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No-tilling Corn into Hairy Vetch: Fertilizer Nitrogen Substitution Without Penalty Due to Delayed Planting

H. M. Saha and J. H. Grove

Previous studies conducted in Kentucky have shown that hairy vetch is an agronomically viable winter legume cover crop for no-till corn production. However, to fully realize the benefits of this cover crop it is necessary to allow enough time for it to accumulate biomass and nitrogen (N) before no-till corn is planted. Thus, early corn planting may not always be feasible. Since delaying corn planting after May 15 in Kentucky usually leads to a decline in corn grain yields, the main question addressed in this study (one for which little information was available) was whether the benefits provided by hairy vetch could offset the consequences of delayed corn planting.

This study was designed to answer the following questions: (1) Do winter cover crops influence the impact of delayed corn planting on grain yield? (2) What effect(s) do winter cover crops have on N mineralization early in the corn growing season before fertilizer N is applied? (3) Does hairy vetch provide benefits other than a supply of N? (4) What economic benefit would a corn grower expect from using hairy vetch in a no-till corn production system? (5) What effect(s) do winter cover crops have on the response of corn to fertilizer N application?

RESULTS

This study was conducted on a Maury silt loam at UK's Spindletop Experiment Farm at Lexington for four years (1992-95). Corn was grown continuously and was planted at three different dates (about...
April 28, May 15, and May 31) each year. Corn was planted following no winter cover (winter weeds only), hairy vetch, or winter wheat at each planting date, and the crop in each cover system was fertilized with four rates of N (0, 60, 120, and 180 lb N/acre as ammonium nitrate) about four weeks after planting.

The function describing the corn grain yield response to the fertilizer N was calculated for each cover system, at each planting date, and for each year. Functions for the winter weeds (no cover) and winter wheat cover systems were not different, so a single function relating grain yield to fertilizer N was calculated to describe those two cover systems. From such functions the optimal fertilizer N rate (the point at which the cost of the last pound of N was just paid for with corn grain) was determined. The corn grain yield at that point was also found. Each of these parameters was calculated for each year and then averaged over the four years of the study (Table 1).

As expected, corn following winter weeds or wheat required greater amounts of fertilizer N to achieve optimal yields than when following vetch (Table 1). Corn following either winter weeds or wheat gave a greater yield response to added N (bigger yield increment with each unit of fertilizer N) than corn following hairy vetch. This indicated a lower supply of soil N under winter weeds or wheat as compared to vetch. Corn grain yields in both winter weeds and wheat cover systems tended to be highest when planting was done in mid-May (Table 1). Though the yield decline was modest, there was a trend for reduced optimal yield at the latest planting date when corn followed winter weeds or wheat. Unexpectedly, this was not true when corn followed vetch, where yield actually rose with delayed planting. The results showed that corn planted following hairy vetch could be delayed by up to four weeks (until June 1) from the start of the corn growing season (May 1), without causing yield loss. However, growers should remember that in a cold, dry spring, when growth of hairy vetch is limited, some of this benefit may not be realized. Both the winter weeds (no cover sown) and wheat systems behaved similarly in many respects. Therefore, it does not appear to be worth investing in seeding winter wheat just for cover in this continuous corn production system.

Net soil N mineralization rates in the first five weeks after cover crop kill (corn planting) were higher under hairy vetch than under either winter weeds or wheat.
data not shown). Thus, hairy vetch improved soil N supply to corn early in the season, prior to fertilizer N application. The nitrogen fertilizer equivalence (NFE) to using hairy vetch can be calculated by subtracting the optimal N rate for corn following vetch from that for corn following winter weeds or wheat. The NFE values ranged from 26 lb N/acre at late April planting dates to 41 lb N/acre at late May planting dates (average of 32 lb N/acre). Though greater NFE values with greater vetch growth and delayed planting were expected, the amount of that increase was smaller than expected, probably because of an unexpected decline in the optimum N rate with delayed planting in both the winter weeds and wheat cover systems. It is not clear why the optimal fertilizer N rate in these two systems declined from 164 to 142 lb N/acre when planting was delayed until at least mid-May.

Grain yield at the optimal fertilizer N rate following vetch was always superior to that following winter weeds or wheat. This difference (a form of "rotation effect") ranged from 3 bu/acre with mid-May planting to 14 bu/acre with late May planting (average of 8 bu/acre). Clearly, greater soil N supply after vetch did not fully account for the greater corn yield observed. This indicates that hairy vetch provided benefits above and beyond a supply of N, perhaps additional soil moisture conservation under the vetch mulch and/or other positive "rotation effects", to the corn which followed. Soil moisture was often higher under corn following hairy vetch (data not shown).

**SUMMARY**

The total value to planting corn after hairy vetch can be calculated as $\text{NFE} \times \text{price of N per pound} + ("\text{rotation effect" yield} \times \text{price of corn per bushel})$. Average corn and fertilizer N prices for the 1992-94 production and marketing years were $2.39/bu and $0.21/lb, respectively. Total value averaged nearly $26/acre (range of about $13/acre with mid-May planting to $42/acre with late May planting). Commodity and input prices, as well as the NFE and "rotation effect" yields, can vary, of course.

The observed benefits of hairy vetch (N supply, soil moisture improvement, and rotation effect) are probably the most important criteria a farmer can use in deciding whether to include this winter legume in a no-till corn production system. It might be misleading to judge the usefulness of hairy vetch based on its N supply characteristic only. When all the benefits provided by hairy vetch are considered, it is evident
that this cover crop fits well in a no-till corn production system in Kentucky. The hairy vetch cover system works particularly well when the spring season is warm and moist enough to encourage rapid growth of the cover crop.

The current recommendation for Kentucky is that corn planting should be completed before May 10 or May 20 in the western and eastern parts of the state, respectively. However, this study shows that there is a period of about four weeks (from 1 May until 1 June) within which corn can be no-till planted into a hairy vetch cover crop without incurring significant yield loss.

Table 1. The optimum fertilizer N rate, and the corn grain yield at that N rate, as a function of winter cover system and corn planting date (ave. 1992-95).

<table>
<thead>
<tr>
<th>Winter Cover</th>
<th>Planting Date</th>
<th>Optimum N Rate</th>
<th>Grain Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>lb N/acre</td>
<td>bu/acre</td>
</tr>
<tr>
<td>weeds/wheat</td>
<td>late April</td>
<td>164</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>mid-May</td>
<td>142</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>late May</td>
<td>142</td>
<td>140</td>
</tr>
<tr>
<td>hairy vetch</td>
<td>late April</td>
<td>138</td>
<td>139</td>
</tr>
<tr>
<td></td>
<td>mid-May</td>
<td>113</td>
<td>148</td>
</tr>
<tr>
<td></td>
<td>late May</td>
<td>101</td>
<td>154</td>
</tr>
</tbody>
</table>