Economic Benefits of Fungicide Use in Corn Production

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Abstract

This study used experimental data from West Lafayette, Indiana to examine the economic benefits of applying fungicide to corn. The average improvements in yield, gross revenue, and net return (gross revenue minus fungicide and application cost) were 4 bushels per acre, $19 per acre, and -$9 per acre, respectively. Stochastic dominance was used to compare the fungicide application treatments to a no fungicide application alternative. Individual fungicides were part of the stochastic dominance efficient sets. However, with recent corn prices, the improvement in yields and gross revenue would not be high enough to make the individual fungicides economically viable.
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Introduction

Excluding seed treatments, fungicides have generally been applied to a greater percent of fruit and vegetable acres than they have to corn, soybean, or wheat acres in the United States. Moreover, fungicide use is substantially lower than the use of herbicides and insecticides on corn acres. A recent USDA-ERS publication notes that 1.69 million pounds of active ingredient of fungicides were applied to corn acres in the U.S. in 2008. In comparison, 198.02 million pounds of active ingredients of herbicides and 4.01 million pounds of active ingredients of insecticides were applied to U.S. corn acres in 2008 (Fernandez-Cornejo et al., 2014). However, there has been increased interest in applying fungicides to corn in recent years (Wise and Mueller, 2011; Grogan, 2013).

There has been very little previous research examining the economic use of fungicides for corn production. Wise and Mueller (2011) discuss the potential impacts of the increased use of fungicides for corn on production practices and whether use can be justified for uses other than disease management. The increased use of fungicides in recent years can be attributed to increased corn prices, increased need for foliar disease management in corn, and promotion of fungicide use for corn. The last of these factors merits further discussion. Agribusinesses selling fungicides have argued that fungicide use may increase yields even in the absence of disease. Benefits cited often include improved stalk strength and stand ability of corn at harvest. Wise and Mueller (2011) summarize the results of numerous field trials that examined the use of fungicides on corn. The authors noted that a yield increase of approximately 6 bushels per acre was needed in 2009 and 2010 to warrant the use of fungicides in corn. A yield increase of 6 bushels or more per acre occurred in approximately 45 percent of the trials summarized. As expected, the yield increase was higher in trials for which the disease severity was more
prevailent. The authors noted that the use of fungicides on corn has potential consequences on the prevalence of fungal populations. Some fungicides used for corn are high-risk for resistance development. Increased use of these fungicides could lead to fungal sensitivity to these fungicides which would make it more difficult to control disease. Grogan (2013) indicated that fungicide application in the early stages of corn production (V5-V6 stages) resulted in a yield increase of only 2 bushels per acre. This relatively small yield boost is likely due to the fact that plant diseases do not usually appear at the early growth stages for corn.

This study used experimental data from West Lafayette, Indiana to examine the economic benefits of applying fungicide to corn. Economic benefits were measured in terms of net revenue per acre and using stochastic dominance. Future work will explore the economic benefits for multiple locations in Indiana.

Data and Methods

Net return per acre (gross revenue minus fungicide and application costs) were computed for three specific fungicides, and for all of the fungicides used in trials that were conducted from 2008 to 2013 at the experiment station in West Lafayette, Indiana. Yield, timing of fungicide application, and disease ratings were collected for each fungicide trial. Depending on the year and trial, the stage of corn development at the time the fungicides were applied ranged from pre-tasselling to post-tasseling stages. Fungicide and application costs were assumed to be $30 per acre in 2013. USDA input price indices were used to estimate fungicide and application costs for 2008 to 2012. The average fungicide and application cost during the study period was $28.25 per acre. Marketing year average corn prices for Indiana were used to compute gross revenue and net return per acre. The marketing year average price ranged from $3.96 per bushel in 2009 to $7.23 per bushel in 2012, and averaged $5.24 per bushel. Gross revenue was computed by
multiplying yield per acre by the marketing year average corn price. Net return per acre was computed by subtracting fungicide and application costs from gross revenue.

First and second degree stochastic dominance, and stochastic dominance with respect to a function (Goh et al., 1989) were used to compare net return per acre for the four fungicide application alternatives (i.e., trials examining three specific fungicides, and the average of trials that examined all fungicides) with the no fungicide application alternative. The stochastic dominance technique is particularly useful when making pair-wise comparisons between mutually exclusive alternatives, as we are doing in this study.

To use stochastic dominance with respect to a function, information on risk attitudes was needed. Abdulkadri and Langemeier (2000), and Huirne et al. (2004) were used to derive relevant risk aversion ranges. Absolute risk aversion coefficient ranges (relative risk aversion ranges) used were as follows: 0 to 0.00111 (0 to 1) to represent slight risk aversion; 0.00111 to 0.00556 (1 to 5) to represent moderate risk aversion; and 0.00556 to 0.01111 (5 to 10) to represent strong risk aversion. Simulation and Econometrics to Analyze Risk (SIMETAR®) developed by Richardson, Schumann and Feldman (2006) was used to conduct the stochastic dominance analysis.

Results

Table 1 reports the average yield, gross revenue, and net return for each fungicide alternative, as well as the difference between each fungicide application alternative and the no fungicide alternative. Average yield and gross revenue were 4.04 bushels and $19.29 per acre higher for the average of all fungicide applications. The difference in yields ranged from less than 1 bushel per acre in 2010 to 10 bushels per acre in 2013. Average disease ratings were largest in 2009. For this year, the average difference in yields was approximately 4 bushels per
acre. For 2013, the year with largest difference in yields, disease was not problematic. The difference in gross revenue ranged from $2 in 2010 to $45 per acre in 2013. Despite improving yield and gross revenue, average net return per acre was $8.96 lower for the average of all fungicide applications alternative. The difference in net return per acre ranged from -$25.53 in 2010 to $15.19 in 2013, the only year for which the net return difference was positive.

For the specific fungicides, A, B, and C; the improvements in yields over the no fungicide application alternative were 5.95, 4.57, and 1.83, respectively. The difference in gross revenue for the specific fungicides ranged from approximately $11 per acre to $31 per acre, and the difference in net return per acre (gross revenue minus fungicide and application costs) ranged from approximately -$17 per acre to $3 per acre. For fungicide A, the only fungicide with a positive average net return difference, the net return difference was positive in 2011, 2012, and 2013, and negative in 2009, 2010, and 2011. For fungicide B, the net return difference was positive in 2013, and negative in the other five years. The net return difference was positive in 2012 for fungicide C, and negative in the other five years.

Table 2 reports the stochastic dominance efficient sets. The all fungicides, three specific fungicides and the no fungicide alternative were part of the first degree stochastic dominance set. The second degree stochastic dominance set was comprised of the no fungicide application alternative, all fungicides, and fungicides A and B. For slightly risk averse corn producers, the efficient set was comprised of fungicide A. For moderately risk averse corn producers, the efficient set was comprised of the no fungicide application treatment and fungicide A. Finally, for strongly risk averse corn producers, the efficient set was comprised of the no fungicide application treatment.

Summary and Conclusions
This study used experimental data from West Lafayette, Indiana to examine the economic benefits of applying fungicide to corn. The recent increased use of fungicides on corn is pertinent from an economic and biological perspective. From an economic perspective, the improvement in corn yield has to be large enough to offset fungicide and application costs. From a biological perspective, use of fungicides, particularly in situations where disease is not prevalent, may lead to increased resistance to fungicides.

On average, yield and gross revenue were approximately 4 bushels per acre and $19 per acre higher for the average of all fungicide treatment alternatives compared to the treatments that did not include fungicide applications. Stochastic dominance results indicated that fungicide A was part of the second degree stochastic dominance set and part of the efficient sets for slightly risk averse and moderately risk averse preferences. Fungicide B was part of the second degree stochastic dominance set. However, it is important to point out the average marketing year average corn price used in this study was $5.24 per bushel. Fungicide A would not be economical if we used a $4.00 per bushel corn price, which is similar to recent corn prices, and the average improvement yields for fungicide A during the study period.

Further work will involve an examination of more treatment sites in Indiana. This work will help determine situations for which fungicide applications are economical.
References


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<th>Fungicide Treatment</th>
<th>Yield</th>
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<th>Net Return</th>
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<td>Fungicide B</td>
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<td>Fungicide C</td>
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Table 2. Stochastic Dominance Efficient Sets.

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<th>FSD&lt;sup&gt;a&lt;/sup&gt;</th>
<th>SSD&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Stochastic Dominance with Respect to Function&lt;sup&gt;c&lt;/sup&gt;</th>
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<tr>
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</tr>
<tr>
<td>All Fungicides</td>
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<td>x</td>
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</tbody>
</table>

<sup>a</sup> FSD = first degree stochastic dominance

<sup>b</sup> SSD = second degree stochastic dominance

<sup>c</sup> LRA = slightly risk averse, MRA = moderately risk averse, and HRA = strongly risk averse.