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Corn & Soybean Science Group Newsletter

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Cooperating Departments: Agricultural Economics, Biosystems and Agricultural Engineering, Entomology, Plant and Soil Sciences, Plant Pathology
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In this Issue:

1. Application Techniques of Sidedressing N

Lloyd Murdock and Greg Schwab, Plant and Soil Sciences

The spiraling costs of fossil fuels are an indicator that nitrogen (N) fertilizer prices are likely to remain high for the foreseeable future. With higher N prices, techniques that improve fertilizer N efficiency are more attractive. Sidedressing is one of the options.

Where Sidedressing Fits

Although sidedressing is the best method for applying N on corn, its effectiveness is greatly determined by soil drainage. Well drained soils have very little loss of N when preplant is compared to sidedress applications. Therefore, there is no difference in the N recommendation between the two methods for well drained soils.

However, poorly drained soils commonly lose substantial amounts of N that is applied before planting. When compared to preplant recommendations, sidedress N recommendations are reduced by 35 lb/a, because sidedress N is more efficient on poorly drained soils.

The method of sidedressing determines its effectiveness and depends on the type of tillage, N fertilizer form and placement in or on the soil.

Low Residue Cover

Soils that are tilled causing less than 30% of soil surface to be covered by residue makes the sidedressing decisions easier. Almost any method or fertilizer form works well here. Although it is sometimes better to inject N than to surface broadcast or stream it on the soil, the differences are usually small. Since volatilization of N from surface placement (except for Anhydrous Ammonia or urea on very high pH soils) is usually small, about any type of N fertilizer can be used with equal effectiveness. However, injecting the fertilizer into the soil always has less risks of loss.

High Residue Cover

When conservation tillage is used one must carefully consider the differences in effectiveness of N sources and placement options.

Subsurface application becomes more important because this places the N below the residue layer and prevents losses of N. It reduces the chance of applied N being partially tied up by the microbes in the residue decomposition process, and prevents the volatilization loss of the urea portion of UAN liquid fertilizer. Commonly, subsurface placement results in a 10-20% increase in the efficiency of the applied N as compared to a surface application.

The type of fertilizer N used for surface broadcast in high residue conditions also has a big effect on efficiency of the sidedress operation. Any fertilizer containing urea has a potential for N loss due to ammonia volatilization. The other type of N loss, when some of the N is tied-up by the microbes decomposing the residue (immobilization), which occurs with this method, exists with any form of surface applied N.

Volatilization losses for surface applied sidedressed urea are commonly in the 0 to 20 percent range but can be higher. The losses depend on soil temperature, soil moisture, amount of surface residue, soil pH, and length of time between application and the first rain event or irrigation. Nitrogen volatilization losses from urea fertilizer applied prior to May 1 are generally low. After May 1, N loss is greatest with urea applied on high residue and moist soil with a warm breezy drying period.

Volatilization can be greatly reduced if a urease inhibitor is used with the surface applied urea fertilizer. Urease inhibitors reduce the activity of the urease enzyme for up to 14 days. As long as it rains during this 14-day period, the urea will be moved into the soil without the risk of volatilization.

2. Fertilizer Nitrogen Rates For Corn: Why No Soybean Credit?

John H. Grove, Plant and Soil Sciences

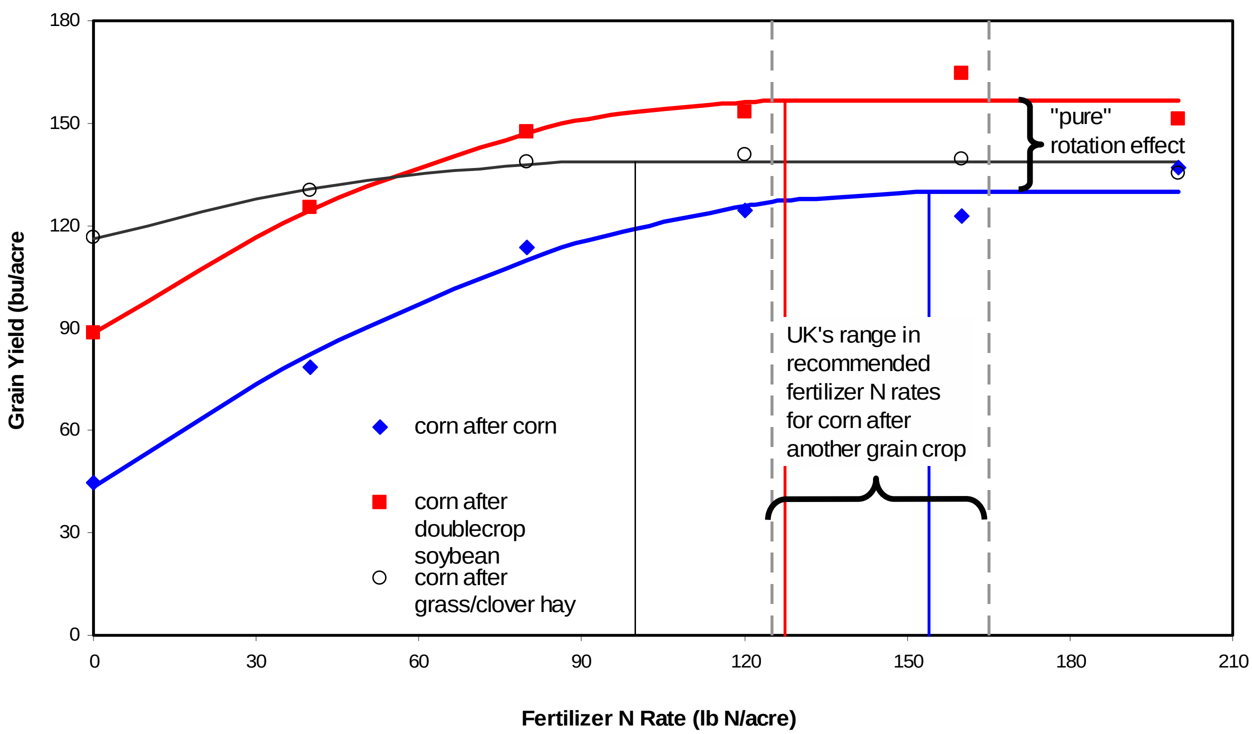
Fertilizer nitrogen (N) prices are very high this year. Corn growers are carefully examining their N management protocol, especially their fertilizer N rate, looking to cut costs and conserve corn's profit potential. UK's recommendations suggest growers consider soil drainage, tillage, fertilizer N timing, nitrification inhibitor use, winter annual legume cover crops and previous crop as they select the fertilizer N rate for each field of corn. However, Kentucky producers have noticed that one important previous crop, soybean, does not result in an adjustment to the recommended corn N fertilization rate. Previous crops of corn, soybean, wheat, and grain sorghum all result in the same fertilizer N rate recommendation. Public universities in states north of the Ohio River give an N credit, usually 1 lb of N per bushel of previous soybean yield, against the fertilizer N rate for corn after corn. Why the difference in recommendations?

Simply put, research data does not support giving an N credit when corn follows soybean, relative to continuous corn. Figure 1 illustrates some of our latest data (average of 2004 and 2005 production years) on this subject. No-till corn was grown on Maury silt loam after corn, soybean, and grass/clover hay. Rates of fertilizer N ranged from 0 to 200 lb N/acre, using ammonium nitrate, and were applied just after planting. Prior doublecrop soybean yield averaged 44 and 50 bu/acre in 2003 and 2004, respectively. Corn yield responses to fertilizer N rate were fitted to curvilinear-plateau models. The solid vertical lines indicate the N rate where each model found no further yield response. The solid vertical lines for corn after corn and corn after doublecrop soybean fall into the area between vertical dashed lines, which represent the range in UK fertilizer N rates recommended for no-till corn following another grain crop on well-drained soil. The solid vertical line for corn after grass/clover hay fell well outside (and below) that range.

The "pure" benefit to crop rotation was 10 or 25 bushels/acre when corn followed grass/clover hay or doublecrop soybean, respectively. This benefit was independent of the yield response to fertilizer N rate. Clearly, larger amounts of N fertilizer will not get continuous corn to yield as well as corn grown in rotation.

Why is the N benefit to corn following soybean so small? Unlike more northern states, much of Kentucky's corn and soybean residues decompose during our mild fall and winters. The N released from soybean residue is lost via denitrification and leaching, leaving little for an "N credit" next spring. In continuous corn, residue breakdown reduces the amount of this high C:N material that would immobilize (tie-up) fertilizer N applied next spring. Thus, late fall through early winter decomposition of our corn and soybean residues diminishes the influence of these previous crops on the optimal rate of fertilizer N for the following corn crop. The data in Figure 1, as well as earlier data from the mid-1990's, indicate that the N benefit to corn after soybean is small (and falls within experimental error). Kentucky corn growers need merely to adjust their fertilizer N rate within the recommended range, using rates in the lower part of the range when corn follows soybean.

Figure 1. Corn Yield Response to Fertilizer N and Rotation (average of 2004 and 2005 seasons)



3. Habits for High Corn Yields

Chad Lee, Plant and Soil Sciences

Recently, I spoke to a group of farmers on the keys and habits for producing high corn yields. While none of the topics were necessarily new to the farmers, the concepts were timely. The increased costs of seed, fertilizer, fuel and land rents have caused many farmers to consider cutting costs or corners to alleviate some of the pressure. In the rush to save money, now is a good time to review the concepts of producing high yields.

There are four keys to high corn yields:

1. Good genetics.
2. Maximize days suitable for growing
3. 90 to 95% light interception at or close to silking (R1)
4. Adequate nutrients, water and air to complete plant growth and seed fill

By optimizing each of these four keys, the odds for producing high corn yields are much improved.

Good hybrid genetics starts with a high-yielding hybrid and includes stress tolerance and defensive traits such as disease tolerance. The best measuring stick we currently have for stress tolerance is yield over multiple locations. Different stresses are imposed at each location and hybrid performance across locations is good indicator of general stress tolerance. Disease tolerance is not necessary every year or in every field, and disease tolerance is difficult to evaluate. Seed companies do their best to provide accurate disease information, but hybrids will sometimes perform differently in the field.

Maximizing days suitable for growing includes selecting the proper hybrid maturity, timely planting, and hybrid stress tolerance. A hybrid that takes about 113 to 117 days to mature is optimal for Kentucky. Hybrids in this maturity group typically perform the best in Kentucky. Exceptions do occur, as in 2005, when the later-maturing hybrids benefited from the late-season rainfall. Optimal planting dates in Kentucky are middle to late April for western Kentucky and early May for central and eastern Kentucky. Hybrid stress tolerance was discussed earlier.

Achieving 90 to 95% light interception at or close to silking (R1) is affected by seeding rate, row spacing, planting date, hybrid maturity and proper weed management. Current UK recommendations will accomplish maximum light interception close to silking. Those recommendations include seeding rates between 22,000 and 30,000 seeds per acre, a row spacing of 30 inches, timely planting, hybrid maturities of 113 to 117 days, and good early season weed control. The ability of corn in 30-inch rows to achieve 90 to 95% light interception at silking is one of the reasons that we normally do not see yield increases from narrow rows.

Providing adequate nutrients, water and air in the soil to complete plant growth and seed fill includes adjusting soil pH, adding the proper amount of N, P, K, and Zn, precipitation, water infiltration and water availability. A soil test is required for accurate adjustments to soil pH, P, K and Zn. While no one can control the amount of rainfall (except by irrigation), water infiltration and water availability can be managed by conserving soil organic matter and reducing soil compaction. Soil compaction will limit water infiltration, reduce water availability and reduce air available to the plant. Reduced tillage and no-tillage are two methods that both conserve soil organic matter and typically reduce soil compaction.

There are at least 10 practices that will allow a farmer to optimize the four keys to high corn yield.

1. Know which fields should be planted to corn.
2. Rotate crops.
3. Tillage (as little as possible): deep ripping, if necessary; no-till where possible.
4. Select high-yielding hybrids.
5. Fertilize according to soil test.
6. Timely planting.
7. N application: timely and adequate.
8. Higher seeding rates on better soils; but not too high
9. Effective, timely pest management control
10. Monitor the crop to handle problems this year and learn for next year.

These 10 practices make sense in theory, but they are not always easy to accomplish in practice. The window for optimal planting in Kentucky is about a week. However, there are very few operations that can plant all their corn acres within a week. So, while these 10 habits will optimize the 4 keys to high yields, real life often makes achieving these habits difficult.

University researchers are looking at ways to alleviate the demand for timely planting. See the related article in this newsletter. In conjunction with county agents, we have investigated seed coating technology (Intellicoat brand) to see if we can plant corn early and delay emergence until the optimal time. Those results were mixed and we are not recommending that technology at this time.

While the 10 habits and 4 keys presented here are not necessarily new to anyone, they are a reminder of the basics behind corn production. By keeping these 10 habits and 4 keys in mind when considering how to manage inputs, each farmer can determine how to maximize returns in his or her operation.

4. Corn Planting Dates

Jim Herbek, Plant and Soil Sciences

The “ideal” goal in planting corn is to choose the optimum planting date that will result in the highest yield potential. However, various factors such as weather (dominant factor), management capabilities, and management risk strategies play a significant role in whether the optimum planting date is achieved by a farmer for his total corn acreage. The risk of planting too early or too late for optimum yield is a compromise that many farmers face. The optimum planting date will vary, not only by region, but can also vary among growing seasons. Corn planting date research indicates the “normal” optimum planting date period; but because of yearly weather fluctuations, the optimum planting date may deviate somewhat from “normal” for any specific year. However, over the long term, the “normal” optimum planting date period provides the best probability for obtaining maximum corn yield potential.

Early planted corn is normal for farmers because many feel they cannot afford to wait for perfect conditions to begin planting. Early planted corn does provide advantages which include: getting a “head start” on planting to avoid weather delays that may result in yield penalties for later plantings; and early plantings also result in the critical pollination time occurring at a more favorable time period than later planting dates. Planting early does not always guarantee optimum yields, particularly if planting occurs **too early** under less than ideal conditions.

How early can we start planting corn? When deciding to start, consider soil conditions (temperature and moisture), calendar date and past experience as guides. Soil temperature is very critical. Average soil temperatures are lower for early plantings and can result in less than ideal stands from delayed corn germination and emergence. Since corn will not germinate below 50ºF, it is very risky to plant corn if soil temperature at planting depth has not reached this minimum requirement. It will take corn at least three weeks or more to germinate and emerge if soil temperature does not increase much above 50ºF after the seed has been planted; which can occur if there is a prolonged cool and wet period after planting. The longer the seed remains in cool soils before emergence, the more subject they are to soil diseases and insects and the greater the risk of reduced and non-uniform stands. Planting corn early is preferred when minimum soil temperature requirements have been met and there are good weather forecast prospects for an increase in soil or air temperatures that will promote more rapid emergence. Constant soil temperatures of 55-60ºF should result in expected corn emergence in about 2 weeks. Optimum soil temperatures for emergence occur above 60ºF.

Soil temperatures have a daily fluctuation cycle and can vary as much as 5-10 degrees each day (day-time highs and night-time lows) in the spring near the soil surface (planting depth). This implies that if corn seed is planted very early, it may not be subjected to a constant soil temperature of at least 50ºF to promote continual germination and growth, which is critical for early planted corn. The daily soil temperature fluctuation will be influenced by air temperature, solar radiation, and also soil moisture. Soil temperatures reach a maximum during mid-day. If soil temperatures have a minimum of 50ºF at planting depth early in the morning and at least 55ºF during mid-day for several consecutive days, this is a “reasonably good” guide to start planting corn.

Calendar date provides an approximate guide when average soil temperatures of 50ºF normally occur in various regions of Kentucky. Based on historical weather data, an average weekly soil temperature of 50ºF “normally” occurs at planting depth under **bare soil** in mid-March in southwest Kentucky, in late March to early April in west and central Kentucky, and early to mid-April in eastern Kentucky. However, because environmental conditions vary each spring, the average weekly soil temperature of 50ºF can occur from one to two weeks earlier or later than the “normal” dates for each region. Because of this yearly variation, actual soil temperature and not calendar date is the best guide to use for early planting. Keep in mind that soil temperature for no-tillage plantings will not warm as early as tilled soils because of residue cover. Depending on the amount of residue, soil temperatures can be as much as 5 degrees cooler than bare soils. As a result, no-till corn planting may have to be delayed several days as compared to tilled soils.

Corn also has an ending optimum planting period, based on calendar date which, if corn is planted beyond this date, will result in less than maximum yield. This “last” optimum planting date is based on planting date research for an area or region and provides an "average" calendar date(s) for corn planting to be completed to avoid a yield loss. Because of variations in environmental/weather conditions each growing season, the "last" optimum planting date may deviate somewhat each year from the "average" date.

A multi-year corn planting date study was conducted in west Kentucky at the University of Kentucky Research and Education Center to determine an optimum corn planting date period. This study was conducted for six years (2000-2005) and included five planting date periods starting in early April at intervals of about 2-2½ weeks. Two medium maturity corn hybrids (non-Bt and Bt hybrid isolines) were used. The study was no-till planted. The yield data for this corn planting date study is contained in Table 1.

Over the 6-year period, average optimum yield was obtained during the mid-late April planting period. Optimum yield consistently occurred during this planting period each of the six years.

The early April planting period yielded slightly less (average of 7%) than the mid-late April planting period. In only one of the six years (2002), did the early April planting period have significantly equal yields to the mid-late April planting date.

The early May planting was the critical planting period for yield loss to occur as a result of planting too late. There was an average yield loss of 8% during this planting period. However, three of the six years (2001, 2004 and 2005), the early May planting period produced yields significantly equal to the optimum planting period of mid-late April. For the other three years (2000, 2002, and 2003), yields were significantly reduced during the early May planting period.

For plantings made after early May, corn yield losses were even greater. For planting periods of mid-late May and early June, average yield losses of 18% and 38% occurred, respectively, compared to the mid-late April planting period. An average yield loss of about 1%/day occurred if corn was planted beyond May 1.

Corn planting progress each Spring will be determined by the weather conditions (moisture and temperature) that occur. Based on recent corn planting progress data from the Kentucky Agricultural Statistics Service, about 15% of the corn acreage in Kentucky is normally planted by April 10. However, this has ranged over the last five years from about 35% in 2004 to less than 10% in 2001 and 2005. Normally, 60-65% of the corn acreage in the state is planted by May 1, but has ranged from over 75% in 2001 and 2004 to less than 50% in 2002.

Based on current planting date research, the "normal" optimum planting period for yield appears to be mid-late April in west Kentucky. Planting earlier or later than this time period resulted in less than maximum yield. Over the long-term, planting dates of April 10 to April 30 should achieve optimum or close to optimum yield potential. To avoid substantial yield losses, corn planting should be completed by May 1-5 in west Kentucky. Extrapolating to other areas of the state: corn plantings should be completed by May 1 in far western Kentucky; by May 5-10 in west-central Kentucky; and by May 10-15 in eastern Kentucky.

Planting date research will tell us what will most likely occur, and not what actually will occur in any specific year. Many farmers will start planting as soon as soil moisture conditions allow them to get into the field. Early planting does have several advantages, as previously stated. If intentions are to plant early, then consideration should be given to the risks (less than ideal stands, frost damage, and loss of potential yield) versus rewards (close to optimum yields and avoiding the risk of possible weather delays later in the planting season). This is a decision that farmers face each year. It is probably worth the risk of starting to plant early (particularly with a large corn acreage) rather than risk the subsequent chance of poor weather causing you to finish planting in mid-late May. Yield penalties for planting too early are usually not as severe as planting too late. By mid-April, if soil moisture conditions are suitable, soil or air temperatures should not have as much impact on the decision to begin planting because of calendar date.

Another aspect of the planting date research study discussed in this article was to determine the economical benefit of using a Bt versus a non-Bt hybrid at each of the planting dates. There are higher seed costs of about $9-$10/acre associated with a Bt hybrid. The two medium maturity hybrids used in this study were hybrid isolines (genetically the same except for the Bt trait). The Bt trait provides resistance to the European and southwestern corn borer which can cause yield loss damage to corn in Kentucky. The Bt and non-Bt hybrid yield comparisons are provided in Table 2.

There was not an economical yield benefit for the Bt hybrid at the two earliest (April) planting dates over the 6-year period of the study. The yields of the Bt and non-Bt hybrids were statistically equivalent. However, beginning with the early May planting date, there was an economic yield benefit for planting the Bt hybrid rather than the non-Bt hybrid. The later the planting date, the greater the yield benefit for the Bt hybrid. Based on corn borer damage evaluation ratings, the non-Bt hybrid had more damage than the Bt hybrid, particularly at the later planting dates. A special thanks to Dr. Ric Bessin and Dr. Doug Johnson of the Department of Entomology for providing the corn borer damage evaluations for this study. The results of this study imply that it would be economically beneficial to plant a Bt hybrid if corn plantings are made after May 1.

Table 1. Planting Date Effect on Corn Yield.

Planting Period (Planting Date Avg.)	Planting Date Range Over Six-year Period	Corn Yield (Bu/Acre)* (Six-year average) (2000-2005)	Average Yield Loss	
			(Bu/A)	(%)
Early April (April 7)	April 3-10	196	-14	(7)
Mid-late April (April 22)	April 17-27	210	0	(0)
Early May (May 9	May 5-13	193	-17	(8)
Mid-late May (May 24)	May 21-31	172	-38	(18)
Early June (June 9	June 5-14	130	-80	(38)

• Location = west Kentucky, (UKREC), (Princeton, Ky.).
*Average of two medium maturity hybrids (Bt and non-Bt).

Table 2. Planting Date Effect on a Bt and Non-Bt Hybrid.

Average Planting Date	Corn Yield (Bu/Acre) (2000-2005)		Bt Hybrid Advantage (Bu/acre)
	Non-Bt Hybrid*	Bt Hybrid*	
April 7	195	197	+2
April 22	208	211	+3
May 9	189	196	+7
May 24	167	178	+11
June 9	118	141	+23

• Location: UKREC (Princeton, Ky.).
*Non-Bt Hybrid = Pioneer 33G26 (2000-2004) and Pioneer 33R77 (2005).
Bt Hybrid = Pioneer 33G30 (2000-2004) and Pioneer 33R78 (2005).

5. New Corn Publications

Chad Lee, Plant and Soil Science

Three new publications are now available to help you manage the 2006 corn crop.
AGR-185: *Nitrogen Transformation Inhibitors and Controlled Release Urea*, by Greg Schwab and Lloyd Murdock.
AGR-187: *Estimating Corn Yields*, by Chad Lee and Jim Herbek.
ENT-16: *Insecticide Recommendations for Corn – 2006*, Ric Bessin and Doug Johnson.

All three publications are available online at: www.uky.edu/Ag/GrainCrops/corn.htm. AGR-185 and AGR-187 are linked under the “Grains Production” heading. ENT-16 is linked under the “Insects” heading.

6. Managing oil and protein levels in soybean

D.B. Egli and Todd Pfeiffer, Plant and Soil Sciences

What can farmers do to produce soybeans with oil and protein levels that are eligible for the premium prices available in some markets? The short answer is, unfortunately, not much. Worrying about oil and protein is a new experience for Kentucky soybean producers. Soybeans are usually sold by the bushel which makes yield the primary focus, but now seed composition has moved into the picture in some markets.

It's the negatives that make it difficult to manage oil and protein levels. There is a negative relationship between oil and protein - as protein concentration goes up, oil concentration goes down. Yield is another negative, it usually goes down as protein concentration goes up. These two negatives make it difficult to combine high yield with high protein and oil levels.

Oil and protein levels are influenced by variety and weather, primarily temperature, during seed filling. Protein levels usually go down as air temperature goes up (and of course, oil levels go up). Temperature could be important when comparing regions (North vs. South) or planting dates (especially double cropped soybeans). Year-to-year variation in temperature makes it difficult to find clear trends in seed composition, but in Kentucky, protein levels in double-cropped soybeans may be a little lower and oil a little higher than soybeans from conventional production systems, but the difference may be small and, in some years practically non existent. Drought may also decrease protein and increase oil levels although this response may be an indirect effect of the high temperatures that normally come with a drought.

The variety you grow will also influence oil and protein levels. Plant breeders in the past simply made sure that oil and protein levels in new varieties were about the same as the varieties they replaced. Breeding can increase soybean protein levels, but breeding for higher protein often reduces yield and oil levels. Some soybean breeders are releasing high protein varieties for specialty markets, and these novel varieties are tested in the Kentucky Soybean Performance Tests. Yield and seed composition data are available to compare the performance of these varieties with conventional grain varieties, and it is easy to find evidence of the two negative relationships in these data.

A soybean variety's protein and oil concentration are stable relative to other varieties. While environmental conditions will move oil and protein levels up or down, varieties continue to rank in a similar order.

The year will largely determine whether protein and oil standards are met. For example, let's choose a standard of greater than 35.5% protein and 19.2% oil. Only 27 of 133 varieties in the Kentucky Soybean Performance Tests in 2003 met this standard, while in 2004 it was 54 of 155 (Table 1). In 2005, however, 104 out of 164 surpassed the standard. The protein and oil genetics of the varieties changed little during those three years, so it was the weather that caused the variation.

Table 1. Protein and oil of soybean varieties each year.

	2003	2004	2005
Total Varieties Tested	133	155	164
Varieties that met 35.5% protein and 19.2% oil	27	54	104
Percent of Total	20%	35%	63%

The negative relationships between yield, oil and protein may make it difficult to produce soybeans with high oil and protein concentrations and exceptional yield. Producers can use the data in the Kentucky Soybean Performance Tests to evaluate yield and seed composition of the varieties offered for sale in Kentucky and decide if they can find a variety that will, first, met the requirements of the buyers and, secondly, make more money than the best variety without the premium.

Our recommendation is that you create a list of varieties that meet your needs for agronomic characteristics: yield, maturity group, SCN resistance, etc. Then check the oil and protein levels in the Kentucky Soybean Performance Tests bulletin. Don't worry about the absolute protein and oil levels, instead, remove from consideration those varieties with below average oil percentages. Then select from the remaining varieties those that have the highest average protein concentration. This approach should give a variety that has the best chance at producing acceptable yield and meeting the oil and protein standards.

Chad D. Lee, Grain Crops Extension Specialist

COOPERATIVE EXTENSION SERVICE
UK
UNIVERSITY OF KENTUCKY
College of Agriculture

Cooperative Extension Service
University of Kentucky
Plant and Soil Sciences Department
Ag. Distribution Center
229 Stadium View Road
Lexington KY 40546-0229

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