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Natural Height Control of Container Grown *Eupatorium fistulosum*[1]

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Abstract

Eupatorium fistulosum, Joe-Pye Weed, is a tall [up to 3 m (10 ft)], upright, native perennial that produces large panicles of rosy purple flowers in the summer. However, its height limits its production in containers because tall plants easily blow over and can be difficult to ship. Rooted liners were transplanted into 3.8 liter (#1) containers on two different dates in the spring to shorten the period of vegetative growth before plants initiated flowers in late spring/early summer. Height increase was essentially halted when flowers were initiated, shortly before plants would be shipped. While plants were at least 64% taller than the maximum acceptable height of 61 cm (24 in), it was evident that manipulating the transplant date could be used to reduce the natural height of this species for container production. Moreover, it was shown that a low rate of controlled release fertilizer could be used in production, thereby reducing nutrient runoff. There was no strong evidence that fertilizer rate affected plant height or quality.

Index words: queen-of-the-meadow, trumpetweed, transplant date, native wildflower.

Species used in this study: Joe-Pye weed (*Eupatorium fistulosum* Barratt).

Significance to the Nursery Industry

Flowering perennials and native plants have become popular with the gardening public. Native wildflowers have become a popular segment of this market. This trend has resulted in demand for increased nursery production. For practical reasons, there is a need to control the height of these plants during shipping and marketing. The wholesale nursery industry prefers to ship containerized perennial plants in the range of 46 to 61 cm (18 to 24 in). The retail nursery also prefers full plants of similar height that are well rooted. Plants in the retail nursery sell best when flower color is minimally obvious or the sale may be lost.

The full landscape potential of Joe-Pye weed (*Eupatorium fistulosum*) is naturally achieved at a much greater height than desired by the industry during the spring and summer sales window. Larger plants are more difficult and expensive to ship and more difficult to sell to the customer. These criteria limit the ability to market the tall Joe-Pye weed at natural flowering times. However, it was clear from our results that the natural height of container-produced Joe-Pye weed could be reduced by delaying the transplanting of liners until mid-spring. Mid-spring transplanting shortens the period for vegetative growth before flowers are initiated, at which point vegetative height increase is essentially halted. There is only minimal height increase due to panicle growth before plants are ready to ship (when flower buds show color). Joe-Pye weed also can be grown with a low rate of controlled release fertilizer, thereby reducing nutrient runoff, without negatively affecting plant quality.

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Introduction

Eupatorium fistulosum, a species of Joe-Pye weed also referred to as queen-of-the-meadow, is a tall [0.9–3.0 m (3–10 ft)], upright, herbaceous, native perennial that ranges from Connecticut to central Florida and west to eastern Texas (USDA Hardiness Zones 3–9; AHS Heat Zones 2–10). The plants have dark green whorls of lance-shaped leaves, and during the summer bear 1.3-cm (0.5 in) dusty rose to lavender flowers occurring in showy panicles that can be up to 46 cm (18 in) across. The showy flowers attract butterflies, hummingbirds, bees and wasps (5). Joe-Pye weed thrives in full sun to partial shade in moist soil with a pH between 4.5 and 7.0 (14). Some geographic populations are cold hardy only to zone 5, and some populations cannot survive heat stress south of USDA Hardiness Zone 7 (5).

The height of this species along with its large panicles of flowers make it quite striking in home landscapes as well as fields and pastures, along road shoulders, and at the edges of woods. But the height, which adds to its attractiveness, is of concern for nurseries that want to produce it in containers. Tall plants easily blow over during production and can be difficult to ship.

Height control in perennial plant production is frequently accomplished by selective pruning, especially those grown outdoors, but it is labor intensive and adds to production costs. Plant growth regulators are occasionally used (6, 8, 10), but there is no growth regulator labelled for use on Joe-Pye weed. Moisture stress is an alternative for height control of species like Joe-Pye weed that have a high water requirement (2). It has been noted that relatively dry sites and reduced fertilization in the landscape caused Joe-Pye weed to remain shorter throughout the growing season (Kathy Davis, U.S. Dept. Agric., Nat. Res. Cons. Serv., National Plant Materials Center; pers. comm.). However, using moisture stress to control height would necessitate that all plants attained equivalent levels of stress at about the same time. Also, the crop would have to be carefully monitored to avoid excessive moisture stress.

An alternative method for height control of herbaceous plants with determinate growth (like Joe-Pye weed) is to schedule potting of liners such that plants are at or near the desired size when they start flowering. If the period for vegetative growth is shortened, it should be possible to control overall height with a shorter growing period. In essence, it is 'natural' growth regulation because the natural transition of meristems from a vegetative state to a reproductive state halts increase in height due to vegetative growth. And since the production cycle is shorter and no pruning is involved, production costs would be reduced. Joiner et al. (7) and Wilfret (15) demonstrated that poinsettia (*Euphorbia pulcherrima* Willd.) height could be controlled under Florida greenhouse conditions by manipulating propagation and/or planting date. Cameron and Fausey (3) suggested that growers who lack greenhouse facilities for 'forcing' perennials into an earlier than normal flowering use this method. Joe-Pye weed seems to be an ideal candidate for using 'natural' growth regulation to control height of container-produced plants. It is a naturally tall plant whose increase in height due to vegetative growth ceases in late spring/early summer when vegetative meristems of main shoots become reproductive. We first observed this 'natural' height control when Joe-Pye weed was planted late in the spring in a demonstration garden (13).

The objective of this experiment was to investigate whether the use of 'natural' height control and a low controlled release fertilizer rate would result in container-grown Joe-Pye weed of a size and flowering state commercially considered ready-to-ship. The use of reduced fertilizer levels was investigated since decreased fertilization reduced Joe-Pye weed height in the landscape (as noted above), and many native herbaceous perennials can be produced in containers using fertilizer rates that are frequently lower than rates recommended for production of typical garden plants (12).

Materials and Methods

The experiment was conducted at two sites: Lively Technical Center, Tallahassee, FL, and the North Florida Research and Education Center, Monticello, FL (both sites — USDA Cold Hardiness Zone 8b; AHS Heat Zone 9). Plants were purchased as dormant rooted liners from North Creek Nurseries (Landenberg, PA). The liners were derived from an ecotype collected from an open, sunny, wet meadow at the Brandywine Conservancy Environmental Management Center in Chadds Ford, PA (USDA Cold Hardiness Zone 7; AHS Heat Zone 5), about 20 miles from the nursery. Liners were potted into 3.8 liter (#1) containers on March 23, 2001, and April 11, 2001. Dormant liners potted in March were placed on outdoor growing beds in full sun. Liners not potted in March were placed in a greenhouse. The average greenhouse minimum and maximum temperatures from March 23 to April 11 were 16.2 ± 1.2C (61.2 ± 2.2F) and 36.9 ± 2.3C (98.5 ± 4.2F), respectively. At the time of potting in April, liners were not dormant [6.6 ± 2.5 and 8.8 ± 2.5 cm tall (2.6 ± 1.0 and 3.5 ± 1.0 in) for Monticello and Tallahassee, respectively]. The potting substrate consisted of hammer-milled pine bark:Canadian sphagnum peat (Berger Peat Moss Inc., St. Modeste, Québec, Canada):rescreened 6B gravel (Martin Aggregates, Chattahoochee, FL) (3:1:1 by vol) amended with one of four rates of Osmocote 18N–2.6P–10K [18–6–12; 8–9 month formulation at 21C (70F); Scotts-Sierra Horticultural Products Co., Marysville, OH] and 0.94 kg/m^3 (1.6 lb/yd^3) Micromax 12S–0.1B–0.5Cu–12Fe–2.5Mn–0.05Mo–12Zn (Scotts Co.). The four Osmocote fertilizer treatments were: 0.5☞ low label rate [1.8 kg/m^3 (3 lb/yd^3)]; 0.75☞ low label rate [2.7 kg/m^3 (4.5 lb/yd^3)]; low label rate [3.6 kg/m^3 (6 lb/yd^3)]; medium label rate [5.4 kg/m^3 (9 lb/yd^3)].

Daily overhead irrigation (pH 7.2) at Tallahassee was 0.5 cm (0.2 in) both in the morning and afternoon. The total rain and average minimum/maximum temperatures for Tallahassee were: March 23–April 11 — 7.6 cm (3.0 in), 10.6C (51.1F)/24.7C (76.5F); April 12–30 — 1.7 cm (0.9 in), 12.0C (53.7F)/26.6C (79.8F); May — 5.8 cm (2.3 in), 15.1C (59.2F)/30.5C (86.9F); June — 39.4 cm (15.5 in), 21.0C (69.8F)/31.4C (88.5F); July — 14.0 cm (5.5 in), 22.5C (72.5F)/32.7C (90.9F). Overhead irrigation (pH 7.5) at Monticello was 0.6 cm (0.24 in) in the morning and 0.3 cm (0.12 in) in the afternoon. The total rain and average minimum/maximum temperatures for Monticello were: March 23–April 11 — 5.8 cm (2.3 in), 9.3C (48.8F)/24.1C (75.3F); April 12–30 — 0.6 cm (0.25 in), 9.9C (49.8F)/26.2C (79.2F); May — 4.7 cm (1.9 in), 14.1C (57.4F)/31.2C (88.2F); June — 35.7 cm (14.1 in), 19.3C (66.7F)/31.0C (87.8F); July — 11.0 cm (4.3 in), 21.4C (70.5F)/32.7C (90.9F).

Plant height (measured from soil line to highest point of plant, including inflorescences), widest width (W1), and width perpendicular to the widest width (W2) were recorded at initial planting and every 3 weeks until harvest. Once flower buds were observed, plants were checked at the beginning of each week to determine if they were ready-to-ship. A plant was deemed ready-to-ship if one or more panicles had fully elongated flower buds that were rosy purple but were not yet fully opened. When all ten repetitions (within a site) of a treatment were considered ready-to-ship, final data was recorded. Plants were rated for overall market quality (rating scale of 1 to 10, increments of 1; 1 = poor and 10 = excellent) based on local industry standards of size [46 to 61 cm tall (18 to 24 in)], growth habit, and flowering. Plants with a quality rating below 8 were not considered marketable. Number of main shoots (there was one panicle per main shoot), height, and width measurements were also recorded. Immediately thereafter, shoots were harvested for dry mass determination [oven dried at 70C (158F) for 7 days].

Plants developed leaf spot (*Pseudocercospora* sp.) and powdery mildew (*Oidium* sp.) (diseases identified by the Florida Division of Plant Industry, Gainesville, FL) beginning in mid-June. As a result, plants were evaluated for disease infection immediately prior to harvest. Percent disease infection was estimated on a scale of 1 to 5, with 1 = none, 2 = < 10%, 3 = 10 to <25%, 4 = 25 to 50%, and 5 = > 50% of leaves affected by foliar disease. Only plants rated as 1 or 2 were considered marketable. Disease ratings were not included in the overall quality rating since flower bud formation had commenced (and hence height increase due to vegetative growth was halted) and disease did not affect size or growth habit. Ready-to-ship date, quality ratings, and disease ratings were based on acceptability to commercial nursery producers.

The experiment was a 2 × 4 factorial, with ten single plant replications per treatment per site arranged in a completely random design. Data for each site were separately subjected to analysis of variance, with polynomial models being fitted through cubic when appropriate.

Results and Discussion

The optimal marketable containerized Joe-Pye weed should be multi-stemmed, about 46 to 61 cm tall (18 to 24 in), and have rosy purple flower buds. No treatment in this study

Table 1. Effect of transplant date and fertilizer rate on container production of Joe-Pye weed.

Transplant date	Fertilizer rate[z] (kg/m^3)	Quality rating[y]	Total increase in ht (cm)[x]	Total increase in ave wd (cm)	No. shoots	Shoot dry mass (g)	Disease rating[w]	Ship date[v]
	Tallahassee							
March 23	1.8	7.5	95.8	34.1	2.4	39.8	1.6	July 3
	2.7	7.3	97.7	48.1	3.1	81.6	2.4	July 10
	3.6	7.4	96.3	44.7	2.7	70.5	2.2	July 4
	5.4	7.0	111.7	43.7	2.5	85.7	3.0	July 5
April 11	1.8	7.3	105.3	45.1	1.9	57.6	2.2	July 15
	2.7	7.5	99.9	42.0	2.2	61.7	2.6	July 11
	3.6	6.7	105.3	45.5	1.8	70.6	3.5	July 8
	5.4	6.8	104.0	50.5	2.4	77.5	3.5	July 10
Significance[u]								
Transplant date		NS	NS	NS	*	NS	***	**
Fertilizer rate		NS	NS	**	NS	***	***	NS
T × F		NS	NS	**	NS	**	*	NS
	Monticello							
March 23	1.8	6.6	76.5	29.8	2.7	25.1	3.8	July 10
	2.7	7.5	87.4	37.1	3.2	48.7	3.8	July 15
	3.6	7.5	98.9	37.2	2.4	56.4	3.9	July 10
	5.4	5.9	116.1	41.3	2.7	81.6	4.4	July 7
April 11	1.8	7.2	85.5	32.7	2.1	45.8	3.2	July 12
	2.7	7.1	89.9	38.9	2.0	66.5	3.0	July 9
	3.6	5.9	91.1	42.0	2.3	75.3	4.3	July 7
	5.4	6.9	103.0	44.5	3.0	90.3	3.1	July 12
Significance[u]								
Transplant date		NS	NS	NS	NS	***	**	NS
Fertilizer rate		*	***	***	NS	***	*	NS
T × F		***	NS	NS	NS	NS	**	NS

[z]Rate of Osmocote 18N–2.6P–10K (18–6–12), 8–9 month formulation; rates correspond to 0.5☞low, 0.75☞low, low, and medium label rates, respectively.

[y]Quality rating scale of 1 to 10 (1 = poor, 10 = excellent) based on a commercially acceptable height of 46–61 cm (18–24 in), flower bud color, and upright habit.

[x]For March 23, increase in height results were equivalent to final plant height since liners were dormant at the time of potting. On April 11, increase in height results are shown to be consistent with the March 23 results; average height (± SD) of liners at time of potting was 8.8 ± 2.5 cm (3.5 ± 1 in) and 6.6 ± 2.5 cm (2.6 ± 1 in) at Tallahassee and Monticello, respectively.

[w]Foliar disease rating of 1 to 5: 1 = none, 2 = <10% of leaves affected, 3 = 10 to <25% of leaves affected, 4 = 25 to 50%, 5 = >50%; ratings of 0 and 1 were deemed commercially acceptable.

[v]Plants in a treatment were deemed ready-to-ship when at least one panicle of each replication in a treatment had fully elongated flower buds that were rosy purple but had not yet opened. Ready-to-ship determinations were made at the beginning of each week. Final growth data and ratings were recorded when all replications within a treatment were deemed ready-to-ship.

[u]NS, *, **, *** nonsignificant, or significant at $P = 0.05, 0.01, 0.001$, respectively.

yielded plants with a mean quality rating of 8.0 (Table 1); however, 34% of the plants at Tallahassee and 25% of the plants at Monticello were rated 8 or 9. There was no strong evidence that either transplant date or fertilizer rate had a substantial effect on plant quality (only low R^2 values resulting from polynomial regression analyses of the significant main or interactive effects at Monticello). The average quality ratings at Tallahassee and Monticello were 7.2 ± 0.8 and 6.8 ± 1.1, respectively.

The low mean quality ratings were primarily attributed to increases in height that resulted in plants that were much taller than commercially acceptable (Table 1). Liners potted on March 23 were 64 and 80% taller (Monticello and Tallahassee, respectively) than the maximum acceptable height of 61 cm (24 in). Dormant liners that resprouted in the greenhouse [and were 6.6 ± 2.5 and 8.8 ± 2.5 cm tall (2.6 ± 1.0 and 3.5 ± 1.0 in) for Monticello and Tallahassee, respectively] when potted up on April 11 were slightly taller than the March plants when deemed shippable. Because of the excessive height some plants from both transplant date treatments blew over. The height of these plants would also present challenges in shipping. There was no strong evidence that decreasing the fertilizer rate could reduce plant height. Although fertilizer rate directly affected height increase at Monticello, there was only a weak linear relationship between fertilizer rate and height increase ($R^2 = 0.30$); fertilizer rate had no effect on height increase at Tallahassee. Transplant date had no effect on total increase in plant height.

The average width of plants in all treatments [Tallahassee — 54.7 ± 1.4 cm (21.5 ± 0.6 in); Monticello — 47.0 ± 2.2 cm (18.5 ± 0.9 in)] was commercially acceptable based on conversations with growers. Like height increase, there was no clear evidence that either transplant date or fertilizer rate affected increase in width (Table 1) as significant fertilizer or interactive effects were only poorly related in a linear manner (R^2 values were all < 0.23).

The number of main shoots directly affected appearance (and hence quality rating) because there was one panicle of flowers per main shoot and the number of main shoots influenced plant width. Transplant date did not seem to be an important factor affecting shoot number (marginal significance at Tallahassee only), and fertilizer rate had no effect.

These results add to the evidence that neither factor played a major role in size or shape of Joe-Pye weed in this experiment. The mean number of main shoots at Tallahassee and Monticello was 2.4 ± 1.6 and 2.6 ± 1.2, respectively, with about 64% of all plants having two main shoots. Pruning would have resulted in a greater number of main shoots (and possibly shorter plants) as evidenced by a few deer-browsed plants (not included in analysis) that had four or more shoots.

Shoot dry mass was related to fertilizer level (Table 1). There were significant main and/or interactive effects at both sites, with the strongest polynomial relationship being cubic at Tallahassee for liners transplanted on March 23 ($R^2 = 0.69$). At Monticello, there was a good linear relationship between fertilizer rate and dry mass ($R^2 = 0.61$); addition of quadratic or cubic components did not improve the model.

Disease severity was evaluated separately from quality because we did not want it to mask the ornamental attributes that were components of the quality rating. Of the 27 plants at Tallahassee that were marketable based on their quality rating (8 or 9), 15 had little to no foliar diseases and hence were saleable. At Monticello, where disease severity seemed to be worse, only four of the 20 plants rated at 8 or 9 were deemed saleable after considering disease. The relationships among transplant date, fertilizer rate, and disease severity were not clear (interaction was significant at both sites). The lack of a clear understanding of how transplant date and fertilizer level affected disease severity may have been due to differences in inoculum levels and conditions at the two sites. However, the level of disease infestation shows that the fungus that caused the leaf spot (which was the most prevalent of the two diseases observed), *Pseudocercospora* sp., seemed to be ubiquitous in our area and is an issue that would have to be considered during production. Given the apparent ubiquitousness of *Pseudocercospora*, plant origin is an issue that might also be considered. A local ecotype of Joe-Pye weed may have been more resistant to this organism than the northeastern ecotype used in our study. In a preliminary study, a Texas selection of black-eyed susan appeared to be much more susceptible to a common *Fusarium* species than a local Florida ecotype when both were grown under Florida conditions (J. Marois, pers. comm.).

Shipping date was not affected by fertilizer level but transplant date was a significant factor at Tallahassee (July 6 and 11 for March and April transplant dates, respectively). Despite the statistical significance, there was little practical difference among the Tallahassee ship dates and the mean ship date for Monticello (July 10).

Based on the results of this study, it was clear that height of container grown Joe-Pye weed could be reduced by transplanting liners in mid-spring. Also, liners should be held in a coldframe or outdoors to slow resprouting prior to potting. Additional work needs to be conducted to optimize the timing but it seems that under our conditions and using the same source for liners, transplanting should be done no earlier than the last week of April but more likely the first half of May. Since flower buds became noticeable in mid-June, transplanting liners during the first half of May would allow for at least several weeks of growth after liners have recovered from transplant shock. Transplant shock was evident in our experiment as the rate of height increase of liners (both sites) that were transplanted on April 11 was lower from April 11 to May 2 than liners transplanted on March 23 (results not shown).

It also was evident that a low fertilizer rate was sufficient for container production of Joe-Pye weed species. The low rate was similar to the fertilizer rate used by the U.S. Dept. Agric. for container production of Joe-Pye weed (11). Fertilizer rates also are low for many other native herbaceous species listed on the Native Plants Network Protocol database (12).

Finally, a factor that should be considered by potential growers of Joe-Pye weed is the source of plant material since flower initiation, and hence cessation of terminal vegetative growth of main shoots, may be affected (as might disease susceptibility as noted before). For example, flower initiation of the Asteraceae species white snakeroot (*Eupatorium rugosum* Houtt.) and black-eyed susan (*Rudbeckia hirta* L.) can be affected by plant origin. Flowering of white snakeroot native to northerly habitats initiates under longer photoperiods than those native to southerly habitats (4, 9). Similarly, a northern ecotype of black-eyed susan was an obligate long-day (LD) plant while a southern ecotype exhibited only a facultative LD response (1).

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