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Does the Correlation Between Spring and Summer Weather Explain the Puzzling Results on Late Planting and Corn Yield?

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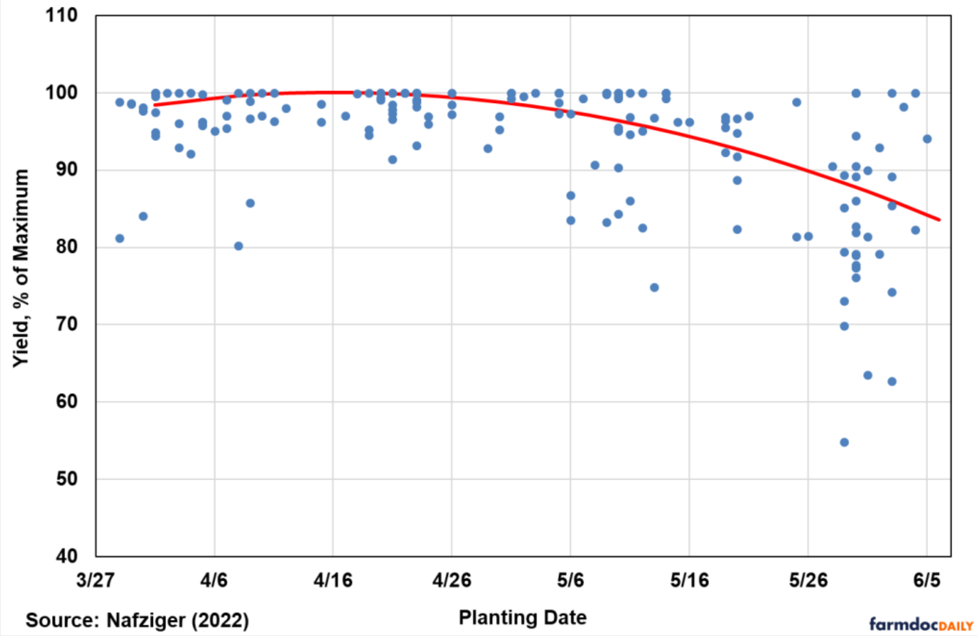
In a recent *farmdoc daily* article (May 9, 2022), corn planting date results from agronomic field trials in Illinois were compared to state-level estimates of late planting impacts. The field trials indicated that the yield penalty for planting past mid-May is non-linear and substantial, with reductions as large as 10 to 20 percent. In contrast, the state-level regression estimates indicated the impact of late planting is linear and rather modest, causing the Illinois corn yield to deviate above or below trend by no more than two bushels in most years. Several explanations for the differing results between the two types of studies were discussed in the article from May 9th. One possibility not explored in that article was a negative correlation between spring and summer weather. If this is the case, cool, wet springs would tend to be followed by better than average summer weather. As a result, the negative impact of late planting on corn yield would tend to be offset by good summer growing season weather. The purpose of this article is to investigate the correlation between spring and summer weather in Illinois to determine if this explains the puzzling results across the different types of planting date studies.

Analysis

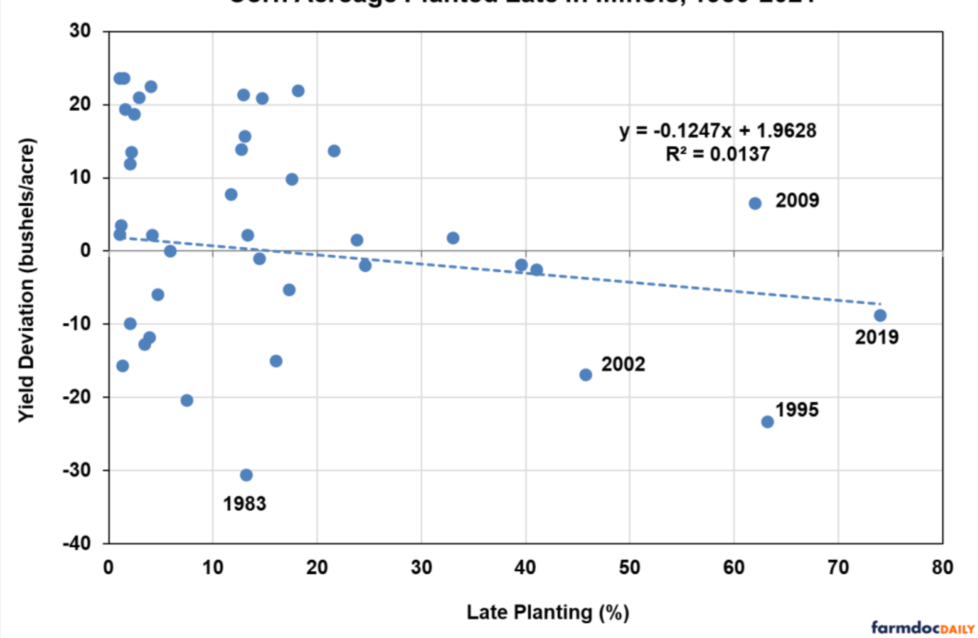
We begin by briefly reviewing agronomic field trial results for corn planting dates in Illinois. This data was presented in earlier *farmdoc daily* articles (April 14, 2022; May 9, 2022). Figure 1 presents the results from 42 central and northern Illinois field trial locations over 2007-2021. Data from these experimental field trials reveal two key patterns. First, there is a relatively wide time window for planting corn in Illinois and expecting "normal" yields. This window runs from roughly early April though early May. Second, the yield penalty is non-linear and increases sharply for planting past mid-May, with reductions as large as 10 to 20 percent.

Figure 1. Corn Planting Date Results from 42 Illinois Agronomic Field Trials, 2007-2021



Next, we review the relationship between a measure of late planting and corn yield for the state of Illinois (*farmdoc daily,* May 9, 2022). Figure 2 shows the estimated relationship between the trend deviation for the statewide yield of corn Illinois and corn acreage planted late over 1980 through 2021. The trend deviation is computed based on a linear trend for Illinois average corn yield over this period. The figure shows that, as expected, there is an overall negative relationship between late planting and corn yield deviations from trend. Specifically, for a 10 percent increase in late planting the Illinois average corn yield decreases by about 1.3 bushels per acre. However, the overall impact of late planting is linear and rather modest, causing the Illinois corn yield to deviate above or below trend by no more than two bushels in most years.

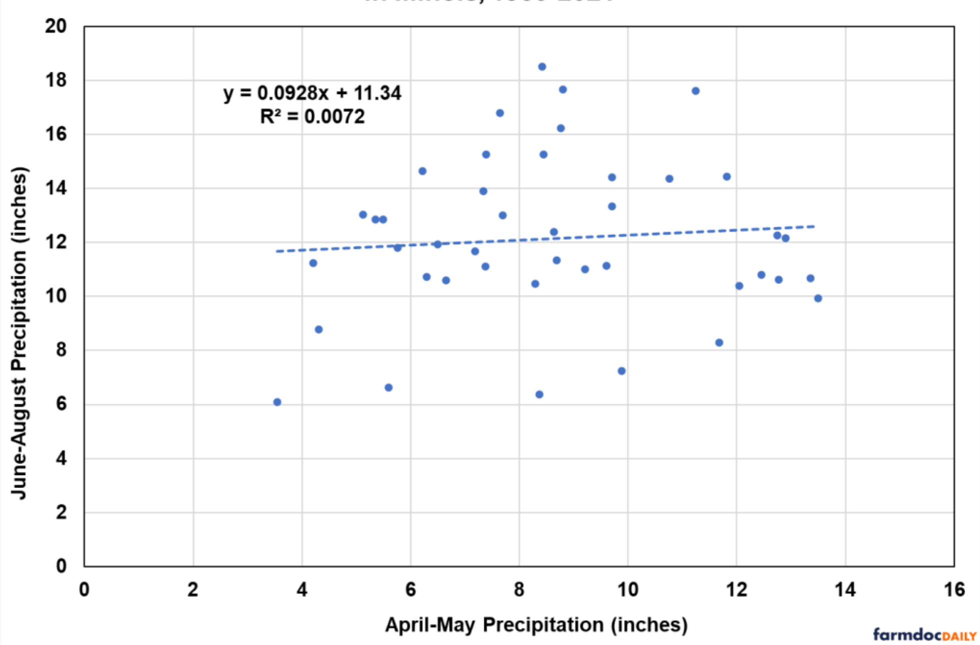
Figure 2. Trend Deviation for State Average Corn Yield versus Corn Acreage Planted Late in Illinois, 1980-2021

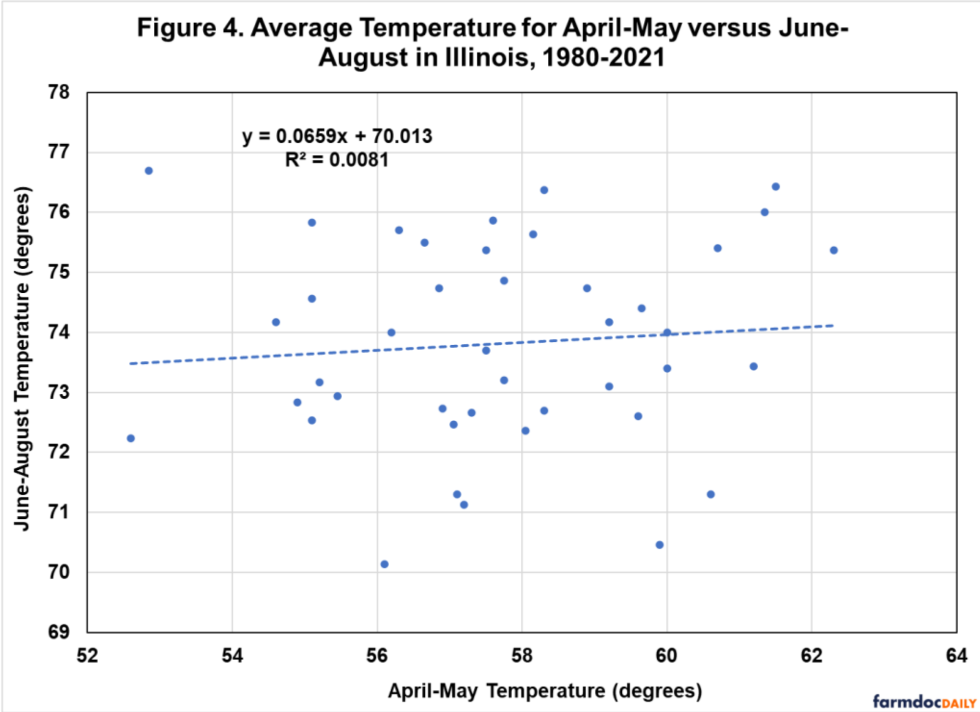


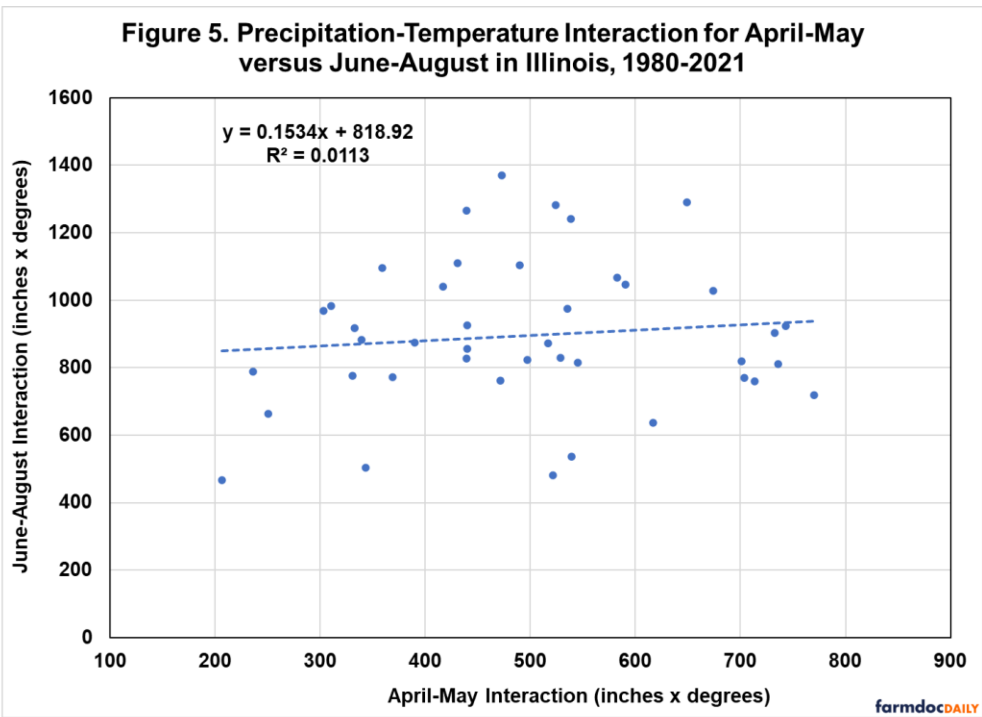
The previous results indicate that the estimated size of late planting impacts from regression estimation using state-level data is linear and fairly small when compared to the non-linear and large late planting impacts based on agronomic field trials. As discussed earlier, a possible explanation is a negative correlation between spring and summer weather. If this is the case, the negative impact of late planting on corn yield would tend to be offset by good weather in the summer growing season. We examine the historical correlation of spring and summer weather in Illinois over 1980 through 2021. Figure 3 presents the correlation between total April-May precipitation and total June-August precipitation. Figure 4 presents the correlation between average April-May temperature and average June-August temperature. Figure 5 presents the correlation between the interaction of April-May precipitation and temperature and the interaction of June-August precipitation and temperature. The interaction is computed as the product of precipitation and temperature for a given period. It is possible that an interaction variable like this better represents growing season weather impact on corn yield.

This is one case where the results are unanimous. There is virtually no evidence of any correlation between the variables shown in Figures 3-5. The R2 in each case is only about one percent. We also checked for correlation between all individual monthly observations for precipitation and temperature in Illinois for April through August. In other words, April-June precipitation correlation, April-July precipitation correlation, and so on. Out of 24 such correlations, only one is statistically significant, no more than what one would expect based on random chance. It is safe to say that springtime weather in Illinois is completely uncorrelated with summer weather. This is consistent with earlier work on the correlation of monthly weather data in Illinois and surrounding states for different periods in the year (*farmdoc* daily, March 8, 2012; April 2, 2012).

Figure 3. Total Precipitation for April-May versus June-August in Illinois, 1980-2021







The complete lack of a relationship between springtime and summer weather means that this type of correlation cannot be an explanation for the puzzling results across the different types of planting date studies. This leaves us with the potential explanations offered in our previous *farmdoc daily* article of May 9th:

1. The planting trial results are reported as the percentage of maximum yield in a test location for a given year, which is not the same as deviation from trend yield. The maximum trial yield in any year can be far above or below trend yield for the state or the entire U.S., and the maximum varies across trial locations. This creates an inherent apples and oranges problem when comparing results from the two types of studies.

2. The planting trial results are site-specific within Illinois, while the data used in regression studies are state averages. State average observations may still be at too high of a level of aggregation to accurately reflect impacts at a local level.

3. The explanatory power of planting date in field trial studies is not as high as commonly perceived. For example, the R2 of the regression equation shown in Figure 1 in only 12.6 percent. This means there is a wide variation in the yield outcome in field trials for a particular planting date, especially the later the planting date. As an example, the lowest yield observation for corn in Figure 3 occurs on June 2nd at 62.7 percent of the maximum yield. Other trial outcomes for the same date result in yield at the maximum of 100 percent. The lesson is that there is a wide potential range of yield outcomes on a given planting date even in field trials.

4. There may be a small sample problem with state aggregate data used in regression studies. As shown in Figure 2, there are only a handful of years with late planting greater than 40 percent. These are the years where we would expect late planting impacts to be large, mirroring the non-linear impacts found for very late planting dates in the field trial studies. It may be the case that summer weather was better than average simply by chance in this small handful of years. This was certainly the case in 2019, which was a record year for late planting. If we assume that field trial data is the best available, this means in the future we should expect to see a cluster of years with high levels of late planting and large negative deviations below trend yield. At that point, the aggregate data used in regression studies would show a similar non-linear relationship as is found in field trial studies.

Implications

The estimated size of late planting impacts from regression estimation using state-level data is linear and fairly small when compared to the non-linear and large late planting impacts based on agronomic field trials. A possible explanation for this difference is a negative correlation between spring and summer weather. If this is the case, the negative impact of late planting on corn yield would tend to be offset by good weather in the summer growing season. We examine the historical correlation of spring and summer weather in Illinois over 1980 through 2021 and find virtually no correlation. Consequently, correlation in spring and summer weather cannot be an explanation for the puzzling results across the different types of planting date studies. Other possible explanations exist but sorting through them will take some time and additional data.

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