Miscanthus ×giganteus Can be Propagated from Stem Cuttings[1]

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Abstract

Giant miscanthus was successfully propagated with 1 or 2-node basal stem cuttings in July and 2-node basal stem cuttings in September. Upper single nodes, especially those 3rd and 4th most distal from the crown, rooted very poorly. There were no consistent differences among peat, perlite, peat:perlite and vermiculite media; however, in July 2007, cuttings in peat:perlite had significantly higher root dry weights than those in other media; and in July 2006, both peat and peat:perlite had significantly higher dry weights than did vermiculite or perlite. Single-node cuttings produced a higher proportion of plants, but 2-node cuttings had significantly more roots, longer roots and higher dry weights. Two-node September cuttings showed a higher percentage of rooting from the upper nodes than did July cuttings of either size. Although 2-node cuttings require larger propagation space and more materials, they produce less waste and a larger finished product than do single-node cuttings.

Index words: giant miscanthus, propagation, biomass, ornamental grasses, landscape grasses, herbaceous perennials.

Species used in this study: giant miscanthus (*Miscanthus ×giganteus* Greef & Deuter ex Hodk. & Renvoize).

Significance to the Nursery Industry

Propagation of sterile plants, such as giant miscanthus, must be done vegetatively. This can be problematic for large grasses that are difficult to handle with traditional crown division. This paper investigated the use of stem cuttings for giant miscanthus, a large ornamental grass that has been extensively studied in biomass research. Stem cuttings can be a successful method of propagating giant miscanthus, with the basal node showing the highest rooting percentages and September cuttings showing increased rooting from upper nodes when using 2-node cuttings.

Introduction

Miscanthus is a genus of approximately 25 species of large, perennial grasses, native to Southeast Asia and Africa. Several *Miscanthus* species are grown as ornamentals in the United States and Europe, including Chinese silvergrass (*Miscanthus sinensis* Andersson), which has escaped cultivation and is invasive in the Mid-Atlantic States (10, 12), and Amur silvergrass [*Miscanthus sacchariflorus* (Maxim.) Franch.], a less common rhizomatous form. A naturally occurring sterile triploid hybrid of these two species is giant miscanthus (*Miscanthus ×giganteus* Greef & Deuter ex Hodk. & Renvoize) (6), a 7–14 foot tall perennial grass, hardy to USDA zone 4 (11) that has potential as a biomass fuel (14, 15, 18). Without viable seed, vegetatively propagating large quantities of giant miscanthus in a cost effective and efficient method is difficult. The large giant miscanthus rhizomes and their stiff bamboo-like culms make it difficult to produce small robust propagules. Rhizome propagated plants have been shown to have a lower number but stronger shoots and thicker rhizome branches than micropropagated plants (8).

Stem cuttings may be an effective alternative means of propagating giant miscanthus. Success with this method has been reported in purple fountaingrass (*Pennisetum advena*, formerly *Pennisetum setaceum* 'Rubrum'), (1, 5); hybrid *Pennisetum* (7); switchgrass (*Panicum virgatum*) 'Heavy Metal' and 'Cloud 9', oriental fountaingrass (*Pennisetum orientale*), blood grass (*Imperata cylindrica* 'Red Baron'), and Indiangrass (*Sorghastrum nutans*) (1). Corley (4) found that only basal cuttings were successful with blue lymegrass (*Elymus glaucus*), but purple fountaingrass (*Pennisetum advena*), ribbongrass (*Phalaris arundinacea* 'Picta'), and seaoats (*Uniola paniculata*) all rooted from 2 or 3-node tip or basal stem cuttings. In that same study (4), Chinese silvergrass, maiden grass (*Miscanthus sinensis* 'Gracillimus'), and zebra grass (*Miscanthus sinensis* 'Zebrinus') all failed to root from stem cuttings.

Field experiments with elephantgrass (*Pennisetum purpureum*) in Florida found genotype, planting date, depth and number of nodes per cutting all affected the success of stem cuttings (17). Entire stems of dwarf 'Mott' elephantgrass were most successful in field establishment with shallow August planting of plants that had been grown under high fertilization rates (13).

The objectives of this experiment were to determine if giant miscanthus could be propagated from stem cuttings and to determine if the media, node position, number of nodes, and time of propagation affected rooting success.

Materials and Methods

We collected culms from 20-year-old, established giant miscanthus plants at the University of Minnesota Landscape Arboretum, Chaska, MN, in July and September in 2006 and 2007. In 2006, the stems were divided into 5 cm (2 in) cuttings taken 1 cm (1/2 in) below the 1st, 2nd, 3rd, and 4th most basal nodes. Cuttings were placed in 128-cell pack plastic trays, 25.07 cm^3 (1.53 in^3) per cell (Landmark Plastics, Akron, OH) with four different media: peat; perlite; peat/perlite 1:1 by vol; and vermiculite. Replications were 10 cuttings per treatment, with three replications per collection date. Trays were placed in a misted greenhouse bench with temperatures of 23.8/18.3C (75/65F) day/night under natural photoperiods (8.78~15.30 hrs per day seasonally). Mist frequency was 8 seconds every 8 minutes from 6 AM until 10 PM. After 11 weeks, the experiment was terminated and

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the following data collected: rooting percentage, number of roots, the longest root length, and root dry weight. Rooting was defined as at least one root with a minimum length of 6 mm (0.25 in).

In 2007, the experiment was repeated, the only difference being the size of the cuttings, which was increased to 10 cm (4 in) and included either the 1st and 2nd most basal nodes or the 3rd and 4th most basal nodes. Due to the larger size, 2007 cuttings were placed in 6.3 cm (w) × 2.3 cm (d) × 8.9 cm (h) pot (250.89 $cm^{3)}$ [2.5 in (w) × 2.5 in (d) × 3.5 in (h); (15.31 in^3)]. Treatments were replicated 3 times per collection date, with 10 replications for each medium and both node positions. The same data were collected as in 2006; additionally, the number of leaves and the longest leaf length were also measured. Nodes were numbered from the base to the apex, with 1 being the most basal, 2 being second above the most basal, etc.; thus node number 4 was the furthest from the base and the closest to the apex of the grass culm. Treatments were placed in a randomized design and data were analyzed separately by year using Duncan's multiple range test for means separation in SPSS (version 8.0 for Windows; SPSS Inc., Chicago, IL).

Results and Discussion

Rooting percentage. Rooting percentages were significantly higher for basal or first-node cuttings taken in July in both years and in September 2007 (Table 1). Overall, upper nodes, whether individual or 2-node cuttings showed less rooting than did basal cuttings. Cuttings taken in September 2006 showed poor rooting, with fewer differences between cuttings from the first and second node position. It is not known why the September 2006 experiment produced such limited success.

In September 2007, the 2-node cuttings with nodes 3rd and 4th most distal from the crown were significantly more successful at rooting than the July 2007 upper cuttings in all media except perlite, perhaps due to the increased maturity of these upper nodes improving their ability to produce adventitious roots.

The seedling root system of grasses first consists of a primary root with branches. This primary root system is replaced by adventitious roots that originate in the pericycle regions of stem nodes and emerge through the subtending leaf sheath as the grass plants grow (3, 9). Thus, older nodes, those proximal to the crown or basal nodes, are more likely to develop roots than are younger nodes more distal from the crown. These results resemble previous work in tender fountaingrass (*Pennisetum advena syn. Pennisetum setaceum* 'Rubrum') (5) and 'Mott' elephantgrass (*Pennisetum purpurem*) (13, 17), where planting date, number of nodes per cutting, and cutting position all affected establishment. Sollenberger et al. (13) suggests that the major limitation of establishing elephantgrass from stem cuttings in the field is the degree to which the stem bases have matured and hardened.

Number of roots. In July 2007, the number of roots was significantly higher with 2-node basal cuttings in perlite than other media or cutting date (Table 2). Although this was consistent with the July 2006 experiment, where the basal node had significantly more roots than did the other nodes, media in July 2006 showed peat:perlite to be significantly better than perlite or vermiculite. In September 2007, cuttings with 1st and 2nd basal nodes showed significantly more roots than nodes 3 and 4, with no media differences. September 2007 cuttings with nodes 3 and 4 produced significantly more roots in peat than in other media.

Root length. Root length was much greater from the larger 2-node cuttings taken in 2007. Compared to 2006, roots were at least three times as long, sometimes much longer (Table 3). Node position was again significant, with basal nodes usually showing the longest roots. There was less variation between node and root length in the September 2007 cuttings. Media did not consistently affect root length.

Root dry weight. In a pattern resembling what was observed for rooting percentages, root dry weights from basal nodes were significantly higher in July 2006, July 2007 and September 2007 than from higher nodes (Table 4). In September 2006, there was no significant root dry weight difference in cuttings from nodes 1 or 2 when grown in peat, perlite

Table 1. Effect of medium, month, and node position on the rooting percentage of *Miscanthus ×giganteus* cuttings.

			Rooting percentage (%)			
			Medium			
Year	Cutting month	Node position	Peat	Perlite	Peat:Perlite	Vermiculite
2006	July	1st	95a[x]	80b	90ab	95a
		2nd	50d	45d	20e	50d
		3rd	15f	5f	10f	10f
		4th	0f	0f	0f	5f
	September	1st	25e	30ed	40d	60c
		2nd	30ed	20e	45d	30ed
		3rd	0f	5f	0f	0f
		4th	0f	0f	0f	0f
2007	July	1th–2nd	93ab	83b	73c	97a
		3rd–4th	10f	23e	23e	20e
	September	1th–2nd	97a	97a	93ab	90ab
		3rd–4th	40d	23e	40d	50d

[z]Mean separation in each year by Duncan's multiple range test ($p \leq 0.05$). Years were analyzed separately.

Table 2. Effect of medium, month, and node position on number of adventitious roots of *Miscanthus ×giganteus* cuttings.

			Number of roots			
			Medium			
Year	**Cutting month**	**Node position**	**Peat**	**Perlite**	**Peat:Perlite**	**Vermiculite**
2006	July	1st	9.5a[z](ab)[y]	6.8a(ab)	10.3a(a)	7.0a(b)
		2nd	3.3b(a)	2.3b(ab)	0.8bc(b)	1.6bc(ab)
		3rd	0.4c(a)	0.1c(a)	0.2c(a)	0.3d(a)
		4th	0.0c(a)	0.0c(a)	0.0c(a)	0.1d(a)
	September	1st	0.9c(a)	1.7bc(a)	2.0b(a)	2.1b(a)
		2nd	0.8c(a)	0.9bc(a)	0.9bc(a)	0.6cd(a)
		3rd	0.0c(a)	0.1c(a)	0.0c(a)	0.0d(a)
		4th	0.0c(a)	0.0c(a)	0.0c(a)	0.0d(a)
2007	July	1st–2nd	11.1a(b)	13.2a(a)	8.3a(c)	8.5a(c)
		3rd–4th	6.7b(a)	4.6c(b)	6.7b(a)	2.7c(c)
	September	1st–2nd	6.5b(ab)	7.5b(a)	6.4b(ab)	6.9b(ab)
		3rd–4th	4.0c(a)	1.6d(b)	2.0c(b)	1.9c(b)

[z]Mean separation in each column using Duncan's multiple range test ($p \leq 0.05$) show node differences by year.
[y]Mean separation in each row using Duncan's multiple range test ($p \leq 0.05$) show medium differences by year.

Table 3. Effect of medium, month, and node position on the longest root length of *Miscanthus ×giganteus* cuttings.

			Longest root length (cm)			
			Medium			
Year	**Cutting month**	**Node position**	**Peat**	**Perlite**	**Peat:Perlite**	**Vermiculite**
2006	July	1st	15.7a[z](a)[y]	4.8a(c)	12.3a(ab)	10.3a(b)
		2nd	8.7b(a)	1.6b(b)	1.4bc(b)	1.3b(b)
		3rd	0.9c(a)	0.1b(a)	0.3c(a)	0.3b(a)
		4th	0.0c(a)	0.0b(a)	0.0c(a)	0.1b(a)
	September	1st	1.7c(c)	4.1a(ab)	5.0a(ab)	9.2a(a)
		2nd	3.3c(a)	1.3b(a)	4.3bc(a)	1.9b(a)
		3rd	0.0c(a)	0.2b(a)	0.0c(a)	0.0b(a)
		4th	0.0c(a)	0.0b(a)	0.0c(a)	0.0b(a)
2007	July	1th–2nd	45.2a(c)	59.4a(a)	53.4ab(abc)	56.8a(ab)
		3rd–4th	22.3c(cd)	48.7bc(b)	58.1a(a)	18.5d(d)
	September	1th–2nd	34.7b(b)	46.2c(a)	35.3bc(b)	47.0b(a)
		3rd–4th	10.2d(d)	45.9c(a)	27.1c(c)	30.5c(bc)

[z]Mean separation in each column by Duncan's multiple range test ($p \leq 0.05$) show node differences by year.
[y]Mean separation in each row by Duncan's multiple range test ($p \leq 0.05$) show medium differences by year.

Table 4. Effect of medium, month, and node position on root dry weight of *Miscanthus ×giganteus* cuttings.

			Root dry weight (mg)			
			Medium			
Year	**Cutting month**	**Node position**	**Peat**	**Perlite**	**Peat:Perlite**	**Vermiculite**
2006	July	1st	135.6a[z](a)[y]	25.9a(b)	100.6a(a)	36.1a(b)
		2nd	63.5b(a)	2.7bc(b)	2.7b(b)	1.8c(b)
		3rd	5.5c(a)	0.6c(a)	0.4b(a)	0.5c(a)
		4th	0.0c(a)	0.0c(a)	0.0b(a)	0.1c(a)
	September	1st	6.2c(a)	14.1b(a)	16.0b(a)	20.8b(a)
		2nd	8.6c(a)	11.9bc(a)	4.1b(a)	1.5c(a)
		3rd	0.0c(a)	0.1c(a)	0.0b(a)	0.0c(a)
		4th	0.0c(a)	0.0c(a)	0.0b(a)	0.0c(a)
2007	July	1th–2nd	1,395.3a(b)	1,016.7a(d)	1,631.0a(a)	1,192.7a(c)
		3rd–4th	533.3b(b)	324.0c(c)	1,519.3b(a)	93.3c(d)
	September	1th–2nd	540.7b(b)	503.0b(b)	493.7c(b)	754.0b(a)
		3rd–4th	179.3c(a)	181.0d(a)	148.0d(a)	137.3c(a)

[z]Mean separation in each column by Duncan's multiple range test ($p \leq 0.05$) show node position by year.
[y]Mean separation in each row by Duncan's multiple range test ($p \leq 0.05$) show medium differences by year.

or peat:perlite, although these weights were significantly lighter than those we measured from the basal nodes from other dates. Root dry weights from cuttings taken in 2007 were much higher than in 2006; cuttings grown in peat:perlite had significantly higher root dry weights than did cuttings in other media across all node positions. Although the July 2006 basal node dry weights were significantly heavier in peat and peat:perlite, they were at least 10 times lighter than those of the basal-node cuttings taken in 2007.

Stored carbohydrates and photosynthetic capacity were likely much higher in the 2-node cuttings. Even though the cuttings were only culms with no leaves, they were comprised of actively growing green tissue that had the capacity to produce larger roots. Photosynthetic capacity of *M. ×giganteus* has been shown to be unique among C4 species; this plant is able to realize the high photosynthetic potential of C4 plants when grown under temperate field conditions. Additionally, two enzymes known to limit C4 photosynthesis correspond to the recovery and maintenance of photosynthetic capacity in *M. ×giganteus* (16). The high photosynthetic capacity of giant miscanthus may positively influence this plants capacity for stem cutting propagation.

The number of leaves and the length of the longest leaf (data taken only in 2007) were similar to the number of roots in the cuttings (data not shown).

Giant miscanthus can be successfully rooted from stem cuttings from actively growing basal-node cuttings. July and September 2-node propagation produced the largest propagules, with September cuttings showing increased success with rooting of upper nodes as compared to single node cuttings taken the previous September. No one medium in these experiments showed consistently higher root numbers, root length, or higher dry weights. If larger propagules are the goal, then 2-node cuttings should be used. If higher total numbers of finished propagules are more important, then individual nodes in positions 1st, 2nd, and 3rd most proximal to the crown should be used to increase giant miscanthus. Growers may find stem cuttings to be an easier method of propagation than traditional crown division for this large ornamental plant.

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