Variety Trials

Landscape Performance, Flowering, and Seed Viability of 15 Japanese Silver Grass Cultivars Grown in Northern and Southern Florida

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Summary. **Japanese silver grass (*Miscanthus sinensis*) and 14 cultivars were transplanted in northern and southern Florida and evaluated for landscape performance, flowering, growth, and seed viability. All plants survived the 84-week study at both locations with the exception of 'Morning Light', where 22% to 33% of the plants died. In northern and southern Florida, 'Arabesque', 'Adagio', 'Cosmopolitan', and 'Gracillimus' received the highest visual quality ratings on average throughout the entire study, yet other cultivars such as 'Central Park' and 'Silberfeder' performed well but had much narrower windows of peak performance. Cultivars such as 'Little Kitten' and 'Sarabande' performed far better in southern Florida than in northern Florida. Regardless of location, 'Morning Light' and 'Puenktchen' generally did not perform as well as other cultivars. In northern Florida, four consecutive months of very good to excellent flowering (75% to 100% canopy coverage) were observed for 'Adagio', 'Arabesque', 'Cosmopolitan', 'Gracillimus', 'Little Kitten', 'Sarabande', 'Silberfeder', and 'Zebrinus'. However, in southern Florida, peak flowering periods for these cultivars were delayed and generally only lasted for 1 to 2 months. On average, plants in northern Florida were larger and produced 2.8 times more flowers than plants in southern Florida. All cultivars produced viable seed with germination of viable seed ranging from 53.6% ('Cabaret') to 100% ('Gracillimus') in southern Florida, and from 49.8% ('Arabesque') to 100% ('Adagio', 'Little Kitten', 'Sarabande', and 'Variegatus') in northern Florida.**

The use of ornamental grasses in median strips, parking lot borders, and for erosion control on slopes has become increasingly popular over the years. Modern grass selections offer a broad range of characteristics to choose from, such as flowering time, panicle size, leaf width and color, and plant form. Of the many ornamental Poaceae genera, *Miscanthus* is among the most popular. Modern silver grass (*Miscanthus* spp.) hybrids are largely attributed to the early work of E. Pagels, a world-famous perennial breeder who turned his attentions to silver grass in the late 1970s. It has been estimated that 50 silver grass selections have been introduced over the past 20 years (Meyer and Tchida, 1999), and Grounds (1998) states that there are now well over 100 named varieties. A strength of silver grass is its extraordinary adaptability to a range of landscape conditions, yet a consequence of this is its ability to self-seed and readily naturalize in areas far beyond its planting. Most silver grass species are wind pollinated, with viable pollen capable of long-distance travel and normal fertilization (Chou et al., 2000). In some respects, the invasive potential of silver grass has been enhanced by horticultural development because some modern cultivars were selected for their ability to flower (resulting in subsequent seed set) in shorter seasons (Darke, 1999).

The effects of invasive grasses on ecosystem function and resource competition are significant (D'Antonio and Vitousek, 1992). Of the species listed as invasive by the Florida Exotic Pest Plant Council (FLEPPC), 8% belong to Poaceae (FLEPPC, 2005). Japanese silver grass is not on the FLEPPC list but nevertheless has received considerable negative attention due to its invasive properties in other states. Native to eastern Asia, the species has escaped cultivation in 25 states [U.S. Department of Agriculture, National Resources Conservation Service (USDA, NRCS), 2004] including Florida (one county) (Wunderlin and Hansen, 2004). It is found in patches throughout the eastern U.S. from Florida to Texas, north to Massachusetts and New York, and generally spreads to disturbed sites along roadsides, woodland borders, and clearings within

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.3048	ft	m	3.2808
3.7854	gal	L	0.2642
2.54	inch(es)	cm	0.3937
28.3495	oz	g	0.0353
3.0515	oz/1000 ft^2	kg·ha^{-1}	0.3277
(°F – 32) ÷ 1.8	°F	°C	(1.8 × °C) + 32

wooded areas (Randall and Marinelli, 1996). Japanese silver grass is listed as invasive by North Carolina, Pennsylvania, and Washington, D.C.; and has been placed on invasive watch lists in Ohio, Indiana, Iowa, Virginia, Kentucky, and Wisconsin (Meyer, 2003). The University of Florida, Institute of Food and Agricultural Sciences (IFAS) assessment of the status of non-native plants in Florida's natural areas concluded that japanese silver grass is not a problem species in northern, central, or southern Florida and may be recommended for ornamental use (Fox et al., 2005). However, this is not a predictive tool and useful only to indicate the current status of invasiveness. Also, to fully assess the invasive status of a species, particularly one with high ornamental value, cultivars should be evaluated. Wilson and Mecca (2003) found large differences in seed production and germination of eight mexican petunia (*Ruellia tweediana*) cultivars, and that dwarf cultivars are not true to type. Wilson et al. (2004a, 2004b) also found large differences in plant growth and seed production of 14 butterfly bush taxa (*Buddleja* spp.) planted in southern (Zone 9b) and western (Zone 8b) Florida.

Due to concerns over invasive self-seeding behaviors, Meyer and Tchida (1999) examined inflorescences of 41 silver grass taxa grown in four USDA cold hardiness zones (Zones 4, 5, 6, and 7) for seed set and germination. Eleven cultivars had less than 18% viable seed, including 'Morning Light', 'Variegatus', and 'Zebrinus', and appeared to represent the least risk for becoming invasive. Seed set was significantly higher in Zone 5 than in Zone 7 and many early-flowering types set viable seed in Zones 4 and 5, whereas later-flowering types set little seed. The wide variation between cultivars and location in Zones 4–7 warranted additional research for Zones 8 and 9.

The ornamental value and performance of japanese silver grass cultivars in Florida has been sparingly characterized in extension or online publications, and only for a handful of cultivars (Gilman, 1999a, 1999b; Thetford, 2005). Also, despite the wide range of cultivars, japanese silver grass is much more commonly used in northern Florida than in southern Florida. Yet, no studies have fully evaluated its landscape potential in either location. The invasive history of japanese silver grass in other states warrants the inclusion of seed production and viability in variety trials. The objectives of this study were two-fold: 1) to assess the ornamental value and performance of 15 japanese silver grass cultivars in two distinct regions of Florida, and 2) to characterize flowering with relation to seed set, viability, and germination among cultivars planted in northern (Zone 8b) and southern (Zone 9b) Florida.

Materials and methods

PLANT MATERIAL AND FIELD CONDITIONS. Fifteen japanese silver grass cultivars were selected for this study based on popularity and availability (Table 1). Clonally propagated selections were obtained as liners from Emerald Coast Growers (Pensacola, Fla.) with the exception of 'Adagio', which were obtained from Tallahassee Nurseries (Tallahassee, Fla.). Liners were finished in 1.0-gal containers on site at the North Florida Research and Education Center (Quincy, Fla.). Nine uniform 1.0-gal plants of each taxon were installed in southern Florida (Fort Pierce; USDA cold hardiness Zone 9b) and northern Florida (Quincy; USDA cold hardiness Zone 8b) on 11 June 2003. Plants were placed 7.0 ft on center in beds covered with black landscape fabric. Plants were sub-irrigated by filling canals (southern Florida) or drip irrigated (northern Florida) as needed and fertilized 4 and 56 weeks after planting with 57 g of 12-month 15N–3.9P–10K Osmocote Plus (Scotts Co., Marysville, Ohio) in the area 12–18 inches from the crown. Plants were treated after 60 weeks with mancozeb (Dithane; Rohm and Hass Co., Philadelphia) at a rate (a.i.) of 2.3 oz/1000 ft^2 to control leaf spot caused by *Bipolaris* species and neem oil extract (Trilogy; Certis USA, Columbia, Md.) at a rate (a.i.) of 4.0 oz/1000 ft^2 to control armored scale (*Duplachionaspis divergens*). Field conditions for southern Florida were as follows: Ankona sand with 1.3% organic matter, pH 5.7, average monthly rainfall 11.03 cm, mean minimum and maximum temperatures 12.7 and 32.1 °C, respectively, and 77.9% relative humidity. Field conditions for northern Florida were as follows: Carnegie loamy fine sand with 2.9% organic matter, pH 5.1, average monthly rainfall 11.14 cm, mean minimum and maximum temperatures 7.6 and 31.2 °C, respectively, and 79.3% relative humidity.

VISUAL QUALITY, FLOWERING, AND PLANT GROWTH. Visual quality (plant color and form) was assessed monthly by three individuals for each cultivar independently at each location. Assessments of foliage color and form were performed on a scale from 1 to 5 where 1 = poor quality, not acceptable, severe leaf necrosis or yellowing; 2 = fair quality, marginally acceptable, some areas of necrosis or yellowing, fair form; 3 = average quality, adequate and somewhat desirable form and color; 4 = good quality, very acceptable, nice color, good form, desirable; and 5 = excellent quality, very desirable landscape performance. On 15 Feb. 2004, plants at each location were cut back to 6–8 inches aboveground in accordance to industry standards. Values for the highest rating, peak month, and cumulative average rating (Table 2) were generated from data collected during monthly evaluations (not presented).

Monthly assessments of flower coverage were performed on a scale from 1 to 5 where 1 = 0% (no flowers present), 2 = 25%, 3 = 50%, 4 = 75%, and 5 = 100% (maximum canopy coverage). Following peak flower production (a time determined when greater than half of the inflorescences faded and were fully mature), the total inflorescence number per plant was recorded at each location.

At the termination of the study (week 84, 13 Jan. 2005), growth indices were calculated for each plant as an average of the measured height and two perpendicular widths. Crown circumference was measured 1 inch above soil level.

SEED GERMINATION AND VIABILITY. Mature inflorescences were removed from each plant at each site and cleaned by hand using a de-hulling trough (Hoffman Manufacturing, Albany, Ore.). Immature seeds or seeds with visible indication of pathogen or insect damage were discarded. Cleaned seeds were air dried at 22 °C for 48–72 h prior to analysis. In accordance with the Tetrazolium Testing Handbook, Contribution No. 29 Association of Official Seed Analysts (AOSA) rules (Peters, 2000), pre-germination viability tests were replicated twice on a subset of 100 seeds per cultivar. Seeds were stained for 4 h at 35 °C in 0.1% tetrazolium solution with positive staining patterns confirming seed viability (Mid-West Seed Service,

Table 1. Common name and plant description of japanese silver grass and 14 cultivars.

Common name	Cultivar	Plant form, foliage, and inflorescence description
Japanese silver grass selection		Wild type selection reverted back from the cultivar 'Strictus'. Medium-textured foliage on a vase-shaped plant. White seed heads held high above foliage.
Adagio japanese silver grass	Adagio	Narrow leaves with white midribs on a compact plant with a mounding form. Silvery white seedheads held just beyond the foliage.
Arabesque japanese silver grass	Arabesque	Narrow leaves on a compact plant with an arching to rounded habit. Airy, white seedheads held moderately high above foliage.
Cabaret japanese silver grass	Cabaret[z]	Wide leaves with prominent, creamy-white, linear variegation along the middles of leaves (reverse variegation pattern of 'Cosmopolitan'). Vigorous, coarse-textured, rounded plant. Creamy-white seedheads held above foliage.
Central park japanese silver grass	Central Park[z]	Wide green leaves with white midribs on a vigorous, coarse-textured plant with an arching, rounded habit. White seedheads are held above the foliage.
Cosmopolitan japanese silver grass	Cosmopolitan[z]	Wide leaves with prominent creamy-white, linear variegation along the margins of leaves (reverse variegation pattern of 'Cabaret'). Vigorous, coarse-textured plant with an upright rounded habit. Creamy-white seedheads held above foliage.
Gracillimus japanese silver grass	Gracillimus	Fine-textured foliage and a graceful, upright growth habit similar to 'Graziella'. Bronze-red seedheads turning pale straw colored and held just above the foliage.
Graziella japanese silver grass	Graziella	Fine-textured foliage and upright growth habit very similar to 'Gracillimus' but more tight. Golden seedheads turning white and held just above the foliage. Seedheads form about a month before 'Gracillimus'.
Little kitten dwarf japanese silver grass	Little Kitten	Narrow foliage on a dwarf plant with an upright-rounded habit. Tight white inflorescences held above the foliage.
Morning light japanese silver grass	Morning Light	Vase-shaped with arching, narrow, variegated foliage. Red-bronze seedheads form about a month after most other cultivars and are held just above the foliage.
Puenktchen little dot grass	Puenktchen	Horizontally banded, yellow variegated leaves on a dwarf plant with an upright habit. Tight, cream-colored seedheads held high above foliage.
Sarabande japanese silver grass	Sarabande	Narrow foliage on a plant with an upright habit. Tight, pale gold seedheads held just above foliage.
Silberfeder japanese silver grass	Silberfeder	Medium-textured foliage on a plant with an upright habit. Airy white seedheads held above foliage.
Variegated japanese silver grass	Variegatus	Medium-textured foliage with prominent, linear, creamy-white variegation on a rounded plant. Tight, white seedheads held above the foliage.
Zebrinus variegated japanese silver grass	Zebrinus	Horizontally banded, yellow variegated leaves are medium-textured on a vase-shaped plant. Straw-colored seedheads held high above the foliage.

[z]Cultivars derived from *Miscanthus sinensis* var. *condensatus.*

Brookings, S.Dak.). An additional 400 seeds per cultivar were subjected to germination tests (four replications of 100 seeds per test) at 20 °C for 14 d in covered petri dishes with two layers of blue blotter paper (Mid-West Seed Service). Seeds were subjected to an 8-h photoperiod. Germination readings were taken at 7 d with a final count at 14 d. Ungerminated seed were subjected to post-germination viability tests (as described above) and used to report percent germination of viable seeds.

Experimental design and statistical analysis. The field experiments were conducted similarly in northern and southern Florida. A randomized complete-block experimental design was used with 15 cultivars placed in three-plant plots replicated three times. Visual quality and flowering data were collected monthly for each replication. At 84 weeks, growth data were collected on each plant sample. Each experiment was subjected to analysis of variance (ANOVA) and significant means separated by least significant difference (LSD), $P = 0.05$ level. Percentage data were transformed by a sqrt arcsine prior to conducting an ANOVA. Transformed means were separated by a Duncan's multiple range test, $P = 0.05$.

Results and discussion

Visual quality and flowering. Visual quality of japanese silver grass varied by location and cultivar (Table 2). In southern Florida, plants remained evergreen throughout the study. Peak visual quality values were recorded from April to November and were generally high (very good to excellent) among cultivars, with the exception of 'Cosmopolitan', 'Morning Light', and 'Puenktchen', that had slightly lower peak ratings (4.0 or less) (Table

Table 2. Maximum visual quality rating, peak time (based on plant color and form), and overall average rating of japanese silver grass and 14 cultivars grown in northern and southern Florida for 84 weeks.

	Southern Florida			Northern Florida		
Cultivars	Highest rating (1–5 scale)[y]	Peak month(s) and year(s)	Avg rating (1–5 scale)[x]	Highest rating (1–5 scale)[y]	Peak month(s) and year(s)	Avg rating (1–5 scale)[x]
Japanese silver grass selection	4.4	Nov. 2003	3.1	4.3	Sept. 2004	2.1
Adagio	5.0	Oct. 2003				
		Nov. 2003	3.9	4.7	Oct. 2003	
		July 2004	3.0			
Arabesque	4.8	Oct. 2003	3.7	4.8	Oct. 2003	3.0
Cabaret[z]	4.4	July 2003	3.1	4.8	Oct. 2003	2.8
Central Park[z]	4.8	Oct. 2003	3.3	5.0	Oct. 2003	2.9
Cosmopolitan[z]	4.0	April 2004	3.1	5.0	July 2004	3.2
Gracillimus	4.7	July 2003				
		Sept. 2003	3.5	4.8	Oct. 2003	3.1
Graziella	4.6	Sept. 2003	3.3	4.3	Oct. 2003	
		Sept. 2004	2.5			
Little Kitten	4.9	Oct. 2003				
		Nov. 2003	3.8	4.0	July 2004	2.2
Morning Light	4.0	July 2003	2.4	3.2	Nov. 2004	1.8
Puenktchen	3.6	July 2004				
		Aug. 2004	2.6	3.7	Sept. 2004	1.9
Sarabande	5.0	Oct. 2003				
		Nov. 2003	3.9	4.2	July 2004	2.5
Silberfeder	4.6	July 2003	3.3	4.9	Oct. 2003	2.7
Variegatus	4.1	July 2004	2.8	4.3	June 2004	
		Nov. 2004	2.9			
Zebrinus	4.6	July 2003	3.3	4.7	July 2004	2.9
LSD (0.05)[w]	0.6		0.2	0.6		0.3

[z]Cultivars derived from *Miscanthus sinensis* var. *condensatus*.
[y]Level of performance was rated 1 (poor quality) to 5 (excellent).
[x]Average rating was derived by dividing the cumulative monthly quality rating by 21 months.
[w]Least significant difference at $P = 0.05$ level.

2). Overall, 'Adagio', 'Arabesque', 'Little Kitten', and 'Sarabande' had higher average visual quality ratings, suggesting that they performed better for longer than the other cultivars (Table 2). In northern Florida, frosts killed aboveground portions of all plants during both winters. Peak visual quality values were recorded from June to Nov. and were generally high (very good to excellent) among cultivars, with the exception of 'Little Kitten', 'Morning Light', and 'Puenktchen', that had slightly lower peak ratings (4.0 or less) (Table 2). Overall, 'Adagio', 'Arabesque', 'Cosmopolitan', and 'Gracillimus' had higher average visual quality ratings, suggesting that they performed better for longer than the other cultivars (Table 2). It should be noted that regardless of planting site, 'Morning Light' and 'Puenktchen' did not perform well throughout much of the study. Similarly, in an ornamental grass evaluation in Tifton, Ga., Ruter and Carter (2000) reported that 'Morning Light' did not grow as well or flower as heavily as 'Adagio'. In the present study, declining performance of 'Morning Light' was partially attributed to 22% (northern Florida) and 33% (southern Florida) fatality. All other cultivars survived the study in both locations.

It should be noted that some decline in plant performance was visually observed in southern Florida during the fall of 2004 following hurricanes Frances (5 Sept.) and Jeanne (26 Sept.), but all plants fully recovered. Also, some decline in plant performance was documented as a result of helminthosporium leaf spot (*Bipolaris* spp.) in northern and southern Florida and an armored scale (*Duplachionaspis divergens*) in southern Florida. Both are considered relatively new pests on silver grass (Hodges, 2005; Loewer, 2004). Leaf spot damage was generally greater in southern Florida than in northern Florida (data not shown). In southern Florida, 'Graziella' appeared to be more resistant, while in northern Florida 'Adagio', 'Central Park', 'Graziella', 'Little Kitten', and 'Sarabande' appeared most resistant. Banks grass mite (*Oligonychus pratensis*) was noted on plants in northern Florida but did not require management.

Flowering performance varied by cultivar and location (Fig. 1, Table 3). On average, plants in northern Florida produced twice as many flowers than plants in southern Florida (Table 3). Average inflorescence number within a single harvest (at 64 weeks) ranged from 11 inflorescences ('Morning Light') to 372 inflorescences ('Little Kitten') for southern Florida; or 72 inflorescences ('Morning Light') to 604 inflorescences ('Arabesque') in northern Florida (Table 3). In southern and northern Florida, peak flowering occurred in Oct. 2003 and Sept. 2004 with greatest flowering (100% of flower canopy coverage) displayed by 'Adagio', 'Arabesque', 'Central Park', 'Gracillimus', and 'Silberfeder' (Fig 1). During 2003, 'Morning Light' and japanese silver grass had poor flower ratings less than 3 (less than 50% of flower canopy coverage) in both locations. During 2004, low flowering (50% or less) was only observed in southern

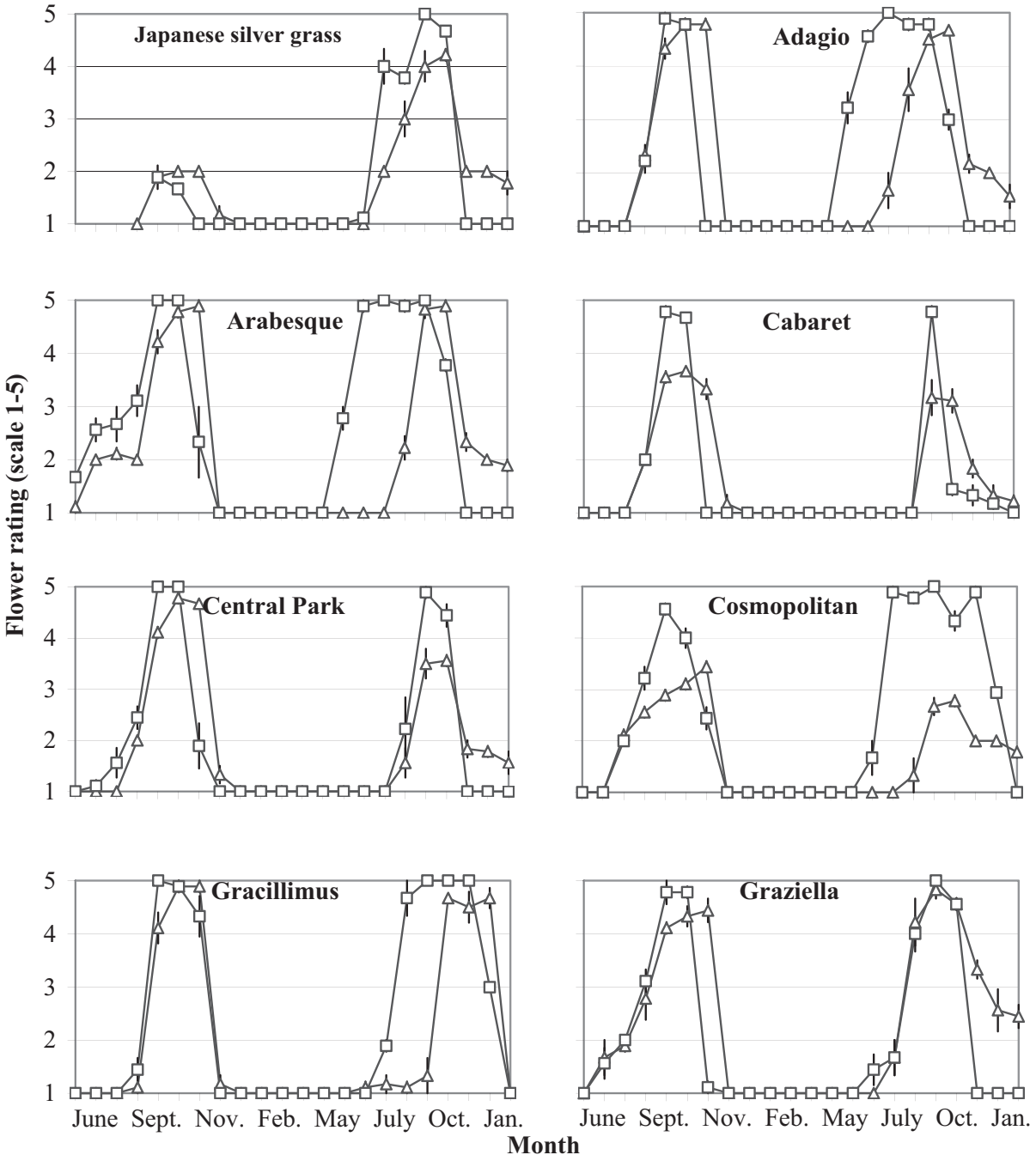

Fig. 1. Monthly flower canopy coverage (percent of flowering canopy) of japanese silver grass and 14 cultivars planted in northern Florida (—❑—) and southern Florida ((—Δ—). Flower canopy coverage was rated 1 (0% coverage) to 5 (100% coverage). Mean values ± SE are shown (n = 3). Figure 1 continued on next page.

Florida for 'Cabaret', 'Cosmopolitan', and 'Morning Light'.

Meyer and Tchida (1999) categorized silver grass taxa as early (before 15 Aug.), mid (15 Aug. to 15 Sept.), and late (after 15 Sept.) season flowering with relation to seed set and invasive potential. Use of their criteria in the present study was difficult because flowering time differed by year. For example, five cultivars in northern Florida flowered earlier in 2004 than in 2003; and six cultivars in southern Florida flowered later in 2004 than in 2003. Flower initiation may have been more uniform among locations in 2003 because all plants were initially grown under the same conditions prior to the 11 June 2003 planting date, and some cultivars began flowering within 4 weeks of planting. Using Meyer and Tchida (1999) flowering criteria for the second year of our study, early season flowerers were 'Puenktchen', 'Zebrinus', and Japanese silver grass (southern and northern Florida); and 'Adagio', 'Arabesque', 'Cosmopolitan', 'Little Kitten', 'Puenktchen', 'Sarabande', 'Silberfeder', 'Variegatus', 'Zebrinus', and japanese silver grass (northern Florida only). Mid season flowerers were 'Graziella' (southern and northern Florida); 'Adagio', 'Arabesque', 'Little Kitten', and 'Silberfeder' (southern Florida only); and 'Central Park' and 'Gracillimus'

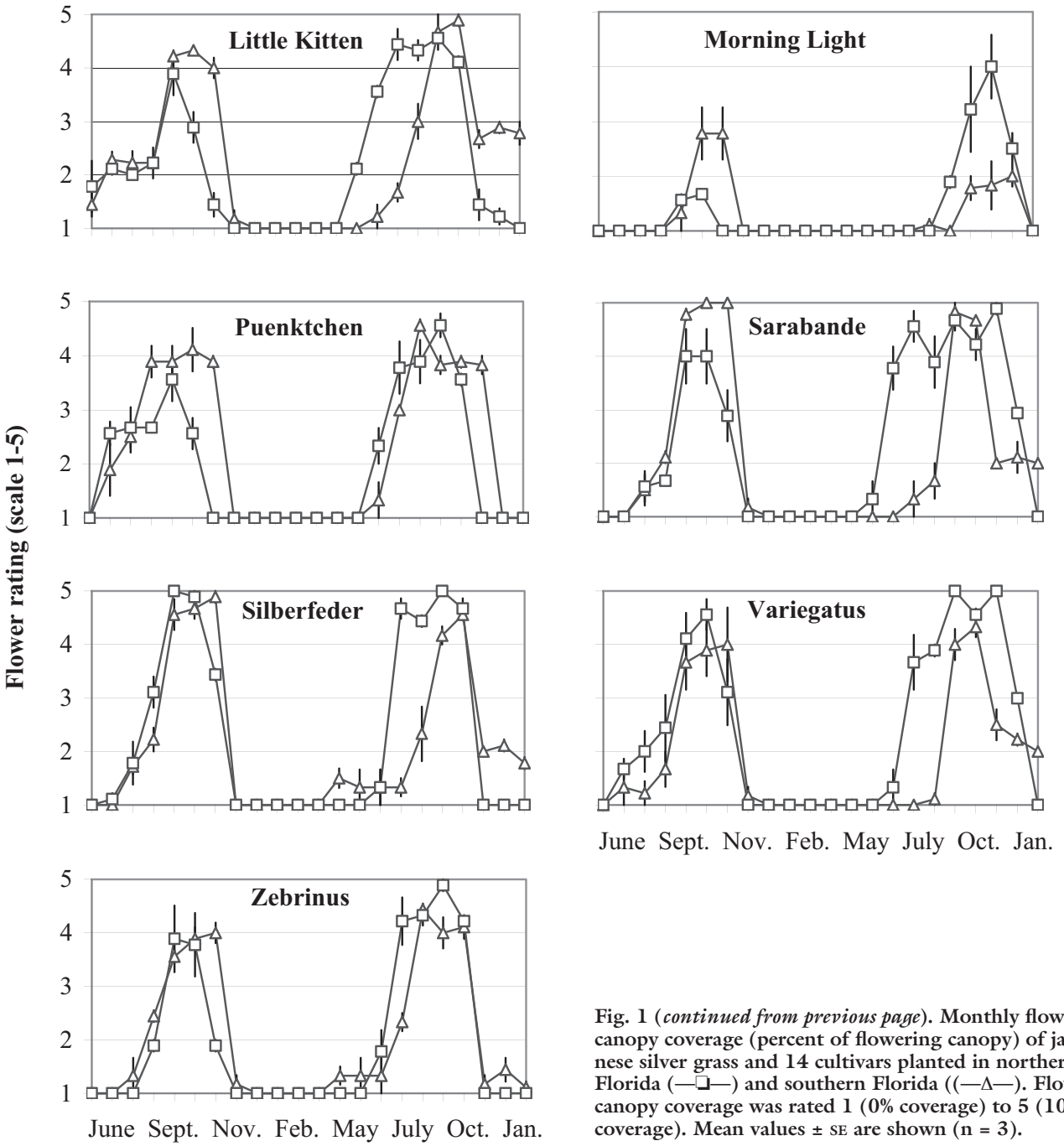

Fig. 1 (*continued from previous page*). Monthly flower canopy coverage (percent of flowering canopy) of japanese silver grass and 14 cultivars planted in northern Florida (—❑—) and southern Florida ((—Δ—). Flower canopy coverage was rated 1 (0% coverage) to 5 (100% coverage). Mean values ± SE are shown (n = 3).

(northern Florida only). Late season flowerers were 'Cabaret' and 'Morning Light' (southern and northern Florida); and 'Central Park', 'Cosmopolitan', 'Gracillimus', 'Sarabande', and 'Variegatus' (southern Florida only). Knowledge of flowering time can be significant, as Meyer and Tchida (1999) reported that many early-flowering types of silver grass set viable seed in Zones 4 and 5, whereas later-flowering types set little seed. Also, a long reproductive period can be associated with invasibility (Gordon and Thomas, 1997). Antique cultivars including 'Gracillimus', 'Variegatus', and 'Zebrinus' are reported to require a very long, hot season to flower (Darke, 1999). Subsequently, their seeds would be less likely to mature in cool regions where they flower very late in autumn. However, modern cultivars were selected for their ability to flower in short seasons, thereby widening their use in colder regions, but increasing the chance for seed maturity and dispersal.

Plant growth varied by cultivar and location (Table 3). In southern Florida, 'Zebrinus' and japanese silver grass were taller than most cultivars; but growth indices were similarly high among 'Adagio', 'Arabesque', 'Cabaret', 'Central Park', 'Graziella', 'Zebrinus', and japanese silver grass (Table 3). In northern Florida, 'Central Park' plants were taller and had a greater growth index than the other cultivars (Table 3). In both locations, 'Arabesque' and 'Central Park' had crown circumferences that exceeded those of other cultivars (Table 3). Vegetative vigor is informative not only from a landscape perspective, but it is also one of numerous biological traits that can predispose a plant to invasiveness.

Table 3. Average panicle number (at 64 weeks), plant height, growth index, and crown circumference (n = 9) for japanese silver grass and 14 cultivars grown in northern Florida (Quincy) and southern Florida (Fort Pierce) for 84 weeks.

	Inflorescence (panicle no.)		Plant ht (cm)[z]		Growth index (cm)		Crown circumference (cm)	
Cultivars	Southern Florida	Northern Florida	Southern Florida	Northern Florida	Southern Florida	Northern Florida	Southern Florida	Northern Florida
Japanese silver grass	75	158	96	143	100	144	120	130
Adagio	290	481	79	104	98	148	167	149
Arabesque	303	604	87	139	115	182	183	181
Cabaret[y]	35	103	75	142	89	155	149	133
Central Park[y]	55	250	93	185	106	214	173	189
Cosmopolitan[y]	26	117	78	150	86	159	148	155
Gracillimus	145	487	79	142	83	143	115	136
Graziella	164	289	80	124	117	119	107	128
Little Kitten	372	365	59	65	78	85	135	113
Morning Light	11	72	31	80	31	80	44	80
Puenktchen	109	131	45	75	59	73	104	95
Sarabande	241	325	81	117	92	126	144	119
Silberfeder	141	439	83	130	89	159	135	143
Variegatus	124	312	70	120	75	139	95	124
Zebrinus	89	144	104	146	106	136	131	132
LSD (0.05)[x]	96	145	11	21	22	28	23	21

[z]1 cm = 0.3937 inch.
[y]Cultivars derived from *Miscanthus sinensis* var. *condensatus.*
[x]Least significant difference at $P = 0.05$ level.

Vigorous plant growth can ultimately coincide with higher seed production (Leger and Rice, 2003; Noble, 1989) and subsequent dispersal. Yet, vigorous vegetative growth can also inhibit reproduction, as a plant concentrates its energy into vegetative rather than reproductive efforts. In the present study, for example, *M. sinensis* var. *condensatus* cultivars ('Cabaret', 'Central Park', and 'Cosmopolitan') grew quite large but produced comparatively fewer inflorescences than plants with similar growth.

Seed viability and germination. Pre-germination tests revealed that seed viability varied by cultivar and location (Table 4). In southern Florida, seed viability ranged from 11% ('Gracillimus') to 77% ('Variegatus' and japanese silver grass). Japanese silver grass, 'Cosmopolitan', 'Silberfeder', and 'Variegatus' had significantly higher seed viability than the other cultivars tested. In northern Florida, seed viability ranged from 45% ('Arabesque') to 94% ('Zebrinus').

Total germination averaged among cultivars was 41.6% (southern Florida) and 66.4% (northern Florida) (data not presented). Although important, these values represent seeds that germinated within the conditions and time period of the germination test and do not take into account seed decay or dormancy. As expected, germination rates of viable seed (confirmed and calculated with post-germination viability tests) were generally higher than total germination values (Table 4). In southern Florida, germination of viable seeds was greater than 90% for japanese silver grass, 'Arabesque', 'Gracillimus', 'Silberfeder', and 'Zebrinus' (Table 4). Comparatively lower germination was observed for 'Little Kitten' (54.4%) and 'Cabaret' (53.6%). In northern Florida, germination of viable seeds was greater than 90% for all cultivars with the exception of 'Arabesque' (49.8%) and 'Gracillimus' (87.3%) (Table 3). Meyer and Tchida (1999) similarly observed that viable silver grass seed varied widely between cultivar, hardiness zone, and year. In

Table 4. Percent viability and germination of seed collected from 14 cultivars and the species of japanese silver grass grown in northern Florida (Quincy) and southern Florida (Fort Pierce).

	Pre-germination seed viability[z] (%)		Germination of viable seed[y] (%)	
Cultivars	Southern Florida	Northern Florida	Southern Florida	Northern Florida
Japanese silver grass selection	76.5 a	75.5 b	99.1 a	99.6 ab
Adagio	56.0 bcd	75.0 b	72.5 d	100.0 a
Arabesque	41.5 d	44.5 e	90.4 bc	49.8 f
Cabaret[z]	46.5 d	63.5 c	53.6 e	95.5 cd
Central Park[x]	45.0 d	80.5 b	67.6 d	99.7 ab
Cosmopolitan[x]	68.5 ab	81.5 b	76.7 d	99.5 ab
Gracillimus	10.5 e	57.0 cd	100.0 a	87.3 e
Graziella	51.0 cd	49.5 de	89.2 bc	98.1 bc
Little Kitten	45.0 d	55.0 cd	54.4 e	100.0 a
Morning Light	---[w]	82.5 b	---[w]	90.3 e
Puenktchen	---[w]	55.5 cd	---[w]	91.1 de
Sarabande	40.0 d	54.0 cd	87.8 c	100.0 a
Silberfeder	67.5 abc	75.0 b	92.2 bc	99.7 ab
Variegatus	77.0 a	58.0 cd	88.5 bc	100.0 a
Zebrinus	50.0 d	94.0 a	94.2 b	99.7 ab

[z]Performed on a subset of 200 seed. Mean separation was conducted by Duncan's multiple range test on transformed means, $P \leq 0.05$.
[y]Performed on 400 seed. Remaining seeds that did not germinate were subjected to viability tests and used to calculate viable seed germination percentages. Mean separation was conducted by Duncan's multiple range test on transformed means, $P = 0.05$.
[x]Cultivars derived from *Miscanthus sinensis* var. *condensatus.*
[w]Insufficient seeds for germination and viability tests.

their study, seed set (average among 41 taxa) was significantly higher in Zone 5 than Zone 7; and germination was significantly higher in Zone 6 than Zone 7. It is interesting to note that Meyer and Tchida (1999) reported 'Little Kitten', 'Morning Light', and 'Variegatus' to have the least risk of self seeding and becoming invasive in Zones 4 to 7 due to low germination rates falling below 18%. However their germination rates were based on total germination and did not take into account seed viability as determined by tetrazolium testing. In our study, post germination viability tests performed on seeds that did not germinate indicated that 0% to 19% of the seed was dormant at the time of testing (data not presented). This was not surprising since seeds of many grasses are characterized as having nondeep physiological dormancy (Baskin and Baskin, 2001). This information, however, may be useful in seed bank studies or control efforts in areas where japanese silver grass is problematic.

In summary, landscape performance, flowering, seed viability, and seed germination varied widely between cultivars evaluated in northern and southern Florida. Suitability of japanese silver grass cultivars in the landscape may be determined by adaptability, flower longevity, foliage color integrity, and low seed set. In southern Florida, visual quality (plant color and form) of 'Adagio', 'Arabesque', 'Little Kitten', and 'Sarabande' were of good to excellent quality and generally did not fall below average throughout the study. In northern Florida, 'Adagio', 'Arabesque', 'Cosmopolitan', and 'Gracillimus' received higher visual quality readings on average throughout the study than the other cultivars. Greatest flowering was observed over an extended time period for 'Adagio', 'Arabesque', 'Central Park', 'Gracillimus', and 'Silberfeder' in both locations. Poor survival, growth and flowering of 'Morning Light' indicate it is less suitable for Florida landscapes. Japanese silver grass cultivars generally had greater growth and flowering and fewer pest problems in northern Florida than in southern Florida, suggesting they are better adapted to temperate rather than tropical climates. Nonetheless, high visual quality ratings of many cultivars in southern Florida could warrant wider landscape use. In southern Florida, 'Arabesque', 'Cabaret', Central Park', 'Gracillimus', 'Little Kitten', and 'Sarabande' had less than 50% seed viability; whereas in northern Florida, the only two cultivars that had less than 50% seed viability were 'Arabesque' and 'Graziella'. While this investigation did not address invasive potential with regards to a cultivar's ability to actually establish and colonize existing vegetation in natural areas of Florida, it does illustrate the wide variation among cultivars and emphasizes the importance of including cultivars in status assessments. Results from this study warrant wider use of some japanese silver grass cultivars in Florida, demonstrate the importance of trialing in more than one location, and emphasize the value of testing cultivars in predictive screening systems currently being developed for Florida.

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