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Growing Soybean Varieties from Multiple Maturity Groups Can Reduce Yearly Yield Volatility

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In the Kentucky Soybean Performance Test program, varieties of maturity groups (MG) 3, 4 and 5 are tested to provide information on their relative yields. The difference in maturity between the earliest and the latest maturing variety in the test in any year is approximately 30 days. In general, although some regional differences appear, the long-term state-wide and within region yield of the different maturity groups (average yield of all varieties in a maturity group) is equal (Table 1). As I've inspected results from the Kentucky Soybean Performance Tests for the last decade, it appeared that some of the variation in yield among varieties at a particular location in a particular year was due solely to the maturity of the variety. Furthermore, large deviations in maturity group yield occurred during consecutive years even within the same testing region. These points are illustrated in Table 1 by specific years from the Lexington, Wickliffe, and Nebo tests. The purpose of this note is to illustrate and discuss reducing soybean yield volatility by growing varieties from different maturity groups.

Materials and Methods

All the information utilized in this analysis came from the Kentucky Soybean Performance Tests 1977-1990. The number of varieties comprising the location average ranged from 58 in 1980 to 84 in 1990. Four regions or locations were used to compare selected variety yield vs. location average yield: Lexington, Princeton, Green River region (Henderson, Owensboro, Morganfield), and Purchase region (Hickman, Wickliffe, Paducah, Clinton, Murray). Only the full-season tests in these locations were used in the comparisons. During this 11 year period, 41 environments were available to analyze. An environment is considered a single location in a single year. The analysis was based on the difference between the selected variety or set of varieties and the environment mean yield, the average yield of all varieties grown in that test. A positive difference indicates the selected variety yielded above the environment mean yield while a negative difference indicates the selected variety yielded below the environment mean yield in the test environment. Yield differences were

rounded to the nearest bushel. The average of these yield differences and the standard deviation of these yield differences were calculated for each selection scheme.

Varieties were selected by different schemes, and, most importantly, either the highest yielding variety regardless of maturity group or the four highest yielding varieties, one each from maturity groups 3, early 4, late 4, and 5 were selected for each scheme. Maturity group 4 was divided into two groups because the maturity range in MG4 was usually twice as large as the maturity range in MG3 or MG5. When four varieties were selected, yield in the following year was calculated as the average of the four varieties; this assumes equal parts of the field area, 25% of the total, would be planted to each of the chosen varieties. The selection schemes were as follows: 1) selection of the variety with the highest 3-year yield in a single region followed by a comparison of the performance of that variety in the same region the following year, 2) selection of the variety with the highest one year yield in a single region followed by a comparison of the performance of that variety in the same region the following year and 3) selection of the variety with the highest 2-year yield statewide (generally seven tests per year) followed by a comparison of that variety in four regions the following year. An example of selection scheme 1 is given: Pella was the highest yielding variety at Lexington for 1977-1979 and in 1980 Pella yielded 42 bu/a at Lexington compared to the Lexington test average yield (environment mean yield) of 38.6 bu/a; this gave a positive difference of 3 bu/a when only one variety was selected. Pella (MG3), Union (4E), Mitchell (4L), and Essex (5) were the highest yielding varieties in the four maturity groups at Lexington for 1977-1979. In 1980 the average yield of these four varietes at Lexington was 39.6 bu/a giving a positive yield difference of one bu/a when four varieties were selected.

These three selection schemes involved constant changes in the variety or set of varieties which were assessed each year. Another set of varieties in which the change in varieties was limited was also chosen for comparison in all regions. The varieties Essex (MG5), Mitchell until 1985 then Pennyrile (MG4), and Williams until 1983 then Williams 82 (MG3), were used to compare varieties from a single maturity group (each of these varieties individually) with production of varieties from multiple maturity groups (average of these three varieties) when the varieties were relatively constant. The variety change in MG4 was necessary because no single MG4 variety was grown for the entire 11 year period.

Results and Discussion

The overall average yield of the 41 test environments was 43.2 bu/a with a standard deviation of 10.1 bu/a. The environment mean yields ranged from 19 bu/a in the Purchase region in 1983 to 59 bu/a in the Green River region in 1990. So, this analysis involved both high yield and low yield environments.

One can concentrate on two sets of numbers, the standard deviation of the yield differences and the maximum positive and maximum negative yield differences. These values along with the yield difference averages are summarized in Table 2 for all selection schemes. The standard deviation is a statistic measuring variability. In this analysis the larger the

standard deviation for the yield differences the greater the variability among the positive and negative yield deviations within a selection scheme.

One can see in Table 3 that the simulated production of 4 varieties, one from each of 4 maturity groups, is much less volatile than the production of one variety, regardless of the selection scheme. The standard deviation when four varieties were used was less than half the standard deviation when only one variety was selected. Likewise, the range between the maximum positive and negative deviations was only half as large for four varieties as for one variety. The same trend holds when three varieties were used continuously. The deviation and the range of an equal production of the three varieties are both smaller than when any one of the three was the only variety produced. Similarly, the number of environments in which multiple varieties produced a negative deviation was fewer under all selection schemes than when only a single variety was used.

More than one selection scheme was used for this analysis in order to show that the reduction in variability achieved by using varieties of multiple maturities is independent of the method used to select the varieties. The combination of a particular variety selection scheme with the option of selecting 4 varieties of different maturity, each planted on 25% of a grower's soybean average, is only one example of a potential strategy for dealing with soybean yield volatility. One's own variety selection scheme and soybean production experience can be used to develop a multiple maturity group strategy. For example, if one's experience points to MG5 superiority, then 60% MG5, 20% MG4, and 20% MG3 is a potential maturity group split.

Conclusion

While variety selection is important, there remains an overriding effect of environment on yield level. The 3 selection schemes used here provided a 1.5 bu/acre yield increase over the environment mean, but the standard deviation among the environments used for this analysis was 10 bu/acre. A typical producer has little influence on environment mean yield. I feel much of the yield variability comes from moisture variability, controllable only by irrigation which is uncommon in Kentucky. A producer may, however, be able to control the volatility of variety yield around the environment mean yield by growing varieties from multiple maturity groups. While a producer would want to be 16 bu/acre above the environment mean yield, one would not want to be 16 bu/acre below the average productivity level of a particular location. Growing varieties from multiple maturity groups reduces both the yield standard deviation around the environment mean and the chance of harvesting yields below the environment's productivity level. The technique should be considered to reduce soybean yield volatility.

Kenneth L. Wells

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Table 1. Yield of soybean varieties within each maturity group based on those varieties tested for the three year periods 1986-1988 and 1989-1991, and examples from specific locations in specific years for all varieties tested at that location in that year.

Year	1986-1991					1986 1987		1987 1988		1988 1989	
Location[a]	ST[b]	LX	PR	PU	GR	Lexington		Wickliffe		Nebo	
Maturity Group	bu/acre										
3	42	40	45	34	55	25	27	31	27	31	52
4	43	40	46	36	56	27	22	27	30	31	53
5	43	38	45	40	55	33	10	26	38	38	45

[a]ST-statewide, LX-Lexington, PR-Princeton, PU-Purchase Region, GR-Green River Region
[b]The statewide yield is not the average of the four regions shown here. Other locations are also included in the statewide average.

Table 2. Average yield difference, its standard deviation, and maximum positive and maximum negative yield differences from 41 test environments for the different variety selection schemes.

	Selection Scheme									
	Changing Varieties						Constant Varieties			
	1[a]	1	2	2	3	3	MG3[b]	MG4[c]	MG5[d]	Avg.[e]
# Varieties Used	1	4	1	4	1	4	1	1	1	3
	Bushels/Acre									
Yield Deviation										
Average	0.9	1.0	2.5	1.9	1.9	1.3	0.2	2.4	2.1	1.6
Standard Deviation	6.0	2.4	5.6	2.3	4.5	1.8	3.8	3.3	4.9	2.2
Maximum Positive	16	7	16	8	15	5	9	7	16	6
Maximum Negative	-16	-7	-12	-5	-5	-4	-10	-7	-8	-3
# tests below environment mean	15	9	11	7	12	3	15	7	14	6

[a] 1) selection based on the highest 3-year variety yield in a single region then tested in that region
2) selection based on the highest one year variety yield in a single region then tested in that region
3) selection based on the highest 2-year variety yield statewide and then tested in all 4 regions
[b] Williams until 1983 then Williams 82 - maturity group 3
[c] Mitchell until 1985 then Pennyrile - maturity group 4
[d] Essex - maturity group 5
[e] (MG3 yield + MG4 yield + MG5 yield)/3

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