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STABILITY OF SOYBEAN CULTIVARS IN ALABAMA

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ONE of the most important management decisions a soybean (*Glycine max* (L.) Merr.) grower makes is selection of the proper cultivar. Many factors can influence the final decision, such as relative seed costs, pest reaction, herbicide tolerance, and maturity date. The decision is further complicated by the fact that Alabama Soybean Variety Test results for the past years indicate some cultivars perform well in some years and poor in others, even at the same location.

The final seed yield of any soybean cultivar is determined by both the genetic yield potential (genotype) and the yield potential of the environment. The genotype is a fixed quantity for any particular cultivar and cannot be changed or manipulated. The level of productivity of a particular environment can be influenced by moisture availability, soil type, fertility level, temperature, length of growing season, and many other variables. Some of these quantities are fixed and others may change from year to year within a particular location. The genetic yield potential of each cultivar reacts differently to different environments. This is called a genotype x environment interaction, and explains why cultivars are recommended on a regional basis within the State instead of on a statewide basis. Because of this interaction effect, it should be possible to select a cultivar that would provide maximum yields in a given environment. Because environments change from year to year in a location, however, this is not possible. The next best alternative would be to select cultivars based on their stability, or consistency of performance from one environment to another. Although two cultivars may have the same average seed yield over a series of environments, one cultivar

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may be quite variable in yield from one environment to another while the other may produce more consistent yields.

Plant breeders and other crop scientists have devoted much effort to the study of genotype x environment interactions *(2)*. Interest in genotype x environment interactions has led to several different procedures for investigating their nature. Sprague and Federer *(6)* used variance components to investigate magnitudes of genotype x environment interactions in single and double cross maize (*Zea maize* L.) hybrids. Yates and Cochran *(9)*, Finlay and Wilkinson *(4)*, and Eberhart and Russell *(3)* developed regression techniques that allowed the genotype x environment interaction to be partitioned into linear and more complex relationships. Soybean researchers in the Midwest have recently used these and other techniques to measure yield stability of soybean cultivars and cultivar blends adapted to that area *(1,7,8)*. No stability studies have been conducted on soybean cultivars adapted to the Southeastern United States.

A stability analysis was conducted on Alabama Soybean Variety Test results for the years 1976-81 to compare cultivars for their consistency of performance in central and southern Alabama. Statistical procedures were similar to those described by Perkins and Jinks *(5)*. In the 3-year period 1976-78 (Experiment 1), nine adapted cultivars (Maturity Groups VI, VII, and VIII) and one unadapted cultivar (Maturity Group V) were analyzed. In the 3-year period 1979-81 (Experiment 2), 12 adapted cultivars and 1 unadapted cultivar were analyzed. Combinations of 8 locations, 3 years, and 1 to 3 planting dates made up a total of 28 environments in each experiment, table 1. Cultivars included in the analyses are listed in tables 2 and 3.

TABLE 1. YEARS, LOCATIONS, AND PLANTING DATES INCLUDED IN THE STABILITY ANALYSES

Location	Exp. 1			Exp. 2		
	1976	1977	1978	1979	1980	1981
Prattville	E[1],L	E,L	L	E	E	E
Marion Junction	E,M,L	E,M,L	E,M,L	E,M,L	E,M,L	E,M,L
Camden	—	—	—	M	—	M
Brewton	M,L	M,L	M,L	M,L	M	M,L
Fairhope	M	M	M	M	M	M
Headland	M	—	M	M	M	M
Monroeville	M	M	M	M	—	M
Shorter	—	—	—	—	—	M

[1]E = early planting date (before May 20); M = medium planting date (May 20 to June 10); L = late planting date (after June 10).

TABLE 2. MEAN SEED YIELDS, DEVIATIONS MEAN SQUARES, AND REGRESSION COEFFICIENTS FOR CULTIVARS ANALYZED 1976-78 (Experiment 1)

Cultivar	Mean seed yield/acre	Deviations mean square	Regression coefficient[1]
	Bu.		*B*
Group V			
Forrest	30.8	21.9	0.00
Group VI			
Davis	34.5	10.5	.00
Coker 136	29.8	21.7	− .19
Centennial	33.3	7.3	.00
Tracy	33.0	9.3	.00
Group VII			
Bragg	36.6	9.3	.00
Ransom	36.1	15.4	.19
Group VIII			
Cobb	36.0	19.1	.00
Hutton	36.2	8.0	.10
Coker 338	37.2	5.4	.00

[1]Zero regression coefficients are reported where the analysis yielded estimates of B not significantly different from zero.

Two stability parameters were estimated that help describe a cultivar's response to environments of varying levels of productivity. The deviations mean square is a measure of the consistency of a cultivar's performance across environments. The lower the deviations mean square value, the more consistent the cultivar. The regression coefficient, or "B" value, is a measure of a cultivar's sensitivity to changes in the produc-

TABLE 3. MEAN SEED YIELDS, DEVIATIONS MEAN SQUARES, AND REGRESSION COEFFICIENTS FOR CULTIVARS ANALYZED 1979-81 (EXPERIMENT 2)

Cultivar	Mean seed yield/acre	Deviations mean square	Regression coefficient[1]
	Bu.		*B*
Group V			
Forrest	22.4	23.9	0.00
Group VI			
Davis	26.2	13.7	.00
Coker 156	26.8	18.9	.00
Centennial	26.5	9.0	− .10
Group VII			
Braxton	28.5	7.4	.00
Bragg	26.4	5.9	.00
Ransom	26.4	6.5	.00
Coker 237	28.0	12.1	.25
GaSoy 17	27.6	7.2	.00
Group VIII			
Dowling	26.3	9.2	.00
Cobb	25.6	23.3	.00
Hutton	24.5	10.3	.09
Coker 488	27.0	6.7	.00

[1]Zero regression coefficients are reported where the analysis yielded estimates of B not significantly different from zero.

tion level of the environment. A regression coefficient of zero indicates average response. A negative regression coefficient indicates a cultivar relatively insensitive to environmental variation, and a positive regression coefficient indicates a cultivar with greater than average sensitivity to changes in the environment. An ideal cultivar should have a high seed yield, a regression coefficient of zero, and a low deviations mean square value. Although they may seem to measure the same quantities, the deviations mean square and the B value are entirely different. Each cultivar shows a somewhat linear response to changes in environmental productivity. As environmental yield potential increases, final seed yield also increases. Each cultivar has a characteristic rate of increase, or "slope", of linear increase. When this slope or rate of increase (B value) has been established, the deviations mean square measures the degree of consistency between the observed values and the calculated regression line. A close agreement results in a low deviations mean square, or stable performance.

The 3-year period 1976-78 (Experiment 1) was favorable for soybean production with a mean yield of 34.3 bushels per acre. Environment mean yields ranged from 15.4 bushels per acre for the late planting at Marion Junction in 1977 to 52.1 bushels for the late planting at Brewton in 1976. Forrest, the Maturity Group V cultivar, had a low seed yield and the highest deviations mean square. This high deviations mean square value indicates an inconsistent yield pattern, or a tendency to yield above average in some environments and below average in others, regardless of the production level of the environment. Coker 136 also had a low seed yield and high deviations mean square. The most consistent cultivar in the test was Coker 338. It had a low deviations mean square and high seed yield, indicating a tendency to produce a consistent yield across different environments.

Regression coefficients for cultivars in Experiment 1 were zero except for Coker 136, Ransom, and Hutton. Coker 136 had a negative regression coefficient, indicating a less than average relationship between yield of Coker 136 and average environmental yield. Ransom and Hutton had positive regression coefficients indicating greater than average sensitivity to environmental variation. These cultivars tended to yield less than average in poor environments and greater than average in environments of high productivity.

The 3-year period 1979-81 (Experiment 2) was less favorable for soybean production, with a mean yield of 26.3 bushels per acre. Environment means ranged from 8.9 bushels per acre at Prattville in 1980 to 50.4 bushels for the medium planting date at Brewton in 1981. Cultivars showing consistent performance across environments were Braxton, Bragg, Ransom, and Coker 488. Regression coefficients were zero for most cultivars. Centennial had a negative regression coefficient, indicating less than average environmental sensitivity. Hutton and Coker 237 had positive regression coefficients. The regression coefficient of 0.25 for Coker 237 was high compared to the other cultivars included in the study. This indicates a tendency for this cultivar to be more sensitive to changes in environmental productivity, yielding well above average under favorable conditions and well below average under unfavorable conditions.

For the cultivars common to both experiments, differing levels of productivity had little effect on the stability parameter estimates. Ransom appeared to be different for the two experiments, having a positive regression coefficient in Experiment 1 and a zero B value in Experiment 2. Centennial had a positive B value in Experiment 2 but a zero B value in Experiment 1. An interesting comparison can be made between Cobb and Hutton, two similar Maturity Group VIII cultivars. In both experiments, Cobb had a high deviations from regression mean square and a zero regression coefficient. Hutton had a lower deviations mean square and a positive regression coefficient. Thus, even though these two cultivars were quite similar in many respects, including seed yields, they were quite different in their stability parameter estimates.

Based on these findings, certain conclusions can be drawn regarding specific cultivar selections for a particular environment. Even though yield levels change from year to year for any location, most soybean producers are familiar with the inherent productive capacity of his individual fields. With this information, these stability performance estimates can serve as additional criteria for selecting the most profitable cultivar.

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