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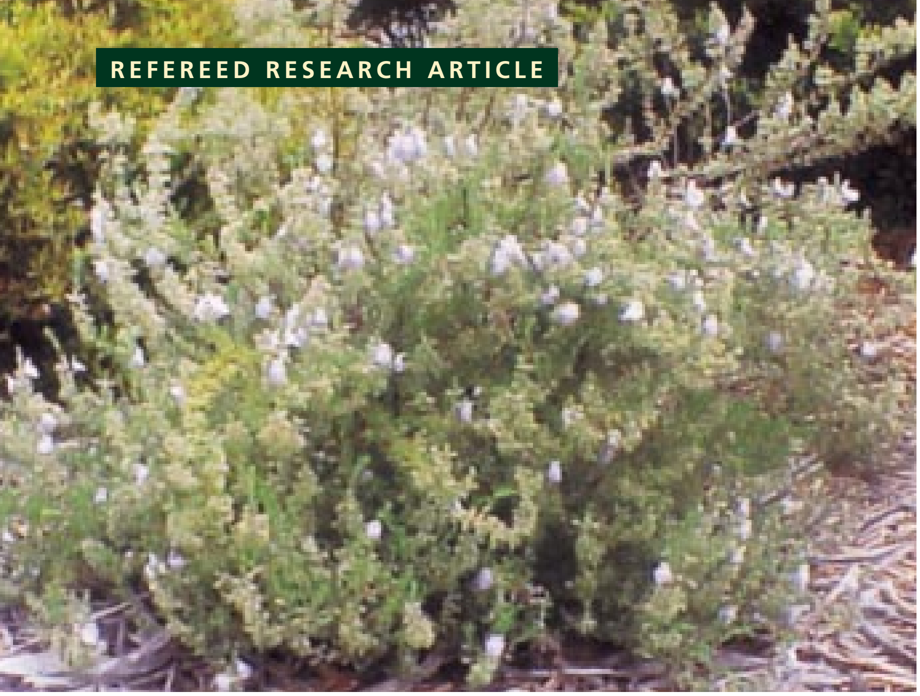

Figure 1 • *False rosemary (*Conradina canescens*) shoot and flower detail and entire plant growing in a non-irrigated Florida landscape.*

Photos by Mack Thetford

Propagation *of* 4 Florida Coastal Dune Species

MACK THETFORD AND DEBBIE MILLER

ABSTRACT

Softwood cuttings of Florida coastal dune species gulf bluestem (*Schizachyrium maritimum* Chapman (Nash) [Poaceae]), seacoast marshelder (*Iva imbricata* Walter [Asteraceae]), false rosemary (*Conradina canescens* Gray [Lamiaceae], and Atlantic St Johnswort (*Hypericum reductum* (Svens.) P. Adams [Clusiaceae]) were propagated with the aid of commercial rooting hormones containing indole-3-butyric acid (IBA) and α-naphthaleneacetic acid (NAA). For all 4 species, an external application of an auxin was not essential for rooting. However, auxin application did improve root quality for seacoast marshelder, false rosemary, and Atlantic St Johnswort.

KEY WORDS: *Schizachyrium maritimum*, *Iva imbricata*, *Conradina canescens*, *Hypericum reductum*, indole-3-butyric acid (IBA), α-naphthaleneacetic acid (NAA), cuttings, auxin, vegetative propagation

NOMENCLATURE: ITIS (2001)

Coastal dunes and beaches comprise between 2800 to 4800 km (1745 to 2991 miles) of seashore in the 5 Gulf states, Georgia, and Puerto Rico. Use of plants to control dune erosion along this seashore is a high priority of Natural Resource Conservation Service plant materials programs (Craig 1991). In addition to the high demand for coastal species used in dune restoration and stabilization projects, demand is increasing for transplants to address needs of developers, homeowners, municipalities, nurserymen, and landscapers near coastal areas.

Several characteristics of coastal species make them candidates for use in southern and/or xeric landscapes. Coastal species usually tolerate salinity, high temperatures, low fertility, wind abrasion, and extremes of soil moisture conditions (Craig 1991). Species endemic to Florida's coastal areas with the aforementioned characteristics can be used in dune restoration and stabilization projects as well as in home landscapes if propagation and production information is made available to the nursery industry.

The need for propagation protocols for dune species and subsequent demand for transplants of many species to meet habitat and food needs of local animal species of concern such as the Santa Rosa beach mouse (*Peromyscus polionotus leucocephalus* Howell [Muridae]) was influenced by recent hurricane activity along the Florida panhandle. Two plant species, gulf bluestem (*Schizachyrium maritimum* Chapman (Nash) [Poaceae]) and seacoast marshelder (*Iva imbricata* Walter [Asteraceae]) are important components of the Santa Rosa beach mouse diet (Moyers 1996). Recovery of beach mouse populations may be aided by restoration practices that increase food availability and habitat heterogeneity. False rosemary (*Conradina canescens* Gray [Lamiaceae]) and Atlantic St Johnswort (*Hypericum reductum* (Svens.) P. Adams [Clusiaceae]) are common to coastal areas of west Florida and contribute to beach mice habitat. Use of these 4 species as drought tolerant landscape species may also help to diminish water and fertilizer use in landscapes of coastal developments.

False rosemary occurs in dunes and scrub areas extending from Florida's Escambia to Wakulla counties (Clewell 1985). It may be used for beach projects requiring planting on the back side of primary dunes, or any side of secondary dunes, and is also a candidate for use in commercial or home landscapes (Figure 1). The shrub is pubescent with numerous stiffly erect or spreading branches and small, revolute leaves ≤1 cm (0.39 in) in length (Bell and Taylor 1982). Flowering occurs from March to November with small clusters of white to lavender 2-lipped, zygomorphic flowers. Although false rosemary is very common in its native range, it is endemic to only a small area of west Florida and adjacent Alabama.

Atlantic St Johnswort is a herbaceous or semi-woody plant with a decumbent growth habit, spreading from the base and forming a low mat (Bell and Taylor 1982) (Figure 2). This plant is a candidate for beach projects requiring planting of interdunal areas and secondary dunes as well as for commercial or home landscapes. Flowers occur from June to September, are terminal and axillary, and may be solitary or in cymules or dichasia. Each flower is 1 to 2 cm (0.4 to 0.8 in) in diameter with 5 clear yellow petals (Radford and others 1983). Atlantic St Johnswort occurs in sandy woods, scrub, and coastal dunes from south Florida to the Carolinas. Ornamental selections within this genus are considered easily started by taking late-summer softwood cuttings from tips of current growth and rooting under high humidity or mist; many hypericum are

Photos by Mack Thetford

Figure 2 • *Atlantic St Johnswort (*Hypericum reductum*) shoot and flower detail and entire plant growing in a non-irrigated Florida landscape.*

TABLE 1

Active ingredient and concentration of auxin treatments used to propagate 4 coastal dune species

Auxin treatment	Active ingredient (ppm)	
	Indole-3-butyric acid	α-Naphthaleneacetic acid
No auxin (control)	0	0
IBA 1000 [a]	1000	0
IBA 5000	5000	0
NAA 500 [a]	0	500
NAA 1000	0	1000
NAA 5000	0	5000
Dip 'N Grow (1:19) [b]	500	250
Dip 'N Grow (1:9)	1000	500

[a] Liquid formulations prepared by dissolving the respective acids in 500 ml isopropyl alcohol to create a 10,000 ppm stock solution and further diluting with distilled water.

[b] Commercially available liquid formulation, diluted with distilled water.

also commercially micropropagated (Hartmann and others 1997).

Gulf bluestem is considered to be the most important species of bluestem grass on the Gulf of Mexico and occurs primarily on dunes, beaches, and coastal swales (Craig 1991) (Figure 3). Following the formation of a more seaward ridge, gulf bluestem replaces sea oats (*Uniola paniculata* L. [Poaceae]) on the newly protected primary ridge within 2 to17 y (Johnson 1997). This plant is a candidate for beach projects requiring planting on the back side of a primary dune, any side of secondary dunes, or for commercial or home landscapes. This prostrate or creeping perennial spreads by long stolons and is easily distinguished by glaucous leaves, prostrate growth habit, and pedicillate spikelets from 4.0 to 6.5 mm (0.2 to 0.3 in)(Clewell 1985).

Seacoast marshelder occurs on coastal dunes throughout the south Atlantic and Gulf region and is used for dune restoration and stabilization projects (Figure 4). The plant has sparse, woody, upright stems reaching heights of 0.3 to 1.2 m (1 to 4 ft). Leaves are fleshy, narrow and lance-shaped, and arrangement may be alternate or opposite. Flowers occur on terminal racemes, are not very showy, and have small lavender petals. The plant is prized for its ability to accumulate sand thereby producing low, rounded dunes (Craig 1991).

Commercial propagation protocols for these 4 species are lacking while commercial demand for a diversity of coastal species has increased following hurricane activity. Our objectives were to determine the optimum auxin treatment and concentration for propagation of these 4 coastal dune species.

Photos by Mack Thetford

Figure 3 • *Gulf bluestem (*Schizachyrium maritimum*) leaf detail and entire plant growing in a non-irrigated Florida landscape.*

MATERIALS AND METHODS

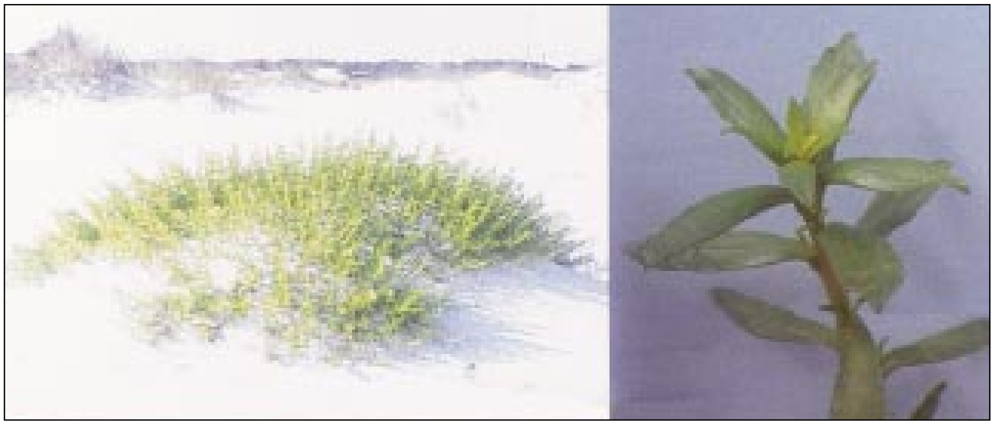

Figure 4 • *Seacoast marshelder (*Iva imbricata*) spring foliage detail and entire plant growing in a fore-dune position.*

Photos by Mack Thetford

Softwood cuttings for all 4 species were collected on 21 July 1997 from Santa Rosa Island, Florida, a coastal barrier island (Lat 30° 18'N, Long 87° 16'W), placed in plastic bags, and stored in a cooler for transport. Before treatment, cuttings were cut to a length of 10 cm (4 in) and the foliage removed from the basal 1 cm (0.4 in) of each cutting. Treatments were based on 3 auxin sources (Table 1): 1) NAA (α-naphthaleneacetic acid); 2) IBA (indole-3-butyric acid); and 3) Dip 'N Grow (Astoria-Pacific Inc, Clackamas, Oregon 97015-0830), a commercially available liquid formulation containing NAA and IBA. NAA and IBA were each dissolved in isopropyl alcohol to prepare 10,000 ppm stock solutions for further dilution with distilled water. Dilution ratios of Dip 'N Grow were based on label recommendations.

The basal 1 cm (0.4 in) of each cutting was treated with a quick dip of an auxin solution for 1 s followed by 15 min of air drying prior to insertion to a 2 cm (0.8 in) depth in 72-cell nursery flat inserts containing a medium of Fafard Mix #2 (Canadian sphagnum peat moss, horticultural perlite, and vermiculite; Conrad Fafard Inc, Agawam, Massachusetts 01001). Intermittent mist operated 6 to 8 s every 10 min from 0700 to 2000 daily, and cuttings were maintained under natural photoperiod. Significance of main effects and interactions were determined using the General Linear Models and LSD or LSMeans procedures of SAS as indicated below using a significance level of 5% (SAS Institute Inc 1989). Residual analysis was conducted and assumptions of equal variance and normality were met (skewedness near 0) for all data with the exception of percent rooting for false rosemary and Atlantic St Johnswort. Unequal variances were stabilized with an arcsine square root transformation and elimination of a single replication for each species. Although means differed with elimination of the single replication, the resultant means separation was consistent with results using all 6 replications and assumptions of equal variance and normality were met.

False Rosemary and Atlantic St Johnswort

Softwood cuttings of false rosemary and Atlantic St Johnswort were prepared from nonbranched terminal shoots. For each species, experimental design was a randomized complete block with 6 cuttings per auxin treatment (Tables 2 and 3) and 6 replications. The experiments ended after 4 wk and percent rooting, root number, and length of the 5 longest primary roots ≥ 1 mm, were recorded. Root dry weight was

TABLE 2

*Effects of rooting hormones on rooting percentage, root number, mean root length, and root dry weight of false rosemary (*Conradina canescens *Gray [Lamiaceae])*

Auxin treatment (ppm)	Rooting (%)	Root number	Mean root length (cm)[a]	Root dry weight (mg)
No auxin (control)	97 ab[b]	10 c	1.9 c	5.8 b
IBA 1000	100 a	13 bc	3.2 ab	7.8 ab
IBA 5000	90 bc	13 bc	3.0 ab	7.7 ab
NAA 500	100 a	18 a	3.1 ab	9.4 a
NAA1000	100 a	13 bc	2.7 abc	8.4 ab
NAA 5000	87 c	13 bc	2.4 bc	10.3 a
Dip 'N Grow (1:19)	90 abc	13 bc	2.8 ab	9.1 ab
Dip 'N Grow (1:9)	97 ab	14 b	3.5 a	9.8 a
LSD (α = 0.05)	11	4	0.9	3.5

[a] 1 cm = 0.4 in.
[b] Means within a column followed by the same letter do not differ (alpha = 0.05).

TABLE 3

*Effects of rooting hormones on rooting percentage, root number, mean root length, and root dry weight of Atlantic St Johnswort (*Hypericum reductum *(Svens. P Adams [Clusiaceae])*

Auxin treatment (ppm)	Rooting (%)	Root number	Mean root length (cm)[a]	Root dry weight (mg)
No auxin (control)	70 bc[b]	6 d	3.0 cd	8.2 bcd
IBA 1000	87 ab	8 cd	3.9 ab	9.6 bc
IBA 5000	93 a	14 a	4.5 a	10.0 abc
NAA 500	83 abc	7 cd	2.8 cd	7.1 cd
NAA1000	93 a	10 b	2.6 d	9.2 bc
NAA 5000	67 c	6 d	0.9 e	5.4 d
Dip 'N Grow (1:19)	89 ab	10 bc	4.0 ab	10.8 ab
Dip 'N Grow (1:9)	93 a	11 b	3.4 bc	12.8 a
LSD (α = 0.05)	18	2	0.8	2.9

[a] 1 cm = 0.4 in.
[b] Means within a column followed by the same letter do not differ (alpha = 0.05).

also recorded. For each experiment, means separation within the main effect of auxin treatment was determined using the LSD test.

Gulf Bluestem

Typical softwood cuttings of gulf bluestem were prepared from terminal shoots representing the first 20 cm (8 in) of each shoot. Shoots were bisected to produce 10 cm (4 in) cuttings with the proximal portions and distal portions (terminal bud intact) segregated. No foliage was removed from the base of the cuttings. Auxin treatments included IBA at 1000 or 5000 ppm and a nontreated control. The experiment had a factorial arrangement of treatments with 2 cutting types (proximal and distal) and 3 auxin treatments with 6 cuttings per treatment and 6 replications. Experimental design was a split plot design with cutting type allocated to main plots and auxin treatments allocated to subplots. The experiment ended after 2 wk and percent rooting (Table 4), root number, length of the 5 longest primary roots ≥1 mm, and tiller number recorded. Significance of main effects of cutting type and auxin were determined with LSMeans.

Seacoast Marshelder

Softwood cuttings were prepared from the uppermost 10 cm (4 in) of nonbranched terminal shoots. Shoots below the 10 cm (4 in) terminals typically contained many short branches. These short shoots, each containing an intact terminal bud, were used to prepare an additional group of 5 cm (2 in) cuttings. Auxin treatments included IBA at 1000 or 5000 ppm and a nontreated control. The experiment had a factorial arrangement of treatments with 2 cutting types (10 cm and 5 cm [4 and 2 in]) and 3 auxin treatments with 6 cuttings per treatment and 6 replications. Experimental design was a split plot design with cutting type allocated to main plots and auxin treatments allocated to subplots. The experiment ended after 3 wk and percent rooting, root number, length of the 5 longest primary roots ≥1 mm, and number of branches recorded (Table 5). Significance of main effects of cutting size and auxin were determined using LSMeans.

Photo by Mack Thetford

Figure 5 • *Detail of multiple tillers of gulf bluestem cutting 5 wk after sticking.*

RESULTS AND DISCUSSION

False Rosemary

Rooting percentage for softwood cuttings without an auxin application was 97% (Table 2). No auxin treatment resulted in a rooting percentage greater than the nontreated control, but NAA 5000 decreased rooting percentage. Two auxin treatments, NAA 500 and Dip 'N Grow 1:9, increased the number of roots per cutting while 5 auxin treatments, IBA 1000 and 5000, NAA 500, Dip 'N Grow 1:9 and 1:19, increased the mean root length per cutting. Root dry weight was also increased for cuttings treated with NAA 500 and 5000 and Dip 'N Grow 1:9 compared with no auxin.

Auxin application increased the number of cuttings that rooted. Moreover, auxin treatment improved some measures of root quality. NAA 500 consistently improved rooting percentages, root number, root length, and root dry weight of false rosemary and provided the greatest improvement of root quality among auxin treatments tested.

Photo by Mack Thetford

Figure 6 • *Rooted cuttings of false rosemary, Atlantic St Johnswort, seacoast marshelder, and gulf bluestem 5 wk after sticking cuttings in 72-cell flats under intermittent mist.*

Atlantic St Johnswort

Softwood cuttings rooted at 70% without an auxin application but application of IBA 5000, NAA 1000, or Dip 'N Grow 1:9 increased the percentage of cuttings with roots (Table 3). IBA 1000, NAA 500, NAA 5000, and Dip 'N Grow 1:9 did not increase the number of rooted cuttings. The disparate response between IBA and NAA at 5000 ppm seems contradictory, however, species are known to respond differently when treated with equal concentrations of IBA or NAA (Hartmann and others 1997). Although auxin application was not needed to propagate softwood cuttings of Atlantic St Johnswort, several auxin treatments improved measures of root quality. IBA 5000, NAA 1000, and both concentrations of Dip 'N Grow increased the number of roots per cutting while root length was increased with application of IBA 1000 and 5000 and Dip 'N Grow 1:19. Root dry weight also increased with Dip 'N Grow 1:9.

In previous research, rooting percentage of a hybrid of this genus, *Hypericum* 'Hidcote,' was similar among cuttings treated with IBA-talc formulations (3000 ppm), IBA-alcohol solution (3000 ppm), and Dip 'N Grow (2000 ppm IBA and 1000 ppm NAA)(Dirr and Frett 1983). However, differences occurred in root numbers where IBA-alcohol solution and Dip 'N Grow resulted in a doubling of roots over the IBA-talc and control treatments. Such responses to mixtures of root-promoting substances are fairly common, leading authors of propagation texts to suggest that mixtures of auxins are sometimes more effective than either component alone. Mixtures may also induce a higher percentage of cuttings to root

TABLE 4

*Effects of indolebutyric acid on rooting percentage of gulf bluestem (*Schizachyrium maritimum *Chapman (Nash) [Poaceae])*

Indole-3-butyric acid (ppm)	Cutting type: Proximal	Cutting type: Distal	Distal versus Proximal *P* value
0	82 a [a]	16 b	0.0001
1000	76 a	29 a	0.0001
5000	76 a	34 a	0.0001

[a] Means within a column followed by the same letter do not differ (alpha = 0.05).

TABLE 5

*Effects of auxin (indole-3-butyric acid) and cutting type on propagation of seacoast marshelder (*Iva imbricata *Walter [Asteraceae])*

Cutting parameter	Indole-3 -butyric acid (ppm)	Cutting type		P value[b]
		5 cm[a]	10 cm	
rooting (%)	0	83 b[c]	94 a	0.0756
	1000	100 a	97 a	0.6557
	5000	81 b	97 a	0.0080
			Cutting type	0.0213
			Auxin	0.0405
			Cutting type X Auxin	0.0774
root number	0	3 b	4 b	0.3099
	1000	7 a	12 a	0.0007
	5000	5 b	11 a	0.0001
			Cutting type	0.0001
			Auxin	0.0001
			Cutting type X Auxin	0.0001
root length (cm)	0	6.6 a	10.7 b	0.0165
	1000	8.8 a	16.1 a	0.0001
	5000	2.9 b	5.0 c	0.2119
			Cutting type	0.0001
			Auxin	0.0001
			Cutting type X Auxin	0.0869
shoot height (cm)	0	13.7 a	18.6 b	0.0001
	1000	15.8 a	21.3 a	0.0001
	5000	10.6 b	21.7 a	0.0001
			Cutting type	0.0001
			Auxin	0.0030
			Cutting type X Auxin	0.0076
branch number	0	1a	3a	0.0001
	1000	1a	3a	0.0001
	5000	1a	2b	0.0037
			Cutting type	0.0001
			Auxin	0.0042
			Cutting type X Auxin	0.0340

[a] 1 cm = 0.4 in.

[b] Means within a column and variable followed by the same letter do not differ (alpha = 5%).

[c] Significance (within rows) of 5 cm versus 10 cm cuttings or main effects and interaction.

and more roots per cutting than either auxin alone (Hartmann and others 1997).

Gulf Bluestem

Proximal cuttings of gulf bluestem may be rooted without auxin (Table 4). Auxin application had no effect on root number (1.6), mean root length (5.3 cm [2.1 in]), or number of tillers per cutting (2). Cutting type (proximal versus distal), however, was very important for this species and did influence the percentage of cuttings with roots. Rooting percentage was greatest for proximal cuttings while distal cuttings (prepared from stem terminals) rooted very poorly. Auxin application to distal cuttings doubled the rooting percentage.

With some woody plants, variations in root production on cuttings taken from differing positions of the shoot are often observed; highest rooting is usually observed in cuttings taken from the basal portions of the shoot (Hartmann and others 1997). The limited number of mature nodes (the primary site of root initiation in cuttings of gulf bluestem) was probably the primary factor contributing to low rooting percentages of terminal cuttings. Given the low rooting percentage for plants produced from distal cuttings (16% to 34%), it may be advisable to grade cuttings and discard terminals.

Seacoast Marshelder

Auxin application was not needed to achieve 80% rooting of 5 or 10 cm (2 or 4 in) cuttings (Table 5). Rooting percentage among 10 cm (4 in) cuttings did not differ (94% to 97%), while among 5 cm (2 in) cuttings, rooting percentage was increased with IBA 1000. However, more 10 cm (4 in) cuttings rooted (all rates), produced more roots per cutting (all rates), and had longer roots per cutting (no auxin and IBA 1000) (Table 5). Increasing the IBA concentration to 5000 ppm did not further improve rooting or root quality above that achieved without auxin application. As expected, shoot height differences remained between cutting sizes, and secondary branching of plants from 10 cm (4 in) cuttings was greater than secondary branching of plants from 5 cm (2 in) cuttings (Table 5). Both 5 and 10 cm (2 and 4 in) cuttings may be used for propagation. Shorter cuttings produced acceptable transplants and should be used when cutting material is limited. Given the obvious difference in transplant size, cuttings should be graded based on initial size prior to rooting.

Photo by Mack Thetford

Figure 7 • *False rosemary, Atlantic St Johnswort, seacoast marshelder, and gulf bluestem produced in 4-in liner pots.*

PRACTICAL IMPLICATIONS

Our studies suggest that each of the 4 coastal dune species could be rooted at high percentages without the application of a rooting compound containing the auxins IBA or NAA. Addition of an auxin, however, did improve root quality measures for false rosemary, Atlantic St Johnswort, and seacoast marshelder. Attention to grading cuttings based on developmental stage of cutting material for seacoast marshelder and gulf bluestem is important for maintaining uniformity in cutting production and subsequent transplant production.

Rooting and transplant quality of gulf bluestem was improved through selection of older cutting material. Cuttings should be prepared by removing the entire above-ground shoot portions of stock plants and sectioning these shoots into 10 cm (4 in) cuttings. Cuttings from the proximal end of above-ground shoots are used to ensure mature nodes are present, and in fact, a greater number of nodes for shoot and root production are available within this region of the plant because of short internodes (Figure 5).

Although these experiments were conducted without bottom heat, our experience rooting these species over the past 4 y has shown a shorter time for root initiation with bottom heat when daytime air temperatures were < 26 °C (79 °F). This has been particularly important for winter propagation of dormant cuttings where root initiation was evident within 2 to 4 wk with the use of bottom heat. Without bottom heat, root initiation of dormant winter cuttings was not evident for up to 6 or 7 wk. Bottom heat was provided with the use of a thermostatically controlled heating cable installed on the surface of the propagation bench with the thermostat set at 25 °C (77 °F).

Production schedules for these species in the spring and summer months are very similar. Cuttings are stuck in pinebark-based substrates such as 100% milled pine bark or Fafard Mix #4-P (pine bark, sphagnum peat moss, horticultural perlite and vermiculite; Conrad Fafard Inc, Agawam, Massachusetts 01001) using 72-cell trays, and roots initiate within 2 to 3 wk. Rooted cuttings are removed from the mist on week 3 or 4, and the plants remain in these flats through weeks 5 to 6 (Figure 6). Plants were irrigated as needed 2 to 3 times each wk and included fertilization (1 to 2 times each wk) with a 150 ppm N solution (Peters $20N:10P_2O_5:20K_2O$; JR Peters Inc, Allentown, Pennsylvania 18106). Seacoast marshelder and false rosemary may be pruned in weeks 4 or 5 prior to transplant or within 1 wk after transplant to initiate branching. Gulf bluestem and Atlantic St Johnswort, in general, will not require pruning. Following transplant into 1-l pots, plants require an additional 4 to 6 wk production period to achieve a full rootball and a canopy of approximately 15 to 20 cm (6 to 8 in) (Figure 7).

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