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GRAIN QUALITY OF EARLY MATURING SOYBEAN GROWN IN KENTUCKY

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Interest in grain quality of US soybean has grown in recent years. For example, in 1990, there was much interest in "component pricing" of soybean grain. Under that plan, growers would be paid a price for their grain that reflected the value of the protein and oil it actually contained, rather than the common price paid to all growers, regardless of any variation in protein and oil content. However, the soybean processing industry is evidently not excited about the complexity of testing individual lots for protein and oil and keeping track of pricing structures depending on those results. As a result, component pricing has yet to happen.

The soybean industry is now looking with interest at new breeding lines with altered fatty acid profiles. For example, US soybean breeders have developed soybean germplasm with low palmitic acid or with reduced linolenic acid. Palmitic acid is a saturated fat, and has prompted health concerns among American consumers. Linolenic acid contributes to off-flavor characteristics in soybean oil. Soybean breeders may be able to develop new varieties with "designer" oils particularly suited to a portion of the oil market. Clearly, the emergence of canola oil as a major competitor with soybean oil has been directly tied to its better fatty acid profile. Thus, we may eventually see farmers growing soybean varieties with altered fatty acid profiles, probably on a contract basis.

How does Kentucky fit into this concept? First, our growing conditions are quite different from those in the major soybean growing regions to our north. Our planting dates are much more flexible, and temperatures during seed-fill are warmer. Warm temperatures during seed-fill reduce linolenic acid content. Perhaps our growing conditions would be even better suited to the production of new low linolenic acid varieties than the conditions in Iowa. Because an overwhelming portion of new variety development in the US is with early Maturity Groups (MG), like MG II, the new, altered fatty acid profile soybean varieties are likely to be from early MGs.

MG II soybean varieties have performed quite well under Kentucky conditions over the past eight years. At the UK research station, yields of MG II varieties have exceeded those of later maturing varieties in the dry years of the late 1980s, and have been quite competitive with later MG varieties in the wetter years of the early 1990s. Farmers had good success with MG II varieties in their own fields in 1993 and 1994. While farmers are appropriately concerned with the yield potential of MG II varieties under our Kentucky conditions, it is also important that we know how growing these varieties several hundred miles south of their normal production zone will affect their grain quality characteristics. The objective of this project, funded by the Kentucky Soybean Promotion Board, was to determine the influence of weather conditions and planting date on grain quality characteristics of early maturing soybean. Four years were used as a sample of Kentucky's weather variability.

Materials and Methods

Soybean varieties from MG I, II, III, and IV were planted in late April, mid May, early June, and late June in 1990 through 1993 on a well-drained Maury silt loam near Lexington, KY.

Hardin represented MG I, Elgin 87 represented MG II, Pella 86 represented MG III, and Lawrence represented MG IV. While these public varieties are no longer among the best yielding varieties available in their respective MG, they were chosen to ensure seed availability for the duration of the entire four year test. The experiments were set up as a separate randomization of a split plot design each season. Whole plots were planting dates, and split plots were varieties. Four replications were used each year. Means separation was based on the least significant difference (LSD) test.

Grain samples were set aside from each plot for analysis of protein content, oil content, and fatty acid composition. From 1990 through 1992, protein content was estimated by flash-combustion, and oil content was determined by gas chromatography. In 1993, both protein and oil content were measured by near infrared reflectance spectrophotometry. Fatty acid content was determined by gas chromatography in all four years.

Results and Discussion

All four varieties had increased protein content with delayed planting (Table 1). Higher protein for delayed planting would be desirable for our producers, since a substantial portion of our crop is planted behind wheat or barley. However, protein content of the earlier three varieties was stable across late April through early June plantings, and increased significantly only for the late June planting date. In contrast, protein content of the latest maturing variety increased 0.6 percentage points from the late April to the mid May planting date. Perhaps cooler seed-fill temperatures were responsible for the increased protein content of soybean planted in late June. Lawrence matured much later than did the other three varieties, so, temperatures during its seed-fill were cooler for the planting dates from mid May and later.

Table 1. Protein content of MG I through IV soybean varieties at four planting dates at Lexington, Kentucky (averaged across the years 1990 through 1993).

Planting Date	Hardin (MG I)	Elgin 87 (MG II)	Pella 86 (MG III)	Lawrence (MG IV)
	% protein content in 13% moisture grain			
Late April	36.4	35.2	35.7	36.4
Mid May	36.0	35.5	35.5	37.0
Early June	36.1	35.6	35.9	37.1
Late June	37.1	36.3	36.5	37.4

LSD (0.10) for comparing variety responses to planting date was 0.4.

In general, oil content fell as planting dates were delayed (Table 2). With the unexplained exception of Elgin 87 for the mid May planting date, the pattern of each variety's response to delayed planting was similar in magnitude but opposite in direction to that shown for protein. The MG I through III varieties had stable oil content across the range of late April through early June planting dates, then their oil content decreased for the late June planting date. In contrast, oil content of Lawrence (MG IV) decreased when planting was delayed from late April to mid May, and was stable after that.

In summary, protein and oil content of MG I, II and III showed little change across the full season planting dates (from late April through early June). When planting of these MGs was delayed until late June, their protein content increased and their oil content decreased. On the other hand, planting dates from mid May through late June had little effect on protein and oil content of the MG IV variety. When planted in late April, the MG IV variety had reduced protein content and elevated oil content.

As planting dates were delayed, Hardin (MG I) showed increased levels of palmitic and linolenic acids, little change in stearic acid, and decreased levels of oleic and linoleic acids (Table 3). The fatty acid response of Elgin 87 (MG II) to planting date was quite similar to that of Hardin (Table 3). It also had increased levels of palmitic and linolenic acids, little change in stearic acid, and a reduction in oleic acid in response to delayed planting. The linoleic acid level of Elgin 87 declined to its lowest point for the early June planting date, and rebounded when planted in late June. The fatty acid profile for Pella 86 (MG III) reacted to planting date in a much different way than did that of the two earlier varieties (Table 3). Only linolenic acid levels increased with delayed planting. Palmitic and stearic acid levels decreased slightly with delayed planting. The early June results for Pella 86 showed a jump in oleic acid and a drop in linoleic acid relative to the other three planting dates. We do not have a good explanation for this unusual pattern. Lawrence (MG IV) also showed a changing fatty acid profile with delayed planting (Table 3). Little change was shown for the two saturated fatty acids (palmitic and stearic). Although the data for the three unsaturated fatty acids showed some variability, the most pronounced changes for Lawrence were observed for the late June planting date. For that particular planting date, oleic acid levels decreased, while linoleic and linolenic acid levels increased.

We must caution producers that the above results were for one variety from each MG, and thus may not reflect MG trends in fatty acid response to planting dates. For example, palmitic and stearic acid levels were lower for Lawrence than for earlier varieties for all planting dates. However, other MG IV varieties may not show a similar trend.

Of particular interest was whether the linolenic acid response to planting depended on the earliness of the varieties grown. For Hardin, most of the increase in linolenic acid occurred with delayed planting between late April and mid May. For Elgin 87, delayed planting increased linolenic acid levels to the greatest extent of the four varieties tested. Both Elgin 87 and Pella 86 had their lowest linolenic acid levels for the late April planting date, and their highest levels for the late June planting date. Linolenic acid levels of these two varieties did not differ between mid May and early June planting dates. For Lawrence, delaying planting from late April to early June had little impact on its linolenic acid levels. It was only when Lawrence was planted in late June that its linolenic acid levels increased.

A Kentucky grower planting MG II varieties on a portion of his/her acreage would be likely to see their overall lowest levels of linolenic acid with a late April planting. Linolenic acid levels of all four varieties were closely related to temperature conditions during seed-fill. Warmer seed-fill temperatures resulted in lowered linolenic acid levels. If a Kentucky producer were to grow a new low linolenic acid variety, it would probably be better to plant this variety as early as possible to take maximum advantage of our warm summer conditions. Of course there is some chance that linolenic acid levels of such varieties may not respond in the same manner as the varieties in our tests.

Table 2. Oil content of MG I through MG IV soybean varieties at four planting dates at Lexington, Kentucky (averaged across the years 1990 through 1993).

Planting Date	*Hardin (MG I)*	*Elgin 87 (MG II)*	*Pella 86 (MG III)*	*Lawrence (MG IV)*
	% oil content in 13% moisture grain			
Late April	18.4	18.8	18.7	19.0
Mid May	18.3	18.1	18.4	17.8
Early June	18.4	18.6	18.7	17.9
Late June	17.7	18.1	18.1	17.6

LSD (0.10) for comparing variety responses to planting date was 0.4.

Conclusions

Full season planting dates had little difference in effect on the protein and oil content of MG I, II, or III varieties. Late June planting dates, which would be commonly used by double crop producers, increased protein content and reduced oil content of these early maturing varieties. In contrast, protein and oil contents of the MG IV variety were stable from mid May through late June planting dates. Protein content was lower and oil content was higher for MG IV when planted in late April.

In general, linolenic acid increased, palmitic, stearic, and linoleic acid levels showed little change, and oleic acid levels decreased with delayed planting. However, fatty acid profiles of the four varieties reacted to delayed planting dates in different ways. We cannot determine if such a variety interaction with planting dates would have any impact on the processing value of the soybean oil. Of greatest interest was the consistent response of linolenic acid levels to planting date. Warmer conditions during seed-fill can usually be expected in Kentucky from late April planting dates. These conditions produced the desirably lower levels of linolenic acid for the varieties used in this test. Perhaps there could be an opportunity for Kentucky producers of early maturing soybean to take advantage of the coming release of low linolenic acid varieties.

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Table 3. Fatty acid profiles of soybean varieties in response to planting dates at Lexington, Kentucky (averaged across the years 1990 through 1993).

Planting Date	*Palmitic acid*	*Stearic acid*	*Oleic acid*	*Linoleic acid*	*Linolenic acid*
	——— % of total fatty acids ———				
	Hardin MG I				
Late April	12.1	4.1	24.5	52.3	7.0
Mid May	12.1	4.4	23.5	52.3	7.7
Early June	12.2	4.2	24.2	51.6	7.9
Late June	12.7	4.2	23.6	51.5	8.0
	Elgin 87 (MG II)				
Late April	12.9	4.2	22.0	52.9	7.9
Mid May	13.0	4.4	21.7	52.3	8.6
Early June	13.0	4.2	22.6	51.7	8.5
Late June	13.3	4.2	20.4	52.8	9.3
	Pella 86 (MG III)				
Late April	12.3	4.7	22.7	53.9	6.4
Mid May	12.1	4.7	23.4	52.9	6.9
Early June	12.0	4.3	25.8	51.1	6.8
Late June	12.2	4.3	23.0	53.1	7.3
	Lawrence (MG IV)				
Late April	10.8	4.0	24.0	54.1	7.1
Mid May	10.8	3.8	25.8	52.7	6.9
Early June	10.9	3.8	24.9	53.3	7.2
Late June	11.1	3.8	22.1	55.0	8.0
LSD (0.10)*	**0.2**	**0.1**	**0.6**	**0.5**	**0.2**

* For comparing planting dates within a variety.