United States Department of Agriculture

FINAL PROJECT REPORT
East Texas Plant Materials Center
Nacogdoches, Texas

Rust Resistance Screening of Indiangrass Accessions Collected in East Texas

Alan Shadow

ABSTRACT

Twenty-three Indiangrass [*Sorghastrum nutans* (L.) Nash] ecotypes were collected in east Texas and grown as part of a seed increase for the Native Prairie Association of Texas. Selections were made from within the collection for individual plants that showed resistance to the foliar disease rust. The selected material was evaluated for three years at the USDA NRCS (Natural Resources Conservation Service) East Texas Plant Materials Center to develop a rust resistant cultivar level plant release. Selected material was compared to 'Lometa' and a plant from within the seed increase collection that appeared to be highly susceptible to rust. Plants were rated for vigor, rust resistance, tiller density, plant height, growth rate, and dry biomass yield. Five selections were made for further evaluation and potential cultivar development.

Comparison of an Indiangrass leaf heavily infected with rust to an Indiangrass plot exhibiting resistance at the USDA – NRCS East Texas Plant Materials Center evaluation field.

INTRODUCTION

Yellow Indiangrass is a native, perennial, warm-season, bunchgrass associated with the tall grass prairies of the central United States, but also occurs throughout the southern pine region (Grelen and Hughes, 1984). It has a wide area of adaptation and may be found throughout most of North America; excluding the western and most northern reaches. Its distribution range encompasses a wide array of climates, plant communities, and soil types which make it an important plant for use as forage in native rangelands, prairie restoration, and conservation practices (Owsley 2011).

Indiangrass is susceptible to fungal pathogens such as *Puccini virgata*, responsible for the foliar disease Rust (Gray 2010). Rust gets its name from the fine, powdery, rust colored residue left by spores on the plant's leaf and (or) stem surface. Rust infections have shown to lower the productivity of eastern gamagrass [*Tripsacum dactyloides* (L.) L] and switchgrass (*Panicum virgatum* L.) (Hopkins et al. 1995; Handley et al. 1990). This effect has also been noted in eastern gamagrass during the growing season following heavy infections the previous year at the USDA NRCS East Texas Plant Materials Center (ETPMC). R. C. Staples noted that obligatory

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parasitic pathogens such as *Puccinia virgata*, are some of the most destructive plant diseases which stunt the host plant's growth and creates necrosis in infected tissues (Staples 2000). Environmental conditions largely determine the longevity and productivity of rust (Rowell 1984). Favorable conditions such as mild winter temperatures, intermittent wet and dry periods, and long photoperiods are found throughout the southeastern United States.

The Native Prairie Association of Texas (NPAT) collected a seed assembly of yellow Indiangrass from east Texas. The ETPMC expanded the seed assembly to create a seed source of local ecotypes for NPAT to use in restoration projects. ETPMC staff noted several plants within the seed increase field were free of rust infections while neighboring plants were heavily infected. The individual plants exhibiting resistance to rust were flagged with marking ribbon for further monitoring. Plants that continued to exhibit resistance to rust were then dug from the field. The objective was to evaluate and select Indiangrass germplasm from the NPAT collection exhibiting resistance to rust for cultivar release.

MATERIALS AND METHODS

Twenty-three plants exhibiting no outward symptoms of disease were visually selected from the NPAT seed increase field at the ETPMC in May 2007. These plants were selected during a period when rust infection was prevalent in the field. To monitor disease presence, a plant exhibiting severe rust infection was selected from the NPAT seed increase field to serve as a disease indicator during the evaluations. The selected material, along with 'Lometa', were dug and split into 6 inch x 6 inch, clonal plugs for transplanting. Each plant within the study was assigned a number, 1-25, for identification purposes. 'Lometa' was assigned number 25 and the rust susceptible selection number 5. Plants were transplanted June 6-7, 2007, the same day they were dug from the NPAT field. They were planted on 4 foot centers into a randomized complete block design with 4 replications and 25 plots per rep. After planting, the plugs were watered in with overhead sprinkler irrigation to aid establishment and reduce transplant shock. A boarder row of plants from the NPAT field exhibiting rust infection were planted around study to mitigate edge effect and to serve as a source of pathogens.

There was 100% survival of the transplanted material. The study area was fertilized annually in mid-April with 25 pounds of 16-16-16 fertilizer. Prowl® herbicide was applied for pre-emergence weed control at 37 oz ai./acre annually in late March. Alley ways between plots were weeded manually or spot sprayed with 2% glyphosate to control weed competition. Tillage between plots was needed during the third year three to keep plots separated. Plateau® herbicide was applied via broadcast spraying at 2 oz ai./acre as needed to provide weed control within the plots.

Biomass yield was recorded in 2008 by clipping each plot on December 29, 2008, after killing frosts had occurred, approximately 8 inches above ground level and weighing the biomass. A grab sample was collected from each harvested plot and dried at 60°C for 24 hours for percent dry matter determination. Plant height and plot spread were also recorded annually in late December. Plot spread, the distance tillers extended from the original crown, was measured in 2007 and 2008 by measuring the distance in inches each plot spread in north, south, east, and west directions. The difference in area between the 2008 and 2007 spread measurements were recorded as growth rate. Spread measurements ceased in 2009 because plants spread into adjacent plants. As previously stated, the plots required tillage to keep them separated during the third year of the study, and spread could no longer be recoded. Tiller density, rust infection, and

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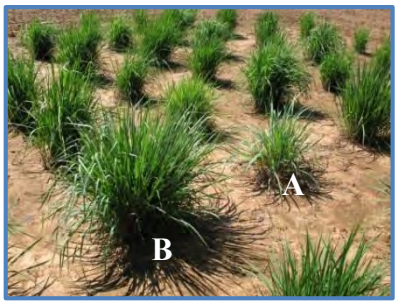
vigor were rated annually during the third week of June on a scale of 1 to 5; 1 being best, 3 average, and 5 worst. When data was normally distributed and variances equal, an analysis of variance was performed to determine differences in evaluation factors. Significant means were separated with the least significant difference test at the 5% level of probability. Data not meeting the assumptions of the analysis of variance was reported as average score over years.

RESULTS AND DISCUSSION

Plotting the three year average of rust scores indicated accession 5 was the most heavily infected accession with a score of 4.08 out of 5 (Figure 1). This supports its visual selection as a disease indicator to monitor favorable conditions for rust and that the rust pathogens were present during the data collection. The top five accessions in sequential order starting with the highest score for resistance were 18, 1, 9, 4, and 22. Their respective scores were 1.25, 1.33, 1.5, 1.58, and 1.75. All the accessions in the study scored below the median score of 3 for rust infection excluding accessions 5, 12, and 11.

Accession 5, left, is heavily infected with rust, while a resistant accession, right, shows no sign of disease. Images were captured on the same day and year in the study area at the USDA-NRCS East Texas Plant Materials Center.

Vigor, overall health and growth of the stand, ratings over the same three year period indicated accession 25, Lometa, was the least vigorous (Figure 2). This was surprising since it was a cultivar level release from the USDA – NRCS Plant Materials Program and used as a control in the study. It was the only accession in the study to score above the median level of 3 with a rating of 3.38. Lometa was originally collected near Lometa, Texas, approximately 250 miles due west of Nacogdoches, Texas. The climate of its point of origin is typically drier than east Texas, and it may not be as adapted as the local eco-types in the study. The top 5 performing accessions for vigor in sequential order were 1, 22, 2, 19, and 9 with scores of 1, 1.38, 1.38, 1.5, and 1.5 respectfully.



Lometa, labeled A, compared to accession 1, labeled B, for vigor and growth, USDA-NRCS East Texas Plant Materials Center

The three year average of Tiller Density, a rating that reflected the number of tillers per plot, supported the Vigor data for, Lometa. Lometa had a tiller density score of 3.63 and was the poorest performing accession for this measurement (Figure 3). All but three accessions, 25, 17, and 21 scored below the median measurement of 3. The top 5

A plot with in the study exhibiting dense tilling, left, compared to a plot with a much weaker tiller density, right, at the USDA – NRCS East Texas Plant Materials Center

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accessions for tiller density in sequential order were 1, 10, 9, 23, and 4 with scores of 1, 1.38, 1.5, 1.63, and 1.75 respectfully.

Dry matter yield per plot is presented in Table 1. Accession 10 was the highest yielding accession at 3.16 lbs. Accessions 16 and 1 were found to have significantly higher yields than other accessions with mean yields of 2.83 and 2.51 lbs. respectfully (Table 1). Accession 5 had the second to lowest dry biomass mean yield with 1.06 lbs. which coincides with Handley (1990) findings for the impact of foliar disease on eastern gamagrass. The mean yield for the study was 1.83 lbs. In contrast, Lometa produced 1.16 lbs.

Accession 5 had the greatest growth rate measured during the study at 15.63 in^2 (Table 1). This was surprising because it was the disease indicator and had one of the lowest vigor ratings (Figure 2). Stress from the rust infection may have stimulated tillering more aggressively than other accessions in an attempt to combat the disease and survive. Biomass data shows that even though it spread rapidly, it yielded very little dry matter compared to other plants with slower growth rates. Accession 1 ranked in the top 5 plants for growth rate, but was not significantly different from most plants evaluated. Growth rate is important in that it demonstrates the potential for a plant to rapidly colonize the planting site and fill in void areas to prevent erosion or produce more biomass.

The mean for height was 52.07 inches with 'Lometa' reaching 56.5 inches (Table 1). Accessions 18 and 1 were significantly taller than all other plants in the study at 69.75 and 69.25 inches, respectively (Table 1). Accession 5 was the second shortest plant in the study at 40 inches giving further evidence to the effect of rust on the overall performance of the plant.

CONCLUSION

Accession 1 was the only plant in the study to rank in the top five for every parameter measured. Five accessions were selected from the study primarily due to their rust resistance scores. The accessions selected were 1, 9, 10, 18, and 22. Accession 10 was the only plant that did not fall into the top 5 in terms of rust resistance, but was included because its rust rating was below 2 and it had the highest biomass yield. Many of the accessions selected ranked high in other categories as well. Accessions 1, 9, and 10 had exceptional tiller density scores. Accession 18 was the most resistant line and the tallest. Accession 22 was one of the most vigorous plants. These five selected plants represent an excellent grouping of favorable plant characteristics with high rust resistant scores. The selected accessions were dug from replications one and two of the study and split into plugs approximately 6 inches square. This material was then planted in a Latin Square Design replicated four times. This planting will serve for advanced evaluation and monitoring of the selected accessions, and serve as a crossing block to generate F_1 seed. The F_1

Accessions 1, 9, 10, 18, and 22 planted into a Latin Square Design at the USDA – NRCS East Texas Plant Materials Center in 2011.

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material should be planted and monitored for disease resistance. A determination can then be made to further work with the seedling generation or to isolate individual superior plant(s) to increase for adaptation testing and potential release.

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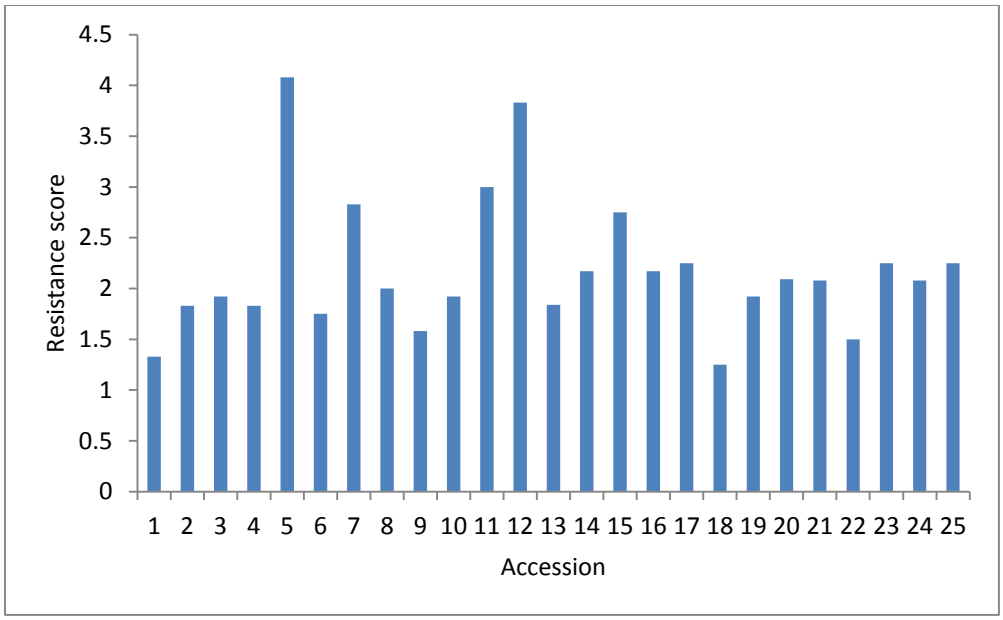

Figure 1 mean rust resistance score of Indiangrass accessions. USDA-NRCS East Texas Plant Materials Center, Nacogdoches, TX 2007-2010 (1 = best; 3 = average; 5= worst).

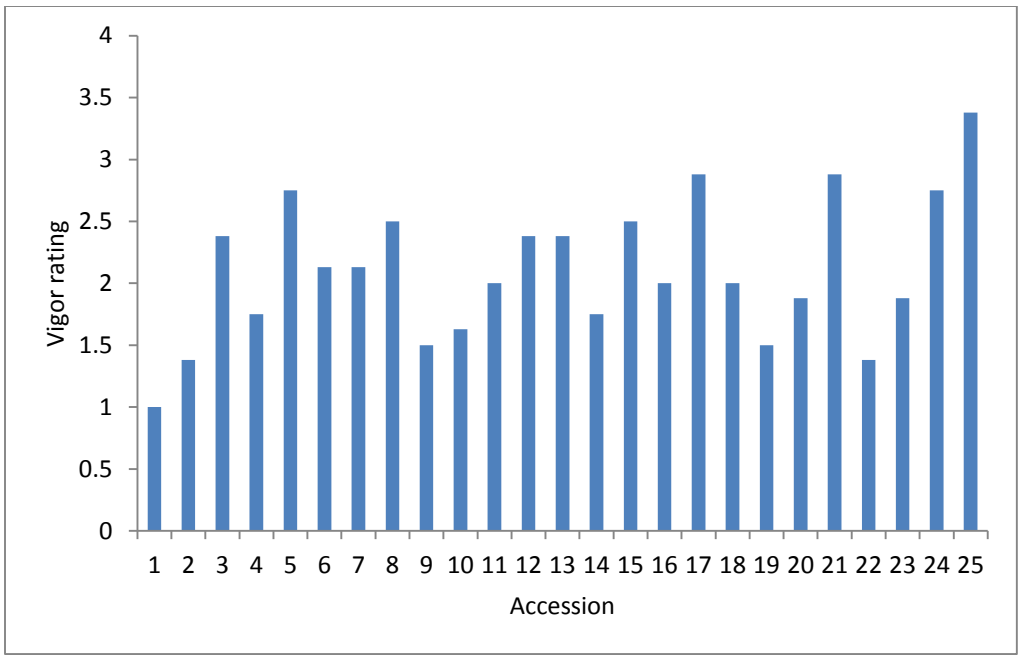

Figure 2 mean vigor rating of Indiangrass accessions. USDA- NRCS East Texas Plant Materials Center, Nacogdoches, TX 2007-2010. (1 = best; 3 = average; 5= worst).

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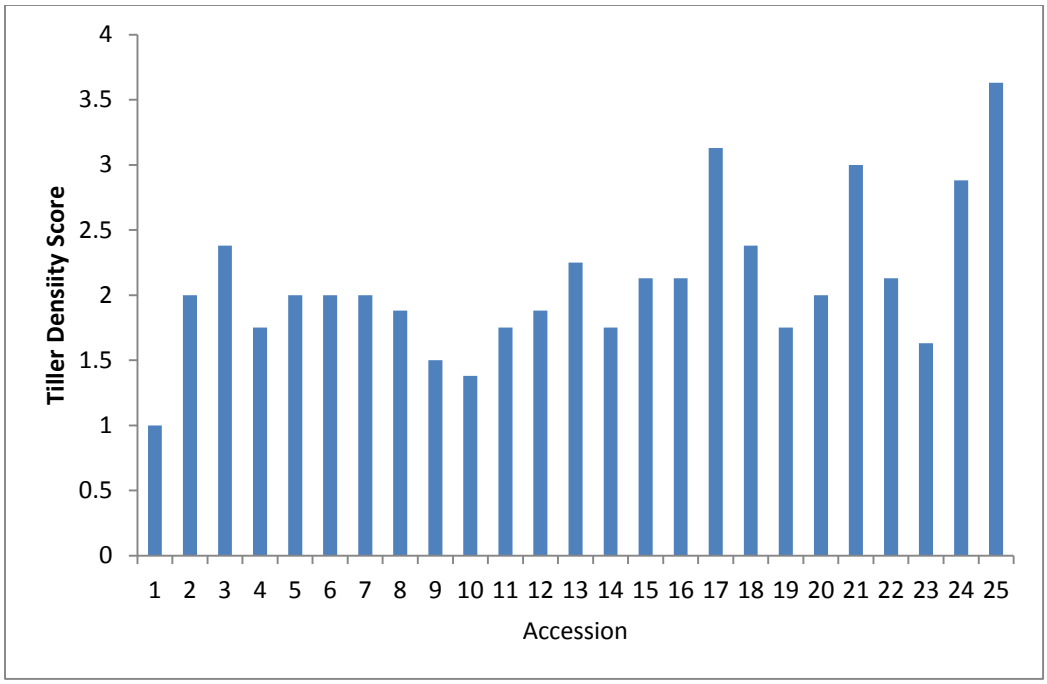

Figure 3 mean tiller density rating of Indiangrass accessions. USDA- NRCS East Texas Plant Materials Center, Nacogdoches, TX 2007-2010 (1 = best; 3 = average; 5= worst).

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Table 1. Biomass yield, growth rate, and height of Indiangrass accessions USDA-NRCS East Texas Plant Materials Center, Nacogdoches, TX (2007-2010)

Accession	Yield	Growth Rate	Height
	--lbs/plot--	--in--	--in--
1	2.51	11.75	69.25
2	1.65	8.75	64.5
3	2.05	8.5	38.5
4	1.65	12.75	41.75
5	1.06	15.63	40
6	1.53	4	51
7	1.55	12.13	56.5
8	2.25	9.5	52
9	2.04	8	50.25
10	3.16	10.06	49
11	2	9.38	46.5
12	1.84	8.5	48.25
13	2.32	11.13	49.25
14	2.13	10.75	62.25
15	1.93	7	54.25
16	2.83	9.63	61.25
17	0.94	9.38	41.5
18	2.04	8.13	69.75
19	1.15	7.25	48.25
20	1.63	5	54.5
21	1.94	7.25	41.5
22	1.5	6.25	53
23	1.71	11.88	45
24	1.32	10.88	57.25
25	1.16	7	56.5
Mean	1.83	9.22	52.07
$LSD_{(0.05)}$	.78[1/]	4.92	9.57

1/ Least significant difference at $P<0.05$.

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