Technology and Product Reports

Height Control of 'Hot Lips' Hybrid Sage to Flurprimidol Substrate Drench

Barbara A. Fair¹, Brian Whipker, Ingram McCall, and Wayne Buhler

ADDITIONAL INDEX WORDS. growth regulator, perennial, *Salvia × microphylla*

SUMMARY. Sages (*Salvia* sp.) have long been popular as summer annuals, culinary herbs, and landscape perennials. We selected 'Hot Lips' hybrid sage [*Salvia × microphylla* (*Salvia greggii* × *S. microphylla*)], a recently introduced perennial sage, to assess efficacy of the growth regulator flurprimidol for controlling height. Substrate drenches of flurprimidol at 0, 0.25, 0.50, 1.0, 2, and 4 mg per pot were applied using 240 mL of solution per pot on 17 June 2010. Plant height was recorded at treatment, 27 days after treatment (DAT), and 48 DAT. Flurprimidol drench concentrations of 0.25 mg per pot and higher controlled plant height by 20% to 41% 27 DAT and by 26% to 50% 48 DAT. While all treatments at 48 DAT produced a significantly shorter plant, concentrations between 0.25 to 1 mg would provide growers options for controlling plant growth by 26% to 44%. Using concentrations over 1.0 mg did not produce any additional control of height in hybrid sage.

Sage is the principal genus within the Lamiaceae family (Page and Olds, 2004). Sages have long been popular as summer annuals and culinary herbs in gardens around the world because of their beautiful flowers and aromatic leaves. In recent years, many species have become popular as perennials and woody subshrubs for landscape beds and water-wise gardens. To serve this increasing interest, breeders have offered new cultivars and hybrids of many sage species. Most sages prefer full sun and well-drained, light soil (Page and Olds, 2004). Many species from Mexico and South America are considered subshrubs (woody perennial base with annual herbaceous shoots) that may not be cold hardy in

southeastern United States (Armitage, 2006). In a 2008–10 field trial, researchers found that autumn sage (*Salvia greggii*) produced an abundance of flowers throughout the summer, but some cultivars had a high mortality rate, likely due to cold, wet winter soils (B.A. Fair, unpublished data). In addition, autumn sage was highly prone to breakage during transport, transplanting, and when employing typical maintenance, such as dead-heading. Other popular salvia used in

those trials, including woodland sage (*Salvia nemorosa*) and 'May Night' meadow sage [*Salvia × sylvestris* (*Salvia pratensis* × *S. nemorosa*)], did not flower as well or as continuously as autumn sage cultivars, but had lower mortality rates and stronger stems.

Many new introductions of autumn sage are hybrids, including 'Hot Lips', introduced by Strybing Arboretum in 2002 (Sayler, 2008). This popular cultivar displays white flowers with red lower lobes resembling lips, thus the common name. Plants flower in early spring through late fall and are quite drought tolerant, and attract bees and butterflies. Hybrid sage was selected for this study based on its popularity in southern gardens and to determine if a plant growth regulator (PGR) could help control stem height, potentially increasing ease of shipping and handling. In previous work (Latimer and Whipker, 2010), with meadow sage, researchers found a 40% increase in basal branching at 4 weeks after treatment with a foliar spray of benzyladenine (Configure[®]; Fine Americas, Walnut Creek, CA). Additionally, Banko and Stefani (1996) found that a foliar application of benzyladenine to mealy sage (*Salvia farinacea*) controlled height and increased branching; and when applied to meadow sage, it increased branching and delayed flowering (Carey, 2008). Most work on perennials has been conducted with such PGRs as uniconazole (Sumagic[®]; Valent, Walnut Creek, CA) and paclobutrazol (Bonzi[®]; ICI Chemicals, Millbank, England).

Much of the PGR work has focused on use of shorter-term, older chemistry with such chemicals as daminozide (B-Nine; OHP, Mainland, PA), chlormequat chloride (Cycocel, OHP), and ancymidol (A-Rest; SePRO Corp., Carmel, IN), but little work had been done with flurprimidol (Topflor, SePRO Corp.) until recently (Latimer, 2004). In addition, much of the work done has been on annuals (Holcomb

Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
29.5735	fl oz	mL	0.0338
3.7854	gal	L	0.2642
2.54	inch(es)	cm	0.3937
28,350	oz	mg	3.5274×10^{-5}
1	ppm	mg·L ⁻¹	1
(°F – 32) ÷ 1.8	°F	°C	(1.8 × °C) + 32

Department of Horticultural Science, Campus Box 7609, North Carolina State University, Raleigh, NC 27695-7609

¹Corresponding author. E-mail: bfair@ncsu.edu.

and Beattie, 1990). Flurprimidol was being tested on floriculture crops but was not yet available in U.S. markets. It has a newer chemistry that makes it a highly potent gibberellin-inhibiting growth regulator (PGR) and is used commercially as a 0.38% concentrate formulation to restrict growth. Flurprimidol has been tested on a number of greenhouse plants such as dianthus [*Dianthus caryophyllus* (Pobudkiewicz and Nowak, 1994)], cape daisy [*Osteospermum ecklonis* (Olsen and Andersen, 1995)], chrysanthemum [*Dendranthema ×grandiflorum* (Pobudkiewicz and Nowak, 1997)], and streptocarpus [*Streptocarpus hybridus* (Pobudkiewicz, 2000)]. Recommendations for commercial use in greenhouse production indicate foliar spray applications of 10 to 30 mg·L⁻¹ to potted sunflower [*Helianthus annuus* (Houska, 1997; Spiess-Urania, 2001)]. In European studies, recommendation for flurprimidol is to use two foliar applications at rates between 0.25 and 0.5 mg·L⁻¹.

As perennials are gaining popularity as potted plants, as well as a landscape staple, the use of PGRs will continue to grow. Many species grow too tall too quickly during production; therefore, our objective was to determine the efficacy of various concentrations of flurprimidol substrate drenches on plant height of the perennial hybrid sage. Drenches were selected for use on the sage as foliar applications were found to be less effective despite higher rates (Krug et al., 2005; B. Whipker, personal communication).

Materials and methods

'Hot Lips' hybrid sage seedlings (128 round 3 × 3-cm cells) were transplanted on 4 June 2010 into 6-inch-diameter round plastic pots filled with a volume of 1.2 L of substrate (Fafard® 1B; Fafard, Anderson, SC). Plants were fertigated by hand as needed with 150 mg·L⁻¹ N using 15N-2.1P-12.5K (Excel® 15-5-15 Cal-Mag; Scotts, Marysville, OH). Greenhouse day/night set point temperatures were 80/70 °F, respectively. The plants were grown under natural light.

Substrate drenches of flurprimidol at 0, 0.25, 0.5, 1, 2, and 4 mg per pot were applied using 240 mL solution per pot on 17 June 2010. We selected these rates to determine

the most effective and economic rate following methodology of Krug et al. (2005) and Latimer et al. (2003). As is common with other growth regulator experimentation (Dasoju et al., 1998; Hilgers et al., 2005; Holcomb and Beattie, 1990; Latimer et al., 2003), this study was performed during one growing season.

The experiment was a completely randomized design with 10 single-plant replications. Plant height (measured from the pot rim to the uppermost part of the inflorescence) was recorded at 4-week intervals on 17 June (treatment date), 14 July (27 DAT), and 4 Aug. 2010 (48 DAT). We selected these dates because all plants began blooming within the first week of treatment, irrespective of flurprimidol rates.

STATISTICAL ANALYSIS. Data for plant height were subjected to analysis of variance using general linear model [PROC GLM (SAS version 9.2; SAS Institute, Cary, NC). PROC REG procedure was used to determine the best-fit linear or quadratic model. Main effects were judged significant or nonsignificant and included in the final model based on a comparison of F values at $\alpha \leq 0.05$.

Results and discussion

'Hot Lips' hybrid sage plant height was fit to a quadratic model with shorter plant heights as the concentration of flurprimidol increased (Fig. 1). The smallest plants were those treated with 4 mg flurprimidol per pot with a mean height of 29.6 cm at 27 DAT and 35.3 cm at 48 DAT. Hybrid sage mean plant height was 41% shorter than the untreated plants (0 mg per pot) for the 4 mg treatments of flurprimidol at 27 DAT. By 48 DAT, the percent of height control had increased to 50% compared with untreated plants for the 4 mg concentration. Whipker et al. (2004) controlled pot sunflower plant height at anthesis by 22% with 2 mg flurprimidol per pot concentration. On pot tulip (*Tulipa* sp.), Krug et al. (2005) had 24% control of plant height in a postharvest environment using a 0.52 mg flurprimidol concentration. In addition, when comparing 1.0 mg per pot paclobutrazol to 0.5 mg flurprimidol per pot, researchers obtained similar and adequate control of pot tulip (Krug et al., 2005). Holcomb and Beattie (1990) recorded 50% shorter

plant height of 'Kobold' gayfeather (*Liatris spicata*) treated with 0.25 mg uniconazole per pot; however, they indicated that flower spikes were abnormally short and flowers often aborted. At the same concentration of flurprimidol, we obtained 26% shorter plants at 48 DAT with typical flowering behavior for hybrid sage.

Conclusions

Plant growth regulators are important tools for growers to control growth, particularly with fast-growing perennials. Results with flurprimidol indicated that drench concentrations of 0.25 to 4 mg per pot controlled plant height by 20% to 41% 27 DAT and by 26% to 40% 48 DAT. There were no differences in plant appearance, leaf color, or flower production across flurprimidol treatments. While all treatments at 48 DAT produced a significantly shorter plant, the degree of control between the 0.25 and 0.5 mg flurprimidol per pot were similar. At these concentrations, it would be advantageous to growers who desire 26% to 32% shorter plants. For growers who ship plants over long distances, increased plant density on shipping carts would be a priority and the higher concentration of 1 mg may be more suitable. Using concentrations >1.0 mg did not produce any additional control of plant height in hybrid sage; thus, concentration of 2 to 4 mg would not be economically or environmentally justified. Plant response to PGRs is affected by the PGR chemistry, plant species/cultivar, and the timing of application (Latimer et al., 2003). There is some persistence for each PGR that is important to consider when selecting a chemical and rate. In this study, at 4 weeks, there was still an effect from the PGR (Fig. 1). In their 2003 study, Latimer et al. found that less potent chemistry found in daminozide controlled height growth of perennials up to 12 weeks after treatment. In theory, this suggests that because flurprimidol's chemistry is more potent, it could potentially hold plants back even longer once planted in the landscape. In contrast, Selmer et al. (2001) found that once pampas grass (*Cortaderia selloana*) treated with optimal commercial drenches of either paclobutrazol or uniconazole were transplanted into the landscape, they quickly grew out of the PGR effect. More trials should

Fig. 1. Flurprimidol substrate drench effects on 'Hot Lips' hybrid sage height, measured 14 July [27 d after treatment (DAT)] and 4 Aug. (48 DAT) (sample size = 10). Quadratic lines were generated from best-fit model and were $y = 0.3821x^2 - 6.0064x + 52.26$ for plant height at 27 DAT ($r^2 = 0.94$) and $y = 1.0125x^2 - 12.73x + 76.75$ for plant height at 48 DAT ($r^2 = 0.95$). Error bars indicate SE of mean height measurements for each flurprimidol drench treatment at either 27 or 48 DAT; 1 mg = 3.5274×10^{-5} oz, 1 cm = 0.3937 inch.

be conducted to assess flurprimidol on growth control of other cultivars/hybrids containing autumn sage and to assess its persistence.

Literature cited

- Armitage, A.M. 2006. Armitage's native plants for North American gardens. Timber Press, Portland, OR.
- Banko, T.J. and M.A. Stefani. 1996. Chemical growth control of *Salvia farinacea* 'Victoria Blue', p. 214–214. In: B.L. James (ed.). Proc. 4th Annu. Southern Nurseryman's Assn. Res. Conf., Marietta, GA.
- Carey, D.J. 2008. The effects of benzyladenine on ornamental crops. North Carolina State Univ., Raleigh, MS Thesis.
- Dasoju, S., M.R. Evans, and B.E. Whipker. 1998. Paclobutrazol drench activity in coir- and peat- based root substrates. HortTechnology 8:595–598.
- Hilgers, K.R., C. Hayes, and W.R. Graves. 2005. Chemical height control of containerized seashore mallow. HortTechnology 15:330–332.
- Holcomb, E.J. and D.J. Beattie. 1990. Growth retardants for perennials, p. 164–169. In: T.L. Davenport (ed.). Proc. 17th Annu. Plant Growth Regulat. Soc. Amer. Conf., Ithaca, NY.
- Houska, P. 1997. *Helianthus annuus* Hemmstoffe. Research report of Lehr- und Versuchsanstalt für Gartenbau, Hannover-Ahlem, Germany.
- Krug, B.A., B.E. Whipker, I. McCall, and J.M. Dole. 2005. Comparison of flurprimidol to ancymidol, paclobutrazol, and uniconazole for tulip height control. HortTechnology 15:370–373.
- Latimer, J.G. 2004. Trends and uses of plant growth regulators on herbaceous perennials, p. 1–4. In: L. Ferguson (ed.). Proc. 31st Annu. Plant Growth Regulat. Soc. Amer. Conf., Charleston, SC.
- Latimer, J.G., H.L. Scoggins, and T.J. Banko. 2003. Persistence of plant growth regulator effects on perennial plants in the nursery. Acta Hort. 624:229–232.
- Latimer, J.G. and B.E. Whipker (eds.). 2010. Configure product information and university trial results. Fine Americas, Inc. Walnut Creek, CA.
- Olsen, W.W. and A.S. Andersen. 1995. Growth retardation of *Osteospermum ecklonis*. Acta Hort. 397:129–138.
- Page, S. and M. Olds (eds.). 2004. Botanical: The illustrated encyclopedia of over 10,000 garden plants and how to cultivate them. 3rd ed. Random House, Sydney, Australia.
- Pobudkiewicz, A. 2000. Controlling the growth habit of streptocarpus hybrids with flurprimidol. J. Fruit Ornamentals Plant Res. 8:9–17.
- Pobudkiewicz, A. and J. Nowak. 1994. The influence of flurprimidol and uniconazole on growth of the CMM dwarf *Dianthus caryophyllus* L. cv. Snowmass. J. Fruit Ornamentals Plant Res. 2: 43–52.
- Pobudkiewicz, A. and J. Nowak. 1997. Response of chrysanthemum (*Dendranthema grandiflora* Kitam) cvs Altis and Surf to flurprimidol application. J. Fruit Ornamentals Plant Res. 5:135–142.
- Sayler, R.D. 2008. WSU Arboretum and Wildlife Conservation Center. 1 Jan. 2012. <http://www.arboretum.wsu.edu/garden_blog_files/hot_lips.html>.
- Selmer, J.C., C.R. Adins, I. McCall, and B.E. Whipker. 2001. Pampas grass responses to ancymidol, paclobutrazol, uniconazole substrate drenches. HortTechnology 11:216–219.
- Spiess-Urania. 2001. Topflor, p. 464–472. In: Spiess-Urania Chemicals GmbH. 2001 produktinformation. Spiess-Urania Chemicals, Hamburg, Germany.
- Whipker, B.E., I. McCall, J.L. Gibson, and T.J. Cavins. 2004. Flurprimidol foliar sprays and substrate drenches control growth of 'Pacino' pot sunflowers. HortTechnology 14:411–414.