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IDENTIFYING DISCRIMINATING ENVIRONMENTS FOR VARIETY SELECTION IN LOUISIANA

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Abstract

GGE Biplot Pattern Explorer was used to identify and rank test locations with respect to discriminating ability and representativeness in Louisiana for lint yield and fiber length using the 1993-2003 Louisiana Official Variety Trials (early and medium maturity). Biplots were created and distances between the ideal and actual environments were measured and averaged. Environments with shorter distances were closer to the ideal environment and were considered more desirable test locations for the trait of interest.

For lint yield, the most desirable selection environment was St. Joseph loam, based on its close proximity to the ideal test location and the low standard deviation. Winnsboro non-irrigated and Bossier City were not good selection environments for lint yield.

For fiber length, Winnsboro irrigated was ranked 1st and St. Joseph loam was ranked 3rd. Winnsboro non-irrigated was ranked 6th. A composite distance, reflecting the distance between the actual and ideal environment for lint yield weighted at 60% and fiber length weighted at 40% was used to determine the desirability of test locations based on simultaneous selection for yield and fiber length. St. Joseph loam was ranked 1st, Winnsboro irrigated was ranked 2nd, and Winnsboro non-irrigated was ranked 6th.

The results of this study indicate that St. Joseph loam or Winnsboro irrigated should be used for selecting varieties for lint yield and fiber length. Additionally, Winnsboro non-irrigated should not be used for selecting varieties due to its low level of discrimination and unique behavior.

Introduction

The efficiency and accuracy of variety selection for a given trait is greatly enhanced in highly discriminating environments compared to non-discriminating environments. Therefore, the identification of highly discriminating environments, for a single or combination of traits, should be of paramount concern to breeders. A second criterion for a desirable selection environment is representativeness. Thus, an ideal test environment should effectively discriminate among genotypes and represent an "average" environment for the region of interest.

The discriminating ability of an environment is comprised of a variety of factors including soil type, pest pressure, drainage, temperature, rainfall, soil fertility, and management decisions. Many of these factors vary between years, therefore, any determination of discriminating ability should be made over as many years as possible to obtain a good sample. A perfectly discriminating environment could be defined as an environment that increases the genotypic variation among varieties for a given trait. That is to say that a breeder can most accurately identify those genotypes exhibiting superior performance and consequently, those that exhibit inferior performance. Ideally, a breeder would conduct the selection phase of the program in the environment that provides the most information for each trait. However, limited resources often inhibit that detail and most breeders use few test locations for selection, mainly for lint yield (Lubbers, 2003). This paper presents a method for determining an ideal test location based on weighted simultaneous selection for different traits.

In addition to exhibiting a high level of discrimination, an ideal test location also needs to be representative of the target growing region. Traditionally, cotton breeding companies have test locations in various mega-regions, e.g., the Mid-South, Southeast, Far West, and varietal selection at those sights is primarily targeted for that region. Thus, to identify an ideal test location for a region, an average, or representative, environment should be used to reflect all environments in the target region.

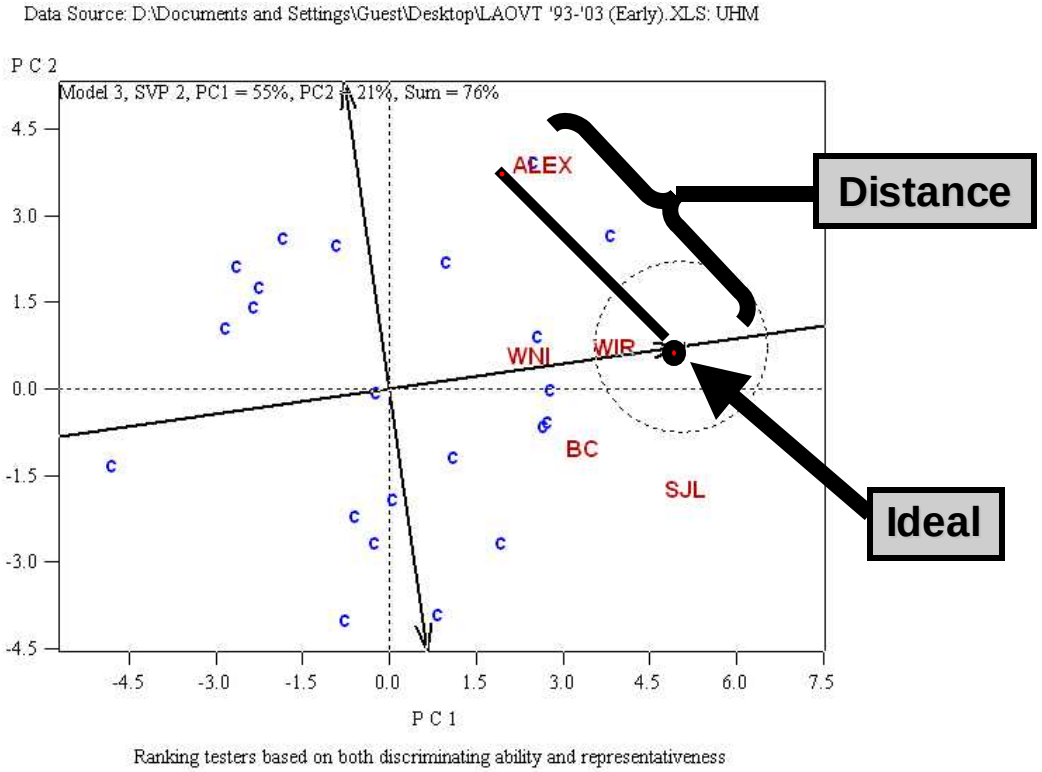
Identification of an ideal test location based on discriminating ability and representativeness implies that selections made at that site have the highest probability of being truly superior genotypes that perform well in all environments in the growing region. In addition, genotypes selected in such an environment may have a higher level of stability in that region as well.

Materials and Methods

The 1993-2003 Louisiana Official Variety Trials (LAOVT), early and medium maturity groups, were used to construct 21 datasets for each year x maturity combination for analysis in GGE Biplot. Though the genotypes were not constant throughout the ten-year period, they were irrelevant and were only used to calculate the desirability of the environments for each year x maturity dataset.

The LA OVTs have traditionally been conducted in 6 locations in Louisiana: Alexandria (ALEX), Bossier City (BC), St. Joseph loam (SJL), St. Joseph clay (SJC), Winnsboro irrigated (WIR), and Winnsboro non-irrigated (WNI). These 6 environments give a good representation of the cotton-growing regions in Louisiana and were analyzed to determine the location that was most desirable for enhancing germplasm selection. Traits analyzed were lint yield and fiber length, alone and as a component of an indexed value.

Data consisted of measurements, for each biplot, between an ideal tester and the actual environment. Yan and Kang (2002) provide a detailed explanation of the biplot calculations and ideal tester determinations. GGE Biplot Pattern Explorer generates a biplot of an ideal tester, an average of the environments in the dataset (representative) and as discriminating as the most discriminating environment in the dataset. Therefore, the distance between the actual environment (ALEX, BC, SJL, SJC, WIR, WNI) and the ideal tester is an indication of the desirability of that environment with respect to discriminating ability and representativeness for that trait.



Distances were standardized by the mean of all environments for each biplot. The standardized distances, for each environment, were averaged over the 21 datasets to obtain an average distance from the ideal tester. These data were presented for lint yield, fiber length, and combined into one indexed value. For the combined value, the average distance for each environment for lint yield was weighted at 60% and for fiber length was weighted at 40%. The resulting combined value represents the average distance from the ideal tester under a 60/40 selection for lint

yield and fiber length, respectively. Environments with shorter distances are ideal selection environments based on discriminating ability and representativeness.

Results and Discussion

The order of desirability, determined by the shortest distance from the ideal, was SJL, SJC, ALEX, WIR, BC, WNI for lint yield (Table 1). Statistically, SJL, SJC, ALEX, and WIR would be equally sufficient test locations for lint yield while BC and WNI were less effective, either by failing to separate among varieties or not representing the other growing regions (Table 1). SJL had the lowest standard deviation of the 6 environments indicating that it was consistently close to the ideal tester and fluctuated less between years (Table 1).

Table 1. Standardized distances between actual and ideal environments, standard deviations, and rankings of 6 environments for lint yield.

Environment	Rank	Distance	SD
St. Joseph loam	1	0.769 a	0.30
St. Joseph clay	2	0.932 ab	0.49
Alexandria	3	0.933 ab	0.43
Winnsboro irrigated	4	0.974 ab	0.44
Bossier City	5	1.141 b	0.35
Winnsboro non-irrigated	6	1.214 b	0.36

Selection for fiber length alone would be most effective in WIR, followed by BC, SJL, ALEX, SJC, WNI (Table 2). Rather than select for fiber length alone, breeders will likely select primarily for lint yield and secondarily for fiber quality. WIR and SJL were ranked 4th and 1st for lint yield and 1st and 3rd for fiber length, respectively, indicating that variety selection in those environments would be accurate and broadly-adapted for both traits (Table 3).

Table 2. Standardized distances between actual and ideal environments, standard deviations, and rankings of 6 environments for fiber length.

Environment	Rank	Distance	SD
Winnsboro irrigated	1	0.669 a	0.48
Bossier City	2	0.871 ab	0.42
St. Joseph loam	3	0.887 ab	0.64
Alexandria	4	1.016 ab	0.65
St. Joseph clay	5	1.113 bc	0.51
Winnsboro non-irrigated	6	1.451 c	0.69

Table 3 shows the average ranking of each environment for both traits and the combined indexed value representing simultaneous selection for lint yield (60%) and fiber length (40%). The composite indexed values indicated that SJL would be the ideal test location for variety selection for both traits in Louisiana (Table 3). WIR and ALEX were

also acceptable locations while BC and WNI provided few meaningful selections and did not reflect the other growing regions in Louisiana.

Table 3. Environments ranked according to desirability for lint yield, UHM, and simultaneous (lint yield + UHM) selection.

Environment	Rank (yield)	Rank (UHM)	Avg. Dist.* (Yield +UHM)	*Avg. Rank*
St. Joseph loam	1	3	0.816	*1*
Winnsboro irrigated	4	1	0.852	*2*
Alexandria	3	4	0.975	*3*
St. Joseph clay	2	5	1.01	*4*
Bossier City	5	2	1.04	*5*
Winnsboro non-irrigated	6	6	1.31	*6*

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