Analysis of Genotype and Genotype By Environment Interaction in Louisiana Sugarcane Research Plots By GGE Biplots

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Introduction

- Sugarcane is cultivated/grown in 23 out of 64 Louisiana parishes in an area occupying 165756.8 hectares.
- The growing area includes two major soil types and other types of growing environments.
- Because the genotype by environment affects the yield of crops, it is necessary to evaluate cultivars in multiple environments for several years.
- The heritability adjusted GGE biplot or HA-GGE is able to graphically display genotype by environment interactions and identify the best cultivars for identified mega-environments and testing sites with the best discrimination and representation.

Materials and Methods

- Sugar per hectare yield data from 21 locations including 9 nursery and 12 outfield test locations (Figure 1) from four years (2012-2015) was analyzed using the GGE biplot software (Yan et al. 2010).
- Heritability adjusted biplots were created with the "where which won" option which discriminates the best genotypes for different locations and the discrimination vs. representation option which identifies location discrimination and representation (Figure 2) and the "mean vs. stability" option which compares the stability of genotypes to their yield.
- The numerical results from the biplots were summarized over years and locations or varieties using mixed model analysis.

Results

- The where which won plots did not identify consistent macro environments across crops or years (Figure 3)
- Comparisons of tester environment's representativeness showed significance in testers and crop by year interaction for both the nursery and outfield locations.
- The locations Glennwood, STG, and STO were the most representative and Magnolia and IRS the least (Figure 4).
- For the descriptiveness of locations, crop by year and year by tester interactions were significant in the nurseries but in the outfield only significant for tester.
- The locations St. Gabriel and St. John were the most descriptive and STO, Fred Martin, Magnolia, and Bonsecour were the least (Figure 4).
- There were no significant differences for instability in the nurseries but in the outfield, genotype was significant.
- The genotypes HoCP 00-950, L 03-371 were the least stable and L99-226 and L 01-283 were the most stable (Figure 5).
- Performance was significant among genotypes in the nursery and crop by genotype and year by genotype were significant in the outfield.
- The top performer most years was L 09-299 and the least performer most years was HoCP 96-540 or HoCP 07-613 (Figure 6).

Figure 1. Locations of nursery and outfield tests in Louisiana. Nurseries are in red, and outfields are in blue.

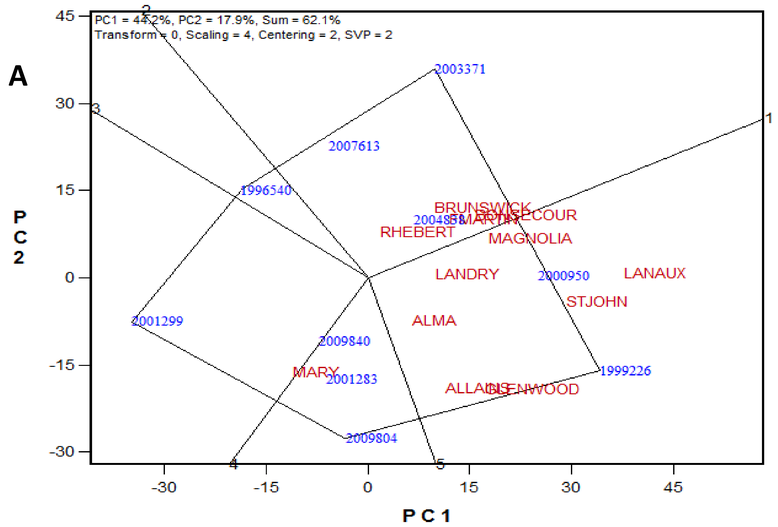

Figure 2. Some of the biplots used in this study: A) where which won; B) discrimination vs. representativeness of testers

	Group 1	Group 2	Group 3
PC 2012	1999226: AFH AFL NEW NIB SGL STG STO	2004838: IRS WES	
1R 2012	1999226: NEW STG STO	1996540: IRS NIB SGL	2001283: AFL WES
2R 2012	2001283: STO NEW SGL	1996540: STG	2000950/1999233: WES
PC 2013	1999226: AFL IRS STG STO WES	2003371: AFH NEW NIB SGL	
1R 2013	1999226: AFH IRS STO WES	2003371: NEW SGL	2001299: NIB
2R 2013	1999233: NEW AFL STO WES	2001299: STG NIB IRS	1999226: SGL
PC 2014	1999226: AFH AFL NEW NIB SGL STG STO WES	1996540: IRS	
1R 2014	1999226: AFH IRS NEW SGL STG STO	— — — — — —	2001299: AFL NIB WES
2R 2014	1999226: AFH AFL WES SGL NEW	none: STO NIB	
PC 2015	1996540: AFH IRS STG STO WES	2004838: AFL NEW NIB SGL	
1R 2015	1999226: AFL NEW NIB SGL STG STO WES	1996540: IRS	
2R 2015	1999226: AFH STG WES NIB SGL SGT AFL NEW	2003371: STO	

Figure 3. List of macro environment for nursery locations for each crop year including locations and most representative cultivar. PC, Plant cane; 1R, first ratoon; 2R second ratoon.

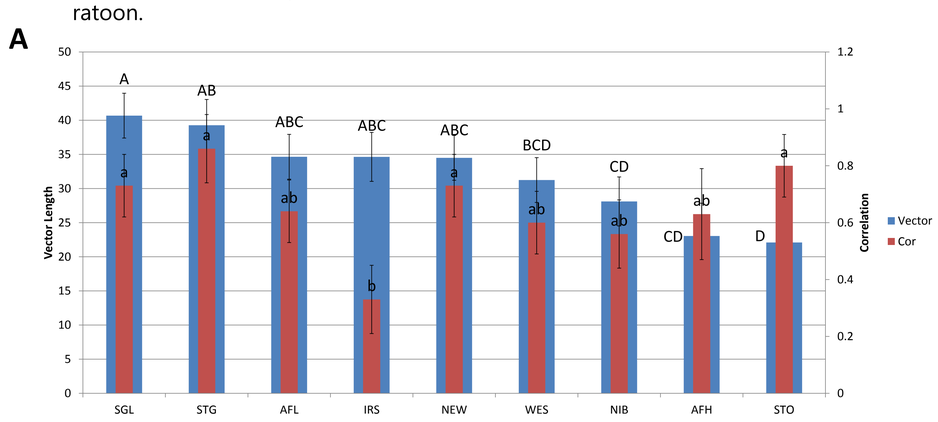

Figure 4. Averages of vector length (left axis) and correlations (right axis) to the average tester axis which represent a test location's discrimination and representation respectively: A) Nursery locations; B) Outfield locations

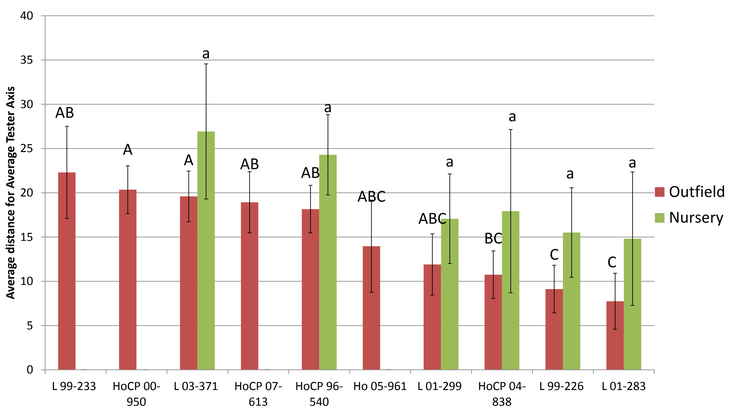

Figure 5. Average cultivar instability in the outfield and nursery plantings. Higher numbers represent higher instabilities

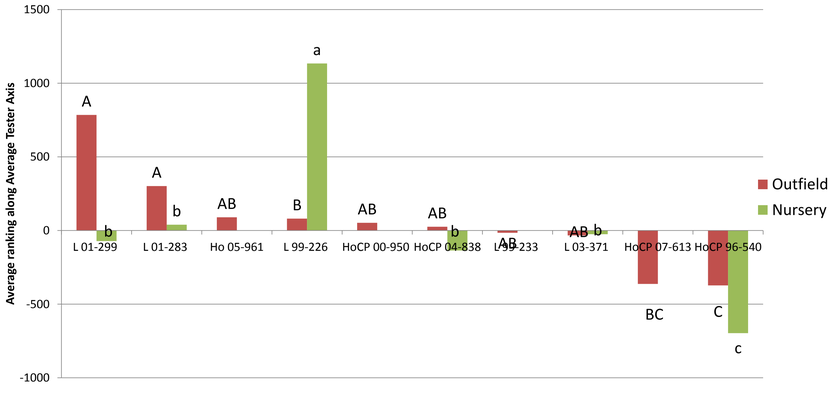

Figure 6. Average performance of cultivars in the nursery and outfield evaluations

Discussion and Conclusions

- No consistent macro environments were identified. This could indicate that the cultivars selected in this study were bred for general performance in any environment or are only selected for one macro-environment.
- Because there are differences in discrimination and representation among the locations tested, location utility could be ranked for breeding purposes. This could be made yearly in the nurseries where there was a year*tester interaction.
- Cultivar utility could also be ranked according to stability and performance for use in evaluation.

Acknowledgements

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Reference

Yan, W., & Holland, J. B. (2010). A heritability-adjusted GGE biplot for test environment evaluation. *Euphytica*, *171*(3), 355-369.