 1999; Kennedy and Scholey, 2006). To date two randomised controlled trials have been