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Title: Development of Large Patch Tolerant and Cold Hardy Zoysiagrass Cultivars for the Transition Zone

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Objective: Phase III (year 3-6) of the evaluation process is focused on replicated field trials comprised of elite zoysiagrass hybrids at multiple environments. The objective of the Phase III field test is the selection of experimental hybrids that have comparable/superior cold tolerance to Meyer, but finer texture, and improved large patch tolerance.

Summary Text:

This was the third year of field evaluation for 60 zoysiagrass experimental hybids selected from 2,858 progeny. These progeny were developed at Texas A&M AgriLife Research in Dallas, Texas by crossing 22 cold-hardy zoysiagrasses with TAES 5645 (*Z. japonica*) or its derivatives that had demonstrated tolerance to large patch in nonreplicated field trials.

In September 2014, twenty top-performing progeny were selected from spaced plantings in Manhattan, West Lafayette, IN, and Dallas, TX. These sixty progeny were returned to Dallas for propagation. In June 2015, vegetative plugs of the 60 progeny along with the standard cultivars Meyer, Zorro, El Toro, Zeon, and Chisholm, were shipped from Dallas, TX and planted in three replicate plots (25 or 36 sq. ft.) in Manhattan, KS, West Lafayette, IN and Dallas, TX. In 2015, the same progeny were also distributed to research cooperators in Blacksburg, VA; Chicago, IL; Columbia, MO; Fayetteville, AR; Knoxville, TN; Raleigh, NC; and Stillwater, OK for evaluation in replicated plots (Fig. 1).

Data Collection and Results

In 2017, data were submitted from all locations except Virginia where a personnel change recently took place. Zoysiagrass progeny coded family (crosses) are shown in Table 1. For presentation in Tables 2 to 5, the top-performing ten progeny are shown along with the controls (standards). In this progress report, for brevity, comparisons are made to Meyer, which is the standard zoysiagrass cultivar used in the transition zone. Data presented are averages from the locations submitting data for a given parameter, and were analyzed using PROC GLM.

- **Large patch.** Large patch was evaluated at KS and AR, where plots were inoculated in September and October 2016, respectively. Large patch was rated on 19 April and 15 May 2017 in AR, and on 24 May, 24 and 30 Sept, and 20 Oct 2017 in KS. Disease development was variable. Large patch ranged from 2% to 43% severity (% plot exhibiting visual symptoms), when averaged over all the dates and both locations (Table 2). Sixteen progeny had statistically less large patch compared to Meyer, which had an average disease severity of 16% average. Progeny that had ,< 10% disease on all rating dates at both locations were:

6099-151, 6102-307, 6119-179 (Fig. 2), and 6100-146. All of these progeny were statistically similar to Meyer in winter injury, spring green up, and turf quality.

- **Winter Injury.** Winter injury was rated at IN, MO, NC, OK, and TN in late spring 2017 as the percentage of each plot exhibiting symptoms. Meyer had 16.6% winter injury, and because Meyer is known to be quite cold tolerant, this number is likely reflective of factors other than just low temperatures (e.g., large patch damage that was slow to green up). Five progeny had a lower winter injury level compared to Meyer (Table 3). Three progenies had more winter injury than Meyer (up to 60% in OK); all other progeny had winter injury levels statistically similar to Meyer.

- **Green up.** Spring green up was rated visually between 13 March and 21 April on a 1-9 scale as 1 = brown and 9 = fully green at MO, OK, NC, IN, TN, KS, AR, and TX. Green-up ratings ranged from 3.1 to 5.7 (Table 4). Thirteen progeny had slower green up ratings than Meyer, and all others were statistically similar to Meyer.

- **Quality.** Turfgrass quality was rated monthly on a 1-9 scale (1 = poorest quality; 6 = minimally acceptable quality; and 9 = optimum color, density and uniformity) between May and September at TX, KS, IL, MO, OK, AR, NC, and IN. Average quality in mid summer (rated in late July to August) ranged from 5.4 to 7.6; four progeny had quality superior to Meyer (6.0) (Table 5).

Summary Points:

- Sixty zoysiagrass hybrids, each arising from a cross between a large-patch tolerant parent and cold-hardy parent, are under evaluation after initially screening 2,858 progeny for quality and cold hardiness.
- Progeny are being evaluated under golf course management conditions at ten locations throughout the transition zone for turf quality characteristics and large patch tolerance.
- The fungus (*Rhizoctonia solani*) causing large patch disease was inoculated in plots in Manhattan, KS and Fayetteville, AR. Several progeny consistently showed better tolerance to large patch compared to Meyer in KS and AR.
- Progeny showed a wide range of variability in turf quality characteristics including winter injury, spring green up, and turfgrass quality.
- Among this group of experimental zoysiagrasses, there appears to be promising progeny that have good winter hardiness, tolerance to large patch, and improved turf quality characteristics, such as TAES 6095-83.
- Progeny evaluations will continue in 2018-2019.

Fig. 1. Zoysiagrass plots in Stillwater, Oklahoma. The same grasses are under evaluation in Arkansas, Illinois, Indiana, Kansas, Missouri, North Carolina, Tennessee, Virginia, and Texas.

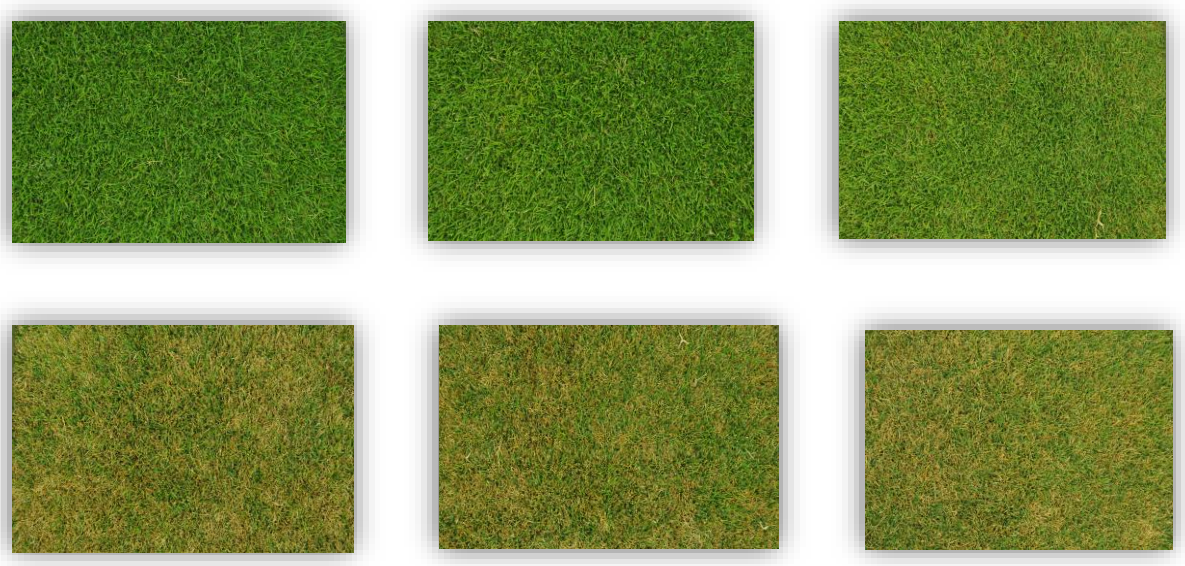

Fig. 2. Overhead photos taken inside a light box of large patch symptoms in a tolerant (6119-179, upper row) and susceptible (6096-81, bottom row) zoysiagrass at Manhattan, KS. Photos were taken on 18 Oct. 2017; each is of a different replicate.

Table 1. Lineage and family codes of top performing Zoysiagrass hybrids.

Coded Family	Zoysiagrass progeny coded family lineage (female × male)
6095	[(*Z. matrella* (L.) Merr. x *Z. matrella*) x *Z. japonica*] x *Z. japonica*
6096	(*Z. matrella* x *Z. japonica*) x *Z. japonica*
6097	(*Z. matrella* x *Z. japonica*) x *Z. japonica*
6099	*Z. japonica*† x *Z. japonica*
6100	[(*Z. japonica* x *Z. pacifica (*Gaud.) Hotta & Kuroti) x *Z. japonica*] x *Z. japonica*
6101	(*Z. matrella* x *Z. japonica*) x *Z. japonica*
6102	*Z. japonica* x *Z. japonica*
6119	*Z. japonica* x [(*Z. matrella x Z. matrella*) x *Z. japonica*]

†For confidentiality, only species names, and not cultivar names, are provided.

Table 2. Large patch infestation in top-performing zoysiagrass progeny and standard cultivars in spring and fall 2017 in AR and KS.

Entry	**Large patch (%)**[†]
6099-151	1.7
6102-307	2.1
6119-179	2.2
6100-146	2.3
6099-77	3.3
6099-447	3.8
6099-69	3.9
6095-83	4.1
6099-145	4.5
6102-289	4.6
Zorro	14
El Toro	14.4
Zeon	10.9
Chisholm	10.9
Meyer	16.1
LSD	10.0*

[†]Large patch was rated as a percentage of the plot area affected on a 0 to 100% scale on 19 April and 15 May 2017 in AR, and on 24 May, 24 and 30 Sept., and 20 Oct. 2017 in KS. Results are averaged over both locations, 6 rating dates, and three replicates per location (n = 18).
*To determine statistical differences among entries, subtract one entry's mean from another entry's mean. Statistical differences occur when this value is larger than the corresponding LSD value ($P < 0.05$).

Table 3. Winter injury of top-performing zoysiagrass progeny and standard cultivars in late spring 2017 in IN, MO, NC, OK, and TN.

Entry	**Winter injury (%)**[†]
6099-10	3.2
6101-71	3.7
6100-86	3.8
6102-62	3.8
6099-77	4.2
6100-146	4.3
6096-36	5.0
6096-117	5.8
6101-9	6.0
6095-101	6.0
Zorro	20.2
El Toro	24.0
Zeon	14.4
Chisholm	6.5
Meyer	16.6
LSD	12.4*

[†]Winter injury was rated on a 0 to 100% scale; results are averaged over five locations and three replicates per location (n =15).
*To determine statistical differences among entries, subtract one entry's mean from another entry's mean. Statistical differences occur when this value is larger than the corresponding LSD value ($P < 0.05$).

Table 4. Spring green up of top-performing zoysiagrass progeny and standard cultivars in spring 2017 in MO, OK, NC, IN, TN, KS, AR, and TX.

Entry	**Spring green up**[†]
6102-62	5.7
6101-9	5.7
6095-83	5.4
6101-26	5.4
6099-10	5.4
6099-8	5.4
6097-74	5.4
6099-383	5.3
6099-145	5.3
6096-36	5.3
Zorro	4.7
El Toro	4.4
Zeon	4.5
Chisholm	5.6
Meyer	5.2
LSD	1.1*

[†]Spring green up was rated on a 1-9 scale (1 = brown; 9 = fully green). Results are averaged over eight locations and three replicates per location (n = 24).
*To determine statistical differences among entries, subtract one entry's mean from another entry's mean. Statistical differences occur when this value is larger than the corresponding LSD value ($P < 0.05$).

Table 5. Turfgrass quality of top-performing zoysiagrass progeny and standard cultivars in summer 2017 in TX, KS, IL, MO, OK, AR, NC, and IN.

Entry	**Turfgrass quality**[†]
6095-83	7.6
6101-154	7.2
6100-86	7.1
6126-71	7.1
6119-179	7.0
6101-32	7.0
6099-10	7.0
6119-14	7.0
6119-168	7.0
6099-69	7.0
Zorro	6.4
El Toro	6.5
Zeon	6.7
Chisholm	6.4
Meyer	6.0
LSD	1.1*

[†]Turfgrass quality was rated on a scale of 1-9 (1 = poorest quality; 6 = minimally acceptable quality; and 9 = optimum color, texture, density, and uniformity) in late July or early August; results are averaged over eight locations and three replicates per location (n = 24).
*To determine statistical differences among entries, subtract one entry's mean from another entry's mean. Statistical differences occur when this value is larger than the corresponding LSD value ($P < 0.05$).