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GROWTH CONTROL OF *SALVIA* × 'INDIGO SPIRES' BY PHOTOSELECTIVE PLASTIC FILMS

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Abstract. **The use of chemical growth retardants is a common practice in the greenhouse industry for controlling plant height for optimal shipping, handling, and establishment in the field. The mandated restricted use of some growth regulating chemicals in agriculture has led to recent developments in greenhouse film production. Photoselective greenhouse films offer a non-chemical alternative to regulate plant growth. Plant response to a photoselective plastic film with a far-red (FR) absorbing property was tested using the perennial *Salvia* × 'Indigo Spires'. Films were designated A_{FR} (FR light-absorbing film) and control (clear plastic film). Light transmitted through the A_{FR} film reduced plant height by 36%, leaf dry weight by 25%, and stem dry weight by 55% compared with the control film. This correlated with a reduction in specific leaf dry weight and specific stem dry weight. The A_{FR} film did not significantly affect the number of leaves compared with the control film. These results indicate that compactness of *Salvia* × 'Indigo Spires' can be achieved by selective reduction of far-red wavelengths from sunlight.**

Plant production facilities often depend on the use of chemical growth regulators to unify plant growth, reduce plant height for optimal shipping and handling, and improve establishment in the field (Norcini et al., 1996). However, due to increasing environmental and human health concerns, the use of some of these chemical regulators has been restricted in agricultural production. The rising interest and need of non-chemical alternatives for plant growth regulation of ornamental crops has led to developments in photoselective greenhouse films. These films are designed to absorb (FR; 700-800 nm) light wavelengths and increase red (R):FR ratios of the light spectrum, thereby producing shorter, more compact plants. However the magnitude of the response depends on the species and cultivar (Rajapakse et al., 1999). The objective of this work was to determine the effect of a photoselective greenhouse film (FR absorbing) on plant growth of the perennial Indigo Spires Salvia (*Salvia* × 'Indigo Spires'). Indigo Spires Salvia was chosen for this study due to its increasing popularity among consumers and its characteristic tall, lanky growth (up to 4 ft), which can make it difficult to handle and awkward to ship (Burnett et al., 2000).

Materials and Methods

Uniform plugs (approximately 7.8 cm tall) of *Salvia* × 'Indigo Spires' (Robrick Nursery, Hawthorne, Fla.) were planted into 3.8-L pots filled with soilless media (Fafard Mix #2, Fafard, Inc., Apopka, Fla.). All plants were top-dressed at a standard rate of 15 g/pot of 15N-9P-12K Osmocote Plus®. Plants were transferred to experimental chambers (90 × 60 × 60 cm) framed with PVC pipe and covered with photoselective (A_{FR}) or non-photoselective (control), polyethylene films (Mitsui Chemicals, Inc., Japan). One fan was placed in each chamber with the opposite end slightly rolled up to ensure proper airflow and prevent heat build-up. Spectral distribution was measured at the beginning and end of the experiment (Table 1, Fig. 1) using a LI-1800 spectroradiometer (LiCOR Inc., Lincoln, Neb.). The photosynthetic photon flux (*PPF*) inside each chamber was adjusted to 181 ± 29 $\mu mol \cdot m^{-2} \cdot s^{-1}$ using cheesecloth. Plants were inspected daily and hand watered as needed. Average minimum and maximum temperatures in the greenhouse were 17.0 and 35.2°C. Plant height (height from media level to apex), number of fully expanded leaves, leaf area, leaf color, flower number and dry

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Table 1. R:FR ratios and estimated photoequilibrium (Pfr/P) of light transmitted through photoselective (A_{FR}) and non-photoselective (control) films.

Treatment	R:FR[z]	Photoequilibrium (Pfr/P)
A_{FR}	1.38	0.75
Control	0.98	0.71

[z]R = 600-700 nm red light; FR =700-800 nm far-red light.

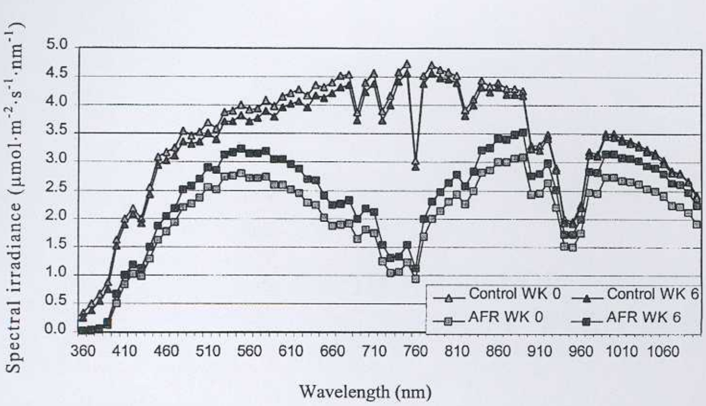

Figure 1. Spectral distribution properties of A_{FR} (far-red light absorbing) photoselective film at 0 and 6 weeks. Control film was a polyethylene film without dye.

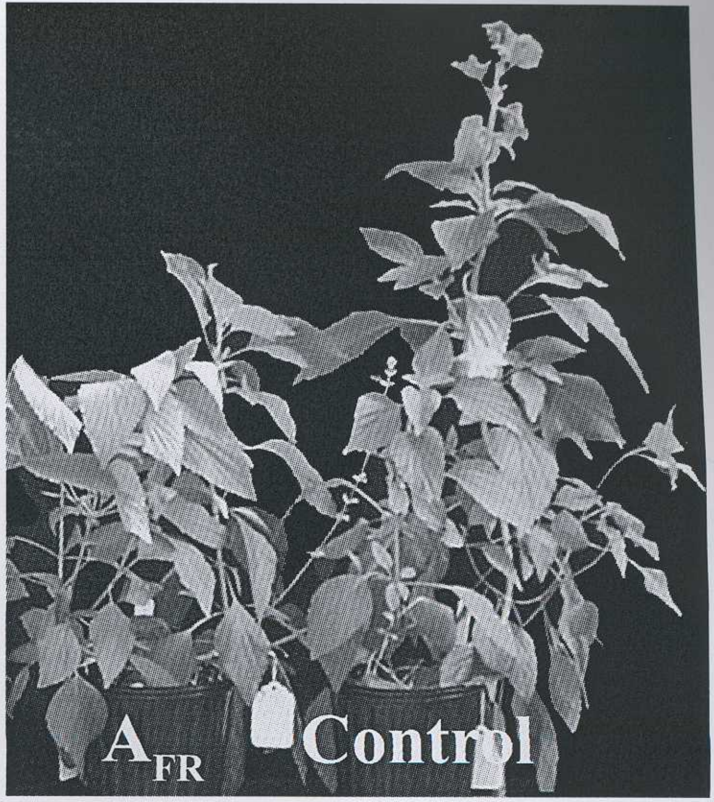

Figure 2. Effects of A_{FR} (far-red absorbing) photoselective film on plant growth and appearance of Indigo Spires Salvia at 6 weeks. Control film was a polyethylene film without dye.

weight of leaves, stems and flowers, and roots were recorded after 6 weeks. Flowering time was recorded when buds reached full color. Experimental film treatments were replicated twice within the greenhouse, six plants randomly placed in each replicate. Data were analyzed using analysis of variance procedure and differences among treatment means were tested by Duncan's multiple range test at P = 0.05.

Results and Discussion

Light transmitted through the A_{FR} film reduced plant height (stem length) of *Salvia* by 36% (Table 2). Similarly, FR light-absorbing photoselective films with light-intercepting dyes were shown to reduce elongation of chrysanthemum and bell pepper plants (Li et al., 2000). Although visually marketable (pers. obs., Fig. 2), plants grown under the A_{FR} film had less leaf area, leaf color, and dry weight than plants grown under the control film (Table 2). In addition, the A_{FR} film appeared to delay flowering of some plants. At 6 weeks, only 58% of the plants grown under the A_{FR} film had flowered compared with plants grown under the control film, of which 92% flowered (data not shown). The effect of photoselective films on flowering appears to be dependent on whether plants are photoperiodic. Flowering of short-day cosmos (*Cosmos sulphureus*), zinnia (*Zinnia elegans* Jacq.), and chrysanthemum (*Chrysanthemum* × *morifolium* Ramat) was only slightly delayed (by 1-2 d) when grown under FR light absorbing film; whereas, the flowering of long-day snapdragon (*Antirrhinum majus* L.) and petunia (*Petunia* × *hybrida* Hort. Vilm.-Andr.) was delayed by as much as 7-13 d when grown under short days and by 2-3 d when grown under long days (Rajapakse et al., 2000; van Haeringen et al., 1998). Because the effects of FR absorbing films are species and cultivar specific (Rajapakse et al., 1999), current research is focused towards determining the effectiveness of photoselective films on additional perennial *Salvia* species.

Table 2. Growth characteristics of *Salvia* plants grown for 6 weeks under far-red absorbing (A_{FR}) and control films.

Film	Plant height (cm)	Leaf area (cm^2)	Leaf color (SPAD)	Leaf dry weight (g)	Stem dry weight (g)	Specific leaf dry weight ($g \cdot cm^{-2}$)	Specific stem dry weight ($g \cdot cm^{-1}$)
Control	72.7 a[z]	3046 a	39.3 a	5.3 a	4.7 a	0.0017 a	0.0644 a
A_{FR}	46.7 b	2553 b	37.4 b	4.0 b	2.1 c	0.0016 b	0.0432 b
TRT	**	*	*	**	**	**	**

[z]Means followed by different letter indicate significance by Duncan's multiple range test at $P \leq 0.05$ (*) or 0.01 (**).

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