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Miscanthus Anderss. Produces Viable Seed in Four USDA Hardiness Zones[1]

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Abstract

Forty-one taxa of *Miscanthus* grown in USDA Hardiness Zones 4, 5, 6, and 7 were examined in 1996 and 1997 for seed set and viability. Although laboratory results varied widely between years, climatic zones, and cultivars, many plants set viable seed. Eleven types had <18% viable seed, including 'Morning Light', 'Variegatus' and 'Zebrinus', and appear to represent the least risk for becoming invasive plants, especially in northern climates. Other characteristics of *Miscanthus* are discussed in terms of invasive potential in the United States.

Index words: exotic plant, risk assessment, seed germination, ornamental grass, landscape grass.

Species used in this study: giant miscanthus (*Miscanthus* x *giganteus* Greef.); small Japanese miscanthus (*M. oligostachyus* Stapf.); eulalia or miscanthus (*M. sacchariflorus* (Maxim.) Hack.*)*; miscanthus or eulalia (*M. sinensis* Anderss.) and cultivars listed in Table 2.

Significance to the Nursery Industry

A beautiful landscape grass, *Miscanthus* has been cited for its invasive self-seeding characteristics. This report examined inflorescences of *Miscanthus* grown in four USDA hardiness zones, at latitudes from 35° to 45° N, for seed set and germination. Viable seed varied widely between year, cultivar, and hardiness zone; however, thirty types had seed viability of >18%. Taxa with little viable seed, <18%, in this study that may be good selections to promote as non-invasive include: *Miscanthus* x *giganteus*, *M. sinensis* cultivars 'Autumn Light', 'Dixieland', 'Kirk Alexander', 'Little Kitten', 'Morning Light', 'Rigoletto', 'Silberfiel', 'Strictus', 'Variegatus', and 'Yaka Jima'.

Nurseries should be aware of the potential self-seeding of this genus and be especially careful where field stock or mother plants are grown near open meadows and fields where seedlings could become established in native plant communities.

Introduction

Miscanthus Anderss. is a popular ornamental and landscape grass (3, 16) native to East Asia and South Africa (17). Since 1980, over 50 *Miscanthus* selections have been introduced, the majority from Germany and the United States. New cultivars show characteristics of natural hybridization (6, 9) and have been selected for early flowering from open pollinated parents (12, 18).

Concern with invasive self-seeding characteristics has been noted in Germany (18, 21) and the United States (5, 19). In western North Carolina (Zone 6), large stands of self-seeded, naturalized *Miscanthus* have established in disturbed areas along roadsides (4).

Matumura and Yukimura (15) found good germination of *M. sinensis* and *M. sacchariflorus* but noted insufficient seed set for forage production. Ploidy levels, which may affect seed set, vary within and between *Miscanthus* species. With a base number of n = 19, current classification is: *M. floridulus* (Labill.) Warb., diploid and tetraploid; *M.* x *giganteus* Greef., triploid*; M.oligostachyus* Stapf., diploid; *M. sacchariflorus* (Maxim.) Hack., variable diploid through hexaploid; and *M. sinensis* Anderss., diploid, triploid, and tetraploid, (1, 11, 14, 17). Self-incompatibility, sterility and triploids have been reported (9, 10, 13). *M. sinensis* 'Goliath', *M. sinensis* var. *condensatus*, and *M.* x *giganteus* are reported to be male sterile or set very little seed (1, 9).

Nurseries and garden centers should know the potential invasiveness of new plants before they are widely distributed. Ascertaining the extent to which *Miscanthus* self-seeds may determine its continued use as an ornamental, decorative plant. Cultivars that set no seed, if available, should be recognized and promoted in the trade. As a warm season grass requiring a relatively long growing season, *Miscanthus* usually flowers from August to October. Seed maturity, and self-seeding, therefore, may vary depending on the location in which the plant is grown. The objective of this research was to determine if seed set and viability vary between ornamental taxa and if there is a relationship between hardiness zone in which the plants are grown and viable seed set.

Methods and Materials

Inflorescences were collected or acquired from locations listed in Table 1. In 1996, collections were made at the end of the growing season, mid-October for Zone 4 and as late as early December for Zones 6 and 7. In 1997, inflorescences were collected in mid to late October when the plants had fully matured in all zones. Collections were from field grown, mature (usually 3-or-more-year-old) plants. Large, full inflorescences with minimal disarticulation were selected, separated into paper bags by type, and mailed to the University of Minnesota. Material was held in a seed storage room (5C) until cleaning. Inflorescences were not available from all locations due to cultivars not grown at that location, no flowers available because the plant was immature, or flowers not produced in the growing season.

Individual inflorescences were cleaned by hand with a de-hulling trough, and seeds were separated from hulls and

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Table 1. Source, location, and number of *Miscanthus* inflorescences examined for seed set and viability.

Name	Address	USDA zone	No. of taxa	
			1996	1997
Minnesota Landscape Arboretum	3675 Arboretum Drive, Chanhassen, MN 55317	4	32	34
Bald Eagle Nursery	18510 Sand Road, Fulton, IL 61252	5	24	30
Kurt Bluemel, Inc. Nurseries	2740 Greene Lane, Baldwin, MD 21013	6	24	34
Plant Delight's Nursery	9241 Sauls Road, Raleigh, NC 27603	7	16	20
John Hoffman Nursery	5520 Bahama Road, Rugemont, NC 27572	7	—	2

chaff with a window screen and then counted. At least three inflorescences were cleaned for each taxon in each year. Seed was bulked for each taxon at each location each year; statistical analysis was based on square root of seed counts. For germination trials, twenty-five seeds were rolled into a paper towel moistened with distilled water and placed in a ziplock bag at room temperature with exposure to minimal light. Seeds were given one month in which to germinate. Germination was defined as the emergence of radical and plumule. The cleaning and germination procedure was the same for 1996 and 1997.

Results and Discussion

Data showed wide variation between cultivar, species, year and location, Tables 2 and 3. However, many *Miscanthus* cultivars and species set viable seed. Seed set was significantly higher in Zone 5 than 7 both years. There was no significant difference between seed set in the other zones. Seed germination revealed Zone 6 had significantly greater germination than Zones 5 or 7 in 1996, and Zone 7 in 1997.

Cultivars with little viable seed, <18%, from at least 3 zones are listed in Table 4. These *Miscanthus* appear to have the least risk of self-seeding and becoming invasive. In this study, many early flowering types set viable seed in Zones 4 and 5, whereas later flowering types set little seed. Results were limited by lack of cultivar availability across all zones for both years, especially in Zone 7.

Cultural management can also affect the amount of seed produced. Plants in Zone 4 were burned back in the spring, a management practice known to increase grass seed production. Lack of uniform management practices may also be reflected in these results.

Self-seeding is just one trait of concern for invasive plants, although it can enable a species to move quickly into native habitats (2). Most *Miscanthus* are bunch grasses, however *M. sacchariflorus* develops extensive creeping rhizomes, while *M.* x *giganteus* and other cultivars exhibit intermediate rhizome vigor.

Grasses have the potential to create widespread invasions where they compete aggressively with native species and also may have substantial ecosystem-level effects (7). *Miscanthus* would be rejected as an ornamental and labeled an invasive plant using Reichard's (20) decision tree model. Based on her research with *woody* plants, the model would advise against planting *Miscanthus* since it has invaded elsewhere (Germany, North Carolina) and it is not native to North America.

Unlike *Lythrum salicaria*, purple loosestrife, which hybridized with native US species to produce invasive offspring, *Miscanthus* has no congeners in North America so crossing with native species poses little risk. New hybrids which develop naturally from nursery populations may still have the potential to become invasive.

Further work is needed to assess the potential for seed germination and competitiveness of *Miscanthus* in nature. Timing of anthesis, flowering period, self and cross-pollination and incompatibility need to be studied. Nurseries and gardeners need to be aware of the potential invasiveness of this genus and be especially careful where field stock or mother plants are grown near open meadows and fields where seedlings could become established in native plant communities.

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Table 2. Seed set and germination of *Miscanthus* grown in four USDA Zones, 1996 and 1997.

Species/ cultivar	Flowering time[z]	Zone															
		4				5				6				7			
		1996		1997		1996		1997		1996		1997		1996		1997	
		Seed no.[x]	Germ.[y] (%)	Seed no.	Germ. (%)	Seed no.	Germ. (%)	Seed no.	Germ. (%)	Seed no.	Germ. (%)	Seed no.	Germ. (%)	Seed no.	Germ. (%)	Seed no.	Germ. (%)
M. x *giganteus*	L	—[w]	—	0	0	0	0	0	0	—	—	0	0	—	—	0	0
M. oligostachyus	E	0	0	—	—	—	—	—	—	23	40	—	—	1	0	—	—
M. sacchariflorus	E	—	—	9	17	14	64	270	48	4	75	15	96	—	—	—	—
M. sinensis ‘Adagio’	M	150	10	906	40	0	0	0	—	49	54	57	12	0	0	0	—
M. sinensis ‘Autunm Light’	L	219	0	147	0	0	0	3669	0	—	—	2913	0	—	—	—	—
M. sinensis ‘Bitsy Ben’	E	96	32	—	—	3216	24	—	—	—	—	—	—	—	—	—	—
M. sinensis ‘Bluetenwunder’	M	7158	18	4932	16	4875	17	5340	72	645	48	123	84	—	—	—	—
M. sinensis ‘Dixieland’	L	0	0	0	0	—	—	0	0	—	—	0	0	33	0	0	0
M. sinensis ‘Ferner Osten’	E	—	—	399	32	—	—	1077	52	—	—	2526	76	—	—	—	—
M. sinensis ‘Flamingo’	E	36	17	—	—	—	—	—	—	63	57	—	—	—	—	—	—
M. sinensis ‘Goliath’	M	1299	48	—	—	—	—	—	—	68	34	—	—	6	0	—	—
M. sinensis ‘Gracillimus’	L	—	—	0	0	—	—	90	0	—	—	0	0	—	—	837	36
M. sinensis ‘Graziella’	M	21	0	2958	40	3288	28	1590	72	127	44	30	88	3	0	0	0
M. sinensis ‘Grosse Fontane’	L	0	0	0	0	0	0	7983	32	114	58	1482	56	0	0	0	0
M. sinensis ‘Herkules’	M	30	20	—	—	—	—	—	—	18	29	—	—	—	—	—	—
M. sinensis ‘Juli’	E	180	35	2082	24	—	—	—	—	2295	61	264	64	—	—	—	—
M. sinensis ‘Kaskade’	L	—	—	0	0	—	—	630	60	—	—	234	72	—	—	—	—
M. sinensis ‘Klein Fontane’	E	33	64	—	—	—	—	—	—	5	33	—	—	—	—	—	—
M. sinensis ‘Kirk Alexander’	L	—	—	0	0	—	—	0	0	—	—	0	0	—	—	255	0
M. sinensis ‘Little Kitten’	L	—	—	0	0	—	—	—	—	—	—	669	0	—	—	231	8
M. sinensis ‘Malepartus’	M	51	47	492	24	3249	4	2811	80	10	10	21	45	8	33	9	67
M. sinensis ‘Morning Light’	L	0	0	0	0	0	0	0	0	0	0	0	0	33	18	1410	0
M. sinensis ‘Nippon’	E	0	0	48	38	90	30	54	60	65	43	66	64	0	0	—	—
M. sinensis ‘Nov. Sunset’	M	738	0	732	36	0	0	0	0	—	—	174	0	—	—	—	—
M. sinensis ‘Positano’	M	1392	32	3213	28	48	6	2319	44	8	88	498	72	—	—	—	—
M. sinensis ‘Puenktchen’	L	819	0	2580	12	1209	0	2736	48	—	—	1641	72	2	100	0	0
M. sinensis ‘Purpurascens’	M	159	16	822	60	174	43	696	52	52	38	12	79	—	—	0	0
M. sinensis ‘Rigoletto’	L	0	0	0	0	—	—	—	—	—	—	120	4	0	0	153	0
M. sinensis ‘Roland’	M	2949	2	4422	36	21	29	672	16	34	41	411	84	—	—	—	—
M. sinensis ‘Rotsilber’	M	3030	8	5499	44	4752	26	1962	68	186	54	588	76	8	17	15	20
M. sinensis ‘Sarabande’	L	45	7	288	8	0	0	0	0	—	—	24	47	17	24	0	0
M. sinensis ‘Silberfeder’	M	0	0	2178	0	1044	0	3009	48	23	72	366	60	—	9	1665	60
M. sinensis ‘Silberpfeil’	L	0	0	0	0	—	—	—	—	—	—	0	0	6	0	0	0
M. sinensis ‘Silberspinne’	M	1827	60	2178	8	1836	20	678	72	112	48	21	52	10	22	—	—
M. sinensis ‘Sirene’	M	984	0	0	0	2949	18	807	44	582	76	669	88	—	—	—	—
M. sinensis ‘Strictus’	L	—	—	9	0	—	—	2571	0	—	—	1131	16	—	—	0	0
M. sinensis ‘Undine’	M	378	5	1635	12	642	10	3342	40	206	56	336	52	—	—	—	—
M. sinensis ‘Variegatus’	L	0	0	255	0	0	0	789	0	11	16	216	0	—	—	0	0
M. sinensis ‘Wetterfahne’	M	—	—	15	0	—	—	9	89	—	—	—	—	—	—	0	0
M. sinensis ‘Yaka Jima’	M	—	—	—	—	0	0	1287	4	—	—	126	0	—	—	0	0
M. sinensis ‘Zebrinus’	L	0	0	0	0	—	—	—	—	852	60	0	0	4	0	0	0
Mean		697	14	1053	14	1142	13	1480	35	231	47	433	40	8	13	208	9

[z]Flowering time in zone 4, E = before August 15; M = August 15–September 15; L = after September 15.

[y]Germ. % = germination percentage.

[x]Seed no. = number of seeds (bulked) from at least three inflorescences.

[w]— = no inflorescences available.

Table 3. Seed set and germination for all *Miscanthus* examined across hardiness zones, 1996–1997.

Zone	1996		1997	
	Seed set (no.)	Germ. (%)	Seed set (no.)	Germ. (%)
4	697ab[z]	14ab	1053ab	14ab
5	1142a	13b	1480a	35ab
6	231ab	47a	433ab	40a
7	8b	13b	208b	9b

[z]Means followed by different letters are significantly different at the P = .05 level as determined by Tukey's HSD method.

Table 4. Miscanthus with less than 18% viable seed in Zones 4–7, 1996 & 1997.

Name	Comments
Miscanthus x *giganteus*	0% germ.
M. sinensis 'Autumn Light'	not avail. Zone 7; 0% germ.
M. sinensis 'Dixieland'	0% germ.
M. sinensis 'Kirk Alexander'	0% germ.
M. sinensis 'Little Kitten'	not avail. Zone 5; 0–8% germ.
M. sinensis 'Morning Light'	0–18% germ.
M. sinensis 'Rigoletto'	not avail. Zone 5, 0–4% germ.
M. sinensis 'Silberpfiel'	not avail. Zone 5; 0% germ
M. sinensis 'Strictus'	0–16% germ.
M. sinensis 'Variegatus'	0–16% germ.
M. sinensis 'Yaka Jima'	not avail. Zone 4; 0–4% germ.

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