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Agronomics of high-yielding corn

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Corn yields in the Corn Belt have been increasing steadily, with the state average yield in Illinois rising at a rate of 1.9 bushels per acre per year from 1970 to 2009, but 3.6 bushels per acre per year since 1996. With few exceptions, the weather during the past 15 years has been very favorable for corn. But improvements in hybrids and in management have played an important part in these yield increases as well.

Some have looked ahead and foreseen continued or accelerated increases in corn yields, with predictions of yields in 20 years (by 2030) of up to 300 bushels. Continuing the current linear trend in Illinois corn yields since 1996 has state average yields reaching about 250 bushels per acre by 2030. Some whole-field averages above 250 bushels have been harvested in places in Illinois in recent years, and most producers have seen such yields on their yield monitors. So we know that hybrids have the genetic potential to produce such yields. We'll examine here what we will need to do in terms of management in order to reach average yields of 250 bushels.

A state average yield of 250, of course, will mean that many fields will need to yield much more than 250, and that we will need to minimize the number of fields that yield less than 200 bushels per acre. Water will remain a common and perhaps increasing barrier to such high average yields. Corn is relatively efficient in its use of water to produce dry matter, and it is not clear that breeding will be able to improve on this. In the Corn Belt, 200-bu corn requires about 22 inches of water. At this same efficiency, 300-bu yields will need about 33 inches of available water. Illinois soils hold a great deal of water available to the crop, but it is not likely that the water supply for the crop will continue to increase over time. This might well limit yield increases at some point in the future.

Some have pointed to very high yields and management inputs used in corn yield contests as an indicator of how we might manage corn in the future. The problem with this thinking is that no single input or rate needs to demonstrate its contribution to yield in a yield contest. If they are anything, contest winning yields are the result of a persistent search for an area of highly productive soil, and a patient wait for ideal weather. Because some soil "sweet spots" are so productive, many contest winners tend to plant corn there every year.

In contrast, managing corn over large areas needs to be both economically and agronomically sound. That is, each input needs to pay its way, and should be used at rates that produce the highest marginal return. We cannot simply "put more on" when it comes to inputs like nitrogen or seeds per acre. But the idea persists that high-yield corn requires early planting, high plant populations, high N rates, and fungicides, along with basics such as sound weed management and careful planting and harvesting.

Because many corn contest winning yields come from corn following corn, some also consider that corn following corn has a higher yield potential than corn following any other crop. We have not found this to be the case in Illinois research; averaged over the past 10 years, corn following corn has averaged about 8 percent lower yield than corn following soybean. There is some evidence, however, that this difference has declined in recent years; averaged over the past three years, this difference is less than 5 percent (Figure 1.) In places like east Central Illinois, where the corn rootworm variant is well-established, many producers feel that corn following corn yields as much as corn following soybean. Research has not, however, shown a consistent advantage for corn following corn, nor a gradual increase in yield potential with more years of continuous corn

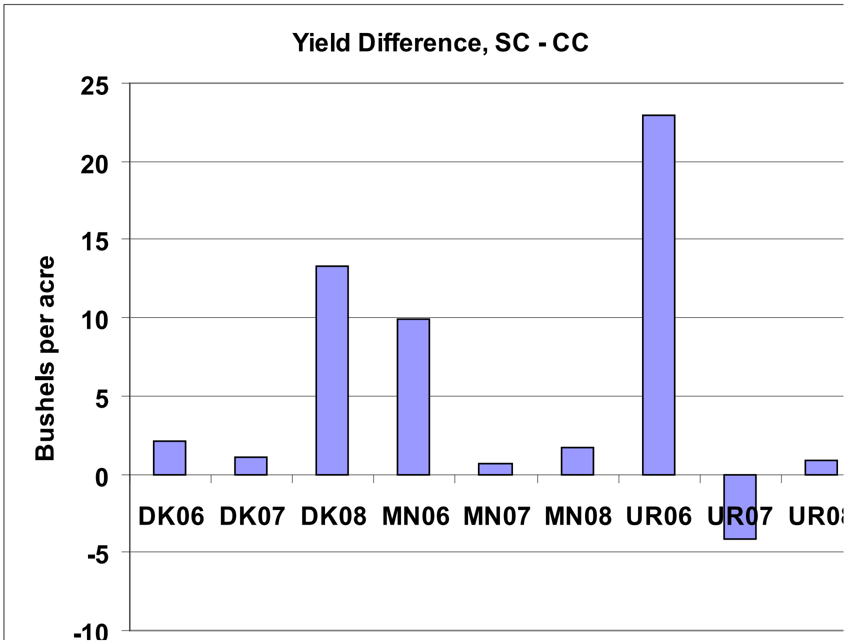

Figure 1. Yield advantage of corn following soybean over corn following corn at three northern Illinois locations (DK = DeKalb; MN = Monmouth; UR = Urbana) from 2006 to 2008.

One factor that most consider critical to high yields is early planting. Recent planting date research in Illinois has confirmed that planting in April tends to produce higher yields, with highest yields coming from mid-April planting (Figure 2.) As the points in this figure show, high yields are still possible when planting is in May. Both 2008 and 2009 had unusually good weather following late planting, and so yields were less affected by late planting than has been the case in some years. Without knowing that rainfall will be plentiful, however, we should try to plant as early as conditions allow, though some in northern Illinois may want to wait until after the first week of April to start. It definitely does not pay to "mud in" corn in early April; the yield loss from poor planting conditions can easily cancel any advantage of early planting.

Nitrogen is one input for which those who enter contests tend to "pull out the stops" and to put on as much N as might be needed to assure that the crop never experiences N deficiency. This is one area where economics and risk need to be considered strongly for those who manage for high yields. Especially when corn follows soybean, Illinois trials generally show little correspondence between corn yields and the N rate it takes to reach those yields (Figure 3.) There is a hint that higher N rates are needed when yields are higher for corn following corn (Figure 4), but this relationship is not very strong.

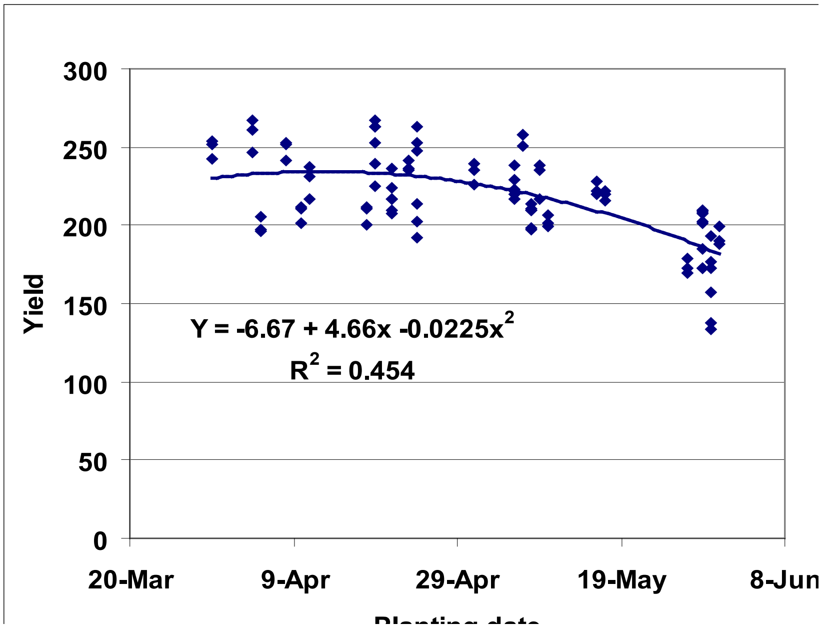

Figure 2. Corn planting date response over eight northern Illinois site-years, 2005-2008.

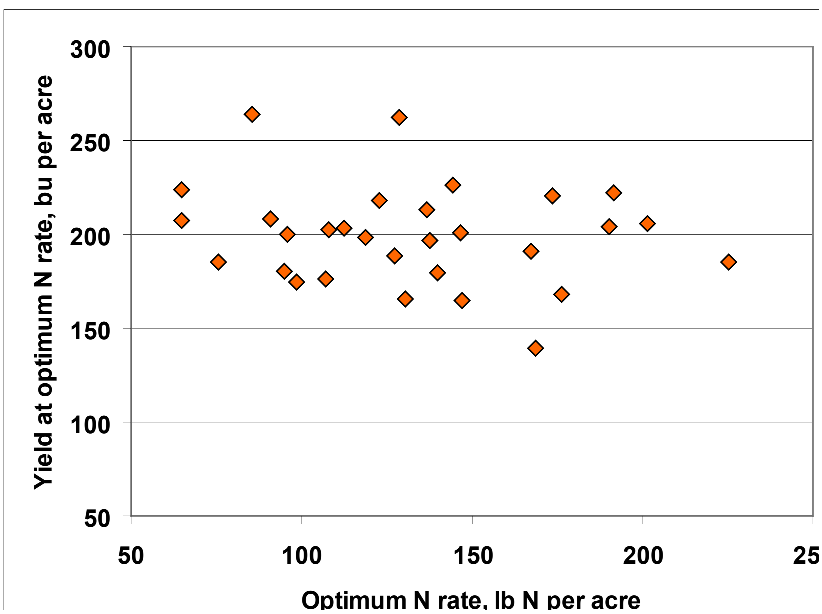

Figure 3. Yields and N rates required to reach each yield for 30 trials in Illinois where corn followed soybean.

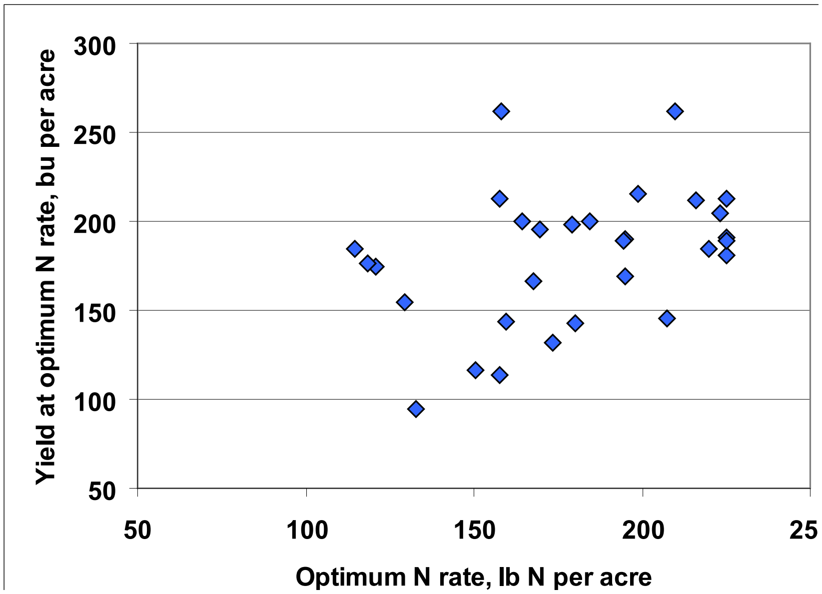

Figure 4. Yields and N rates required to reach each yield for 30 trials in Illinois where corn followed corn.

Because N recommendations were based on expected corn yield for so many years, and because we know that high-yielding corn crops need to take up a lot of N (about 1.2 lb N per bushel, with about 2/3rds of that N in the grain), it is still difficult for many to accept that high corn yields may not require high N rates. The "problem" is that our higher organic matter soils are capable of providing much of the N the crop needs. But the extent to which they do this is highly dependent on the weather, much like yields themselves are. Just like we have no good way to guess what yields will be before the season begins, we also have no good way to know how much N the soils will provide.

Plant population is another area in which many producers feel that "more is better." Recent research supports this, showing that higher yields tend to need more plants per acre (Figure 5.) In the studies that were used to generate Figure 5, the populations were established by thinning, so represent final stands. Stands ranged from 20,000 to 45,000. As in the case of N rate, optimum plant populations can be calculated based on the ratio of the input cost ($ per thousand seeds) to the price of corn. In this case, the ratio of 1.0 was used; for example, when one bushel at $3.50 "buys" 1,000 seeds when one unit (80,000 seeds) costs $280.

One other input that many producers feel is critical to maximizing corn yield is foliar fungicide. This input has been widely used in corn over the past three years, though usage in 2009 was less than in 2008. While we have found positive yield responses to foliar fungicide, in many cases the yield increases have failed to pay for this input, which now "costs" 8 to 10 bushels of added yield. While in some cases we have seen yield increases under light disease pressure, so it is possible that fungicides might increase yields as a physiological effect. Because this response is not very consistent, we believe that foliar fungicides should be used when foliar diseases are at a level that calls for control.

In conclusion, it is clear that the genetic potential of corn hybrids has been increasing, and that yields of 250 to 300 bushels per acre are possible, if not yet common. It is likely that such yields will become more common over the nest two decades, though that will continue to depend to some extent on the weather. Stress tolerance and genetic potential for yielding ability will continue to be important traits for hybrids. It is likely that agronomic practices will continue to evolve as corn price and costs of agronomic inputs change, and as the responses of hybrids to inputs continue to change. Environmental factors may also become more important, and could in some cases limit inputs such as N.

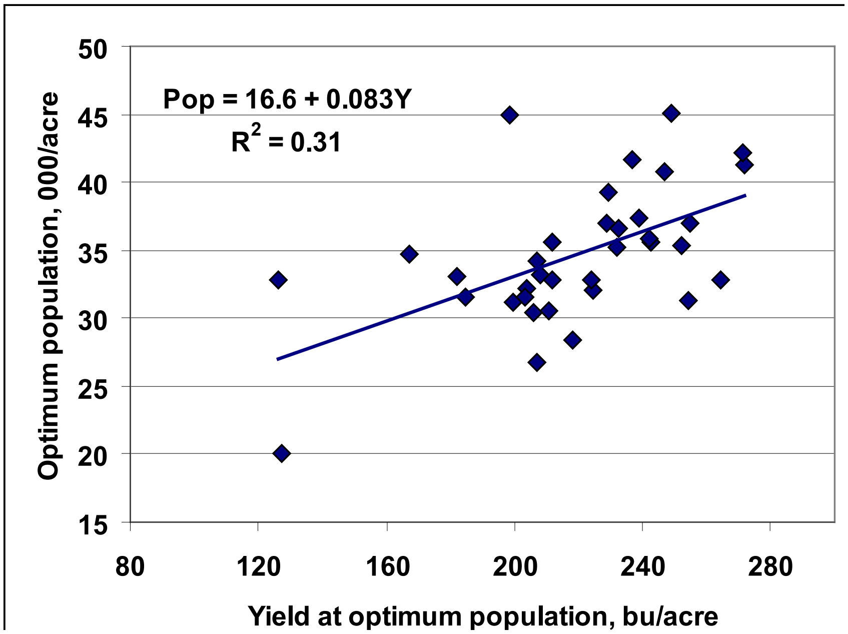

Figure 5. Yield and final plant stand needed to reach that yield over 36 trials in northern Illinois. Optimum plant populations are calculated at a ratio of 1,000 seeds priced equal to the value of one bushel of corn.