‘Tift PA17’, ‘Tift PA18’, and ‘Tift PA19’ Ornamental *Pennisetum alopecuroides*

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Pennisetum alopecuroides (L.) Spreng. is a perennial warm-season grass native to Asia and Australia that is used mainly as an ornamental in the United States. This species is frequently referred to as “fountain grass,” which can be misleading because a number of *Pennisetum* species use this common name designation. The Missouri Botanical Gardens (2020) website ‘*Pennisetum alopecuroides*’ reports that cultivars usually range in height from 0.75 to 1.5 m.

Reduced seed production in vegetatively propagated ornamentals and turfgrass is a desirable trait because it helps maintain the purity of a commercial cultivar. Seed-sterile turfgrasses have been developed by creating triploid interspecific hybrids and by using gamma radiation (Baxter and Schwartz, 2018). Seed set in *Miscanthus sinensis* Andersson (1855) has been reduced by ploidy manipulation (Ranney and Touchell, 2016) and gamma radiation (Hanna and Schwartz, 2019).

‘Desert Plains’ (Trucks, 2010) and ‘Ginger Love’ (Horvath, 2016) are *P. alopecuroides* cultivars developed from seedling selections. ‘JS Jommenik’ (Spruyt, 2016) was selected as a shoot mutation. All are vegetatively propagated *P. alopecuroides* patented cultivars, but none mentions seed production for these cultivars in the patents. Blackman (2011) developed ‘Burgundy Bunny’ from a natural mutation and mentions no seed observed, but this cultivar was not compared to a seed-producing genotype. Hanna and Schwartz (2020) significantly reduced seed production in ‘Praline^{TM}’ (‘Tift H18’) and ‘Hush Puppy^{TM}’ (‘Tift PA5’) with cobalt 60 gamma radiation. Our objective

was to use cobalt 60 gamma radiation to reduce seed production in *P. alopecuroides* genotypes with desirable ornamental characteristics.

‘Tift PA17’ (PP31,062), ‘Tift PA18’ (PP31,097), and ‘Tift PA19’ (PP31,176) are perennial *P. alopecuroides* selections with desirable ornamental characteristics and significantly reduced seed production. They were approved for release by the University of Georgia College of Agricultural and Environmental Sciences in 2016 after evaluation in Tifton, GA (elevation, 107.9 m; lat. 31.4505°N, long. 83.5085°W) and Blairsville, GA (elevation, 573.9 m; lat. 34.8762°N, long. 83.9582°W). They were compared with Tift PA24, a seed-fertile *P. alopecuroides* genotype with desirable ornamental characteristics, at both locations. Cultivars were tested on a Tifton loamy sand and a Transylvania clay loam in Tifton and Blairsville, respectively. Their active growing seasons are April through November in Tifton and May through October in Blairsville. The 20-year average monthly rainfall values for the growing season were 114 mm (range, 94–121 mm) and 90 mm (range 68 to 118 mm) in Blairsville and Tifton, respectively. The 20-year average monthly high temperatures for the growing season are 26 °C (range, 21 to 29 °C) and 28 °C (range, 21 to 33 °C), whereas the average monthly low temperatures are 13 °C (range, 6 to 17 °C) and 16 °C (range, 8 to 21 °C) in Blairsville and Tifton, respectively. There were no droughts

Genotypes were evaluated for inflorescence and leaf height, canopy diameter, inflorescence length and number per plant, leaf length and width, and seed set. Data for each variable were subjected to an analysis of variance. Fisher’s least significance differences at $P \leq 0.05$ were used for mean separation.

Origin

Seeds from plant accession ‘Tift PS1122’, with a mixture of *P. alopecuroides* ecotypes sent to the United States from China in 1999, were irradiated on 11 Nov. 2010 with 20 Kr of cobalt 60 gamma radiation. Two-hundred thirty plants were planted in the field in Tifton on 29 Mar. 2011. In 2011, eight of the 230 plants grown from the seeds treated with 20-Kr were evaluated and selected based on their morphological desirability and reduced seed set. Open-pollinated seeds (a second generation of seeds) of these eight selected plants were harvested and irradiated with 10 Kr of cobalt 60 on 10 Jan. 2012. One-hundred forty-two plants were established in the field in Tifton in 2012 from three of the eight plants selected in 2011. No plants were established from seed of five of the selections after the second cycle of cobalt 60 radiation on 10 Jan. 2012. Plants grown from irradiated seeds usually have chimeras or sectors for the trait of interest. Therefore, plants with desirable ornamental characteristics were divided into four quadrants: “a” was 3 o’clock and, moving around the plant counterclockwise, “b” was 12 o’clock, “c” was 9 o’clock, and “d” was 6 o’clock; these were transplanted to the field in 2011. As many propagules as possible were sampled from each quadrant, and five or more inflorescences from each quadrant were examined for female fertility. The highly seed-sterile plant 125, sector “a” on plant number 137, and sectors “a,” “c,” and “d” on plant 140 were all selected and asexually propagated to produce ‘Tift PA17’, ‘Tift PA18’, and ‘Tift PA19’, respectively.

Table 1. Inflorescence heights of four *Pennisetum alopecuroides* selections (PA24 is the seed-fertile control) planted at two locations in Georgia.

‘Tift’ entry	Inflorescence ht ²							
	Tifton ^y			Blairsville ^x				
	2012	2014	2015	2012	2013	2014	2015	
‘PA17’	180 ^w	99	101	178	116	130	155	
‘PA18’	57	58	64	91	110	110	112	
‘PA19’	56	46	52	102	125	101	124	
PA24	56	45	69	84	102	91	103	
LSD ^v	62	51	83	107	126	106	106	
	6	9	8	9	12	14	9	

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²Plant height (cm) measured from the ground level to the top of the inflorescence.
^yTifton: Tests planted 18 Apr. 2012, 2 June 2014, and 12 May 2015, and measurements obtained 15 Oct. 2012, 9 Sept. 2014, and 21 Aug. 2015, respectively.
^xBlairsville: Planted 14 Apr. 2012, 16 May 2013, and 15 May 2014, and measurements obtained 9 Sept. 2012, 9 Sept. 2013, 22 Sept. 2014, and 24 Sept. 2015 (data obtained from 2014 plants), respectively.
^vGrowth days of plants included in ratings.
^wLeast significant difference at $P \leq 0.05$.

Table 2. Leaf heights of four ornamental *Pennisetum alopecuroides* selections (PA24 is the seed-fertile control) planted at two locations in Georgia.

'Tift' entry	Leaf ht ^z							
	Tifton ^y				Blairsville ^x			
	2012	2013	2014	2015	2012	2013	2014	2015
	180 ^w	170	99	101	148	116	130	155
'PA17'	78	41	41	42	53	74	52	81
'PA18'	72	40	33	37	66	97	47	89
'PA19'	74	48	28	43	52	74	43	67
PA24	86	41	34	54	60	73	50	83
LSD ^v	9	8	7	5	5	9	10	5

^zLeaf height (cm) measured from the ground level to the top of the leaf canopy.

^yTifton: Tests planted 18 Apr. 2012, 13 Apr. 2013, 2 June 2014, and 12 May 2015, and measurements obtained 15 Oct. 2012, 30 Sept. 2013, 9 Sept. 2014, and 21 Aug. 2015, respectively.

^xBlairsville: Planted 14 Apr. 2012, 16 May 2013, and 15 May 2014, and measurements obtained 9 Sept. 2012, 9 Sept. 2013, 22 Sept. 2014, and 24 Sept. 2015 (data obtained from 2014 plants), respectively.

^wGrowth days of plants included in ratings.

^vLeast significant difference at $P \leq 0.05$.

Table 3. Canopy diameters of four ornamental *Pennisetum alopecuroides* selections (PA24 is the seed-fertile control) at two locations in Georgia.

'Tift' entry	Canopy diam (cm) ^z			
	Tifton ^y		Blairsville ^x	
	2012	2015	2014	2015
	180 ^w	101	130	155
'PA17'	86	76	128	153
'PA18'	77	69	100	159
'PA19'	94	99	129	148
PA24	81	98	123	136
LSD ^v	10	9	25	7

^zCanopy diameter is the average diameter of the widest and narrowest diameters of a single plant canopy.

^yTifton: Tests planted 18 Apr. 2012 and 12 May 2015, and measurements obtained 8 Oct. 2012 and 21 Aug. 2015, respectively.

^xBlairsville: Planted 15 May 2014 and measurements obtained 22 Sept. 2014 and 24 Sept. 2015 (data obtained from 2014 plants).

^wGrowth days of plants included in ratings.

^vLeast significant difference at $P \leq 0.05$.

Table 4. Number of inflorescences per plant of four ornamental *Pennisetum alopecuroides* selections (PA24 is the seed-fertile control) at two locations in Georgia.

'Tift' entry	Inflorescences ^z				
	Tifton ^y			Blairsville ^x	
	2012	2014	2015	2014	2015
	180 ^w	99	101	130	155
'PA17'	195	83	65	81	100
'PA18'	258	156	73	89	120
'PA19'	150	230	149	109	98
PA24	79	135	62	75	67
LSD ^v	33	42	16	43	19

^zNumber of inflorescences per plant.

^yTifton: Tests planted 18 Apr. 2012, 13 Apr. 2013, 2 June 2014, and 12 May 2015, and measurements obtained 15 Oct. 2012, 30 Sept. 2013, 9 Sept. 2014, and 21 Aug. 2015, respectively.

^xBlairsville: Planted 14 Apr. 2012, 16 May 2013, and 15 May 2014, and measurements obtained 9 Sept. 2012, 9 Sept. 2013, 22 Sept. 2014, and 24 Sept. 2015 (data obtained 2014 plants), respectively.

^wGrowth days of plants included in ratings.

^vLeast significant difference at $P \leq 0.05$.

'Tift PA17' (Supplemental Figs. 1 and 2), 'Tift PA18' (Supplemental Figs. 3 and 4), and 'Tift PA19' (Supplemental Figs. 5 and 6) were tested in Tifton and Blairsville from 2012 through 2015. Evaluation tests consisted of five and four single plant replications arranged in a randomized complete block experiment in Tifton and Blairsville, respectively. Propagules were rooted and established in the greenhouse 6 weeks before

being transplanted to the field on 160-cm centers. Weeds were controlled by both chemical and mechanical methods. Plots were only irrigated at planting to ensure uniform establishment. Other experimental entries were included in each test. Tift PA24 was selected from Tift PS1122 and served as the seed-fertile control with desirable ornamental characteristics (Supplemental Fig. 7). Experiments were established each

year and data were obtained from 1-year-old plants, except the 2015 measurements in Blairsville, which were obtained from 2-year-old plants.

Description and Performance

'Tift PA17', 'Tift PA18', and 'Tift PA19' were generally equal to or significantly shorter from ground level to the top of the inflorescence (Table 1) and height of leaves (Table 2) compared with Tift PA24. Only 'Tift PA18' had significantly taller inflorescence height in 2015, and 'Tift PA18' had significantly taller leaf height during 3 of 4 years than Tift PA24 in Blairsville. 'Tift PA17' had the tallest leaves according to the Tifton test in 2014. Canopy diameter (Table 3) was generally similar among the cultivars, except in Blairsville in 2015, when 2-year-old plants of 'Tift PA17', 'Tift PA18', and 'Tift PA19' had wider canopies than Tift PA24. 'Tift PA17', 'Tift PA18', and 'Tift PA19' produced more inflorescences than Tift PA24 according to two of the five tests (Table 4). 'Tift PA19' produced more inflorescences than Tift PA24 according to four of the five tests. Inflorescence lengths were generally equal to or significantly shorter than those of Tift PA24 (Table 5), except that 'Tift PA17' had longer inflorescences during all four years in Blairsville. Leaf length and width of 'Tift PA17', 'Tift PA18', and 'Tift PA19' were similar to or smaller than those of Tift PA24 (Table 6). Mature plant colors for 'Tift PA17', 'Tift PA18', and 'Tift PA19' were Green-141B, Green-143A, and Green-143A, respectively, according to the Royal Horticultural Society (2007) color index. Inflorescence colors were Greyed Orange-165B, and Greyed Orange-165D for 'Tift PA17' and 'Tift PA19', respectively, and Greyed Purple-183A for 'Tift PA18'.

Gamma radiation of seeds successfully reduced the seed set in these three selections (Table 7). 'Tift PA17', 'Tift PA18', and 'Tift PA19' produced less seed per inflorescence than Tift PA24 according to all tests (Table 7). The six seeds produced by 'Tift PA18' in 2013 in Blairsville were from a semi-fertile sector on one plant in the experiment. Then, this plant was removed from the population. Germination tests were conducted for seeds produced by 'Tift PA17', 'Tift PA18', 'Tift PA19', and Tift PA24 in Blairsville. Seed were stored in manila envelopes for 6 months at room temperature in the threshing shed and then allowed to germinate for 45 d at 27 °C in steam-sterilized soil in the greenhouse. Seed germination tests consisted of 25 seeds from three different plants (replications) harvested in Oct. 2014 in Blairsville. Germination tests were conducted in Apr. 2015 in the greenhouse to allow seeds to experience a dormancy period and simulate field conditions. Germination of the few seeds produced by 'Tift PA17', 'Tift PA18', and 'Tift PA19' (Table 7) were 34%, 32%, and 16%, respectively, compared with 93% for

Table 5. Inflorescence lengths of four ornamental *Pennisetum alopecuroides* selections (PA24 is the seed-fertile control) at two locations in Georgia.

'Tift' entry	Inflorescence length (cm) ^z					
	Tifton ^y		Blairsville ^x			
	2012	2015	2012	2013	2014	2015
'PA17'	12	11.1	15	16	16	19
'PA18'	9	8.2	14	14	11	15
'PA19'	11	10.7	11	12	11	14
PA24	13	11.1	13	15	13	15
LSD ^v	1	0.8	1	1	2	1.4

^zInflorescence length: mean of three inflorescences per plant.

^yTifton: Tests planted 18 Apr. 2012 and 12 May 2015, and measurements obtained 15 Oct. 2012 and 21 Aug. 2015, respectively.

^xBlairsville: Planted 14 Apr. 2012, 16 May 2013, and 15 May 2014, and measurements obtained 9 Sept. 2012, 9 Sept. 2013, 22 Sept. 2014, and 24 Sept. 2015 (data obtained from 2014 plants), respectively.

^vGrowth days of plants included in ratings.

^vLeast significant difference at $P \leq 0.05$.

Table 6. Leaf characteristics of individual plants of four ornamental *Pennisetum alopecuroides* selections (PA24 is the seed-fertile control) at two locations in Georgia.

'Tift' entry	Leaf length ^z (cm)			Leaf width ^y (mm)		
	Tifton ^x		Blairsville ^w	Tifton ^x		Blairsville ^w
	2012	2015	2015	2012	2015	2015
'PA17'	28.9	27.6	47	6.2	5.7	8.8
'PA18'	22.6	23.0	50	6	5.5	10.2
'PA19'	25.1	26.6	48.8	4.8	5.2	9
PA24	26.8	33.6	40.2	6.5	7.4	9.6
LSD ^v	5.1	3.3	10.9	1.4	0.7	1.1

^zLeaf length (average of three culms) was measured from the leaf collar to the leaf tip of the latest fully extended leaf.

^yLeaf width (average of three culms) was measured in the center of the latest fully extended leaf.

^xTifton: Tests planted 18 Apr. 2012 and 12 May 2015, and measurements obtained 15 Oct. 2012 and 21 Aug. 2015, respectively.

^wBlairsville: Planted 15 May 2014 and measurements obtained 24 Sept. 2015 (data obtained from 2014 plants).

^vLeast significant difference at $P \leq 0.05$.

Table 7. Seed set per inflorescence (planted at two locations) and seed germination (from one location) of four ornamental *Pennisetum alopecuroides* selections (PA24 is the seed-fertile control) planted in Georgia.

Entry	Seeds per inflorescence ^z					Seed germination (%) ^y
	Tifton ^x		Blairsville ^w			Blairsville
	2013	2015	2013	2014	2015	2014
'PA17'	0.0	0.0	2.0	0.8	0.2	34
'PA18'	0.8	0.0	6.0	0.9	0.3	22
'PA19'	0.3	2.4	0.0	NA	1.2	16
PA24	15.4	91.5	121	102	71.2	93
LSD ^v	0.3	0.0	26	29.4	1.3	21

^zSeeds per inflorescence: each replication was the mean of four random inflorescences.

^ySeed germinations: germination tests consisted of 25 seeds from three different plants (replications) harvested in Oct. 2014 in Blairsville. Germination tests were conducted in Apr. 2015 to allow seeds to experience a dormancy period and simulate field conditions.

^xTifton: Tests planted 13 Apr. 2013 and 12 May 2015, and measurements obtained Oct. 2013 and Oct. 2015.

^wBlairsville: Planted 16 May 2013 and 15 May 2014, and measurements obtained 9 Sept. 2013, 22 Sept. 2014, and 24 Sept. 2015 (data obtained from 2014 plants), respectively.

^vLeast significant difference at $P \leq 0.05$.

NA = not available (sample was lost).

Tift PA24, further reducing the seed-producing potential of 'Tift PA17', 'Tift PA18', and 'Tift PA19'. Although we have

not determined the cause of the reduced seed set in these cultivars, research involving mutagens in our laboratory (unpub-

lished) has shown that cobalt 60 gamma radiation can break chromosomes, thereby resulting in irregular segregation at microsporogenesis and megasporogenesis and pollen and egg cell abortion.

'Tift PA17', 'Tift PA18', and 'Tift PA19' are vigorous perennial ornamental *P. alopecuroides* cultivars with desirable leaf textures, inflorescence color and density, and plant shape. These cultivars exhibit very low seed set at both low elevations (Tifton, GA) and higher elevations (Blairsville, GA). In general, these new cultivars have more robust plant height, canopy spread, leaf texture, and inflorescence production than other reported reduced seed set cultivars such as Praline^{TM} and Hush Puppy^{TM} (Hanna and Schwartz, 2020).

Availability

'Tift PA17', 'Tift PA18', and 'Tift PA19' are cultivars patented by the University of Georgia. Field plantings of breeder material for 'Tift PA17', 'Tift PA18', and 'Tift PA19' are maintained at the University of Georgia, Tifton Campus. As protected cultivars, 'Tift PA17', 'Tift PA18', and 'Tift PA19' can be produced only by nurseries licensed by the Georgia Research Foundation. 'Tift PA17', 'Tift PA18', and 'Tift PA19' will be marketed as 'Etouffee^{TM}', 'Cayenne^{TM}', and 'Jambalaya^{TM}', respectively.

Literature Cited

- Baxter, L.L. and B.M. Schwartz. 2018. History of bermudagrass turfgrass breeding research in Tifton, GA. *HortScience* 53:1560–1561.
- Blackman, L. 2011. *Pennisetum* plant named 'Burgundy Bunny'. US PP21917 P2.
- Hanna, W.W. and B.M. Schwartz. 2019. 'M77' Ornamental *Miscanthus sinensis*. *HortScience* 54:1–3.
- Hanna, W.W. and B.M. Schwartz. 2020. 'Tift H18' and 'Tift PA5' Ornamental *Pennisetum alopecuroides*. *HortScience* 55:974–976.
- Horvath, B. 2016. *Pennisetum alopecuroides* plant named 'Ginger Love'. US PP26442 P2.
- Missouri Botanical Gardens. *Pennisetum alopecuroides*. (n.d.) 10 Apr. 2020. <<https://www.missouri-botanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?taxonid=285289&isprofile=1&basic=Pennisetum%20alopecuroides>>.
- Ranney, T.G. and D.H. Touchell. 2016. *Miscanthus sinensis* grass named 'NCMS1'. US PP26387 P3.
- Royal Horticultural Society. 2007. RHS colour chart. 5th ed. Royal Horticultural Society, London.
- Spruyt, J. 2016. *Pennisetum* plant named 'JS Jommenik'. US PP27435 P2.
- Trucks, G.M. 2010. *Pennisetum* plant named 'Desert Plains'. US PP20,751 P2.

Supplemental Fig. 1. 'Tift PA17' in landscape (year of establishment) in Blairsville, GA.

Supplemental Fig. 2. 'Tift PA17' in maintenance nursery (2-year-old plants) in Blairsville, GA.

Supplemental Fig. 3. 'Tift PA18' in landscape (year of establishment) in Blairsville, GA.

Supplemental Fig. 4. 'Tift PA18' in maintenance nursery (2-year-old plants) in Blairsville, GA.

Supplemental Fig. 5. 'Tift PA19' in research plots (year of establishment) in Tifton, GA.

Supplemental Fig. 6. 'Tift PA19' in maintenance nursery (2-year-old plants) in Blairsville, GA.

Supplemental Fig. 7. Tift PA24 in maintenance nursery (1-year-old plants) in Blairsville, GA.