Response to “Comments on ‘Need for a Soil-based Approach in Managing Nitrogen Fertilizers for Profitable Corn Production’ and ‘Soil Organic Nitrogen Enrichment Following Soybean in an Iowa Corn-Soybean Rotation’”

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The article by Mulvaney et al. (2006) focuses largely on the need to reduce excessive N fertilization, a common occurrence with yield-based recommendations for corn (Zea mays L.) production. An obvious potential is demonstrated for soil-based N management to increase fertilizer N use efficiency, since the Illinois Soil N Test (ISNT) was significantly related to crop N requirement and was the most powerful predictor of error in yield-based recommendations.

In contrast, Dr. Greenfield’s letter focuses on the chemical basis of the ISNT and difficulties that arise in differentiating responsive and nonresponsive soils when test values are interpreted, not in terms of a measured concentration, but as a percentage of total soil N. We would point out first of all that the ISNT is directed toward routine soil testing, rather than quantitative characterization of soil N. On page 179 of our paper, for example, we noted that the ISNT “is designed to estimate an alkali-labile fraction of soil N, nominally referred to as amino sugar N, which has been related to net N mineralization.” This fraction was originally referred to as (NH$_4^+$ + amino sugar)-N by Khan et al. (2001), following conventional nomenclature employed in fractionating hydrolyzable soil N, but could originate from an array of other alkali-labile compounds, as documented in recovery tests reported by Mulvaney and Khan (2001). The test procedure involves mild heating under alkaline conditions in lieu of more rigorous hydrolysis with strong acid, so there is no need for the correction advocated by Dr. Greenfield. Such corrections were likewise avoided in previous work utilizing acid hydrolysis to compare N distributions for responsive and nonresponsive soils (Khan et al., 2001; Mulvaney et al., 2001), since resolution of these two groups would have been unaffected.

Because crop uptake of N necessarily depends on the quantity available, ISNT interpretations were made in our work, as previously by Khan et al. (2001), on the basis of measured concentrations. A different approach has been taken when Dr. Greenfield expresses these concentrations relative to total soil N, a practice that has often been applied in reporting the distribution of hydrolyzable soil N. The effect is apparent from Table 1, which summarizes results obtained in comparing total N, (NH$_4^+$ + amino sugar)-N, and amino acid N for soils under contrasting long-term management within the Morrow Plots. Not surprisingly, N concentrations were much higher with manuring and a legume rotation, than when corn was grown continuously without the use of manure. Yet this difference was inverted by expressing (NH$_4^+$ + amino sugar)-N as a percentage of total soil N, quite in contrast to practical experience that corn requires little, if any, N fertilization when grown following alfalfa with regular manuring. Similar difficulties have frustrated numerous attempts to relate the distribution of hydrolyzable soil N to soil type, cropping, or cultivation, and the usual conclusion, as noted on page 173 of Mulvaney et al. (2006), has been “that no particular fraction of hydrolyzable soil N is more labile than others.” A percentage interpretation of the ISNT may be consistent with previous research concerning the chemistry of soil organic N, but will lead to erroneous conclusions regarding the inherent and management-induced differences that exist among soils in their N-supplying capacities.

We concur with Dr. Greenfield that the chemical basis of the ISNT should be further clarified; however, practical utilization of any soil test must always be contingent on whether test values are related to plant response in the field. Evidence that the ISNT meets this requirement has been provided by Mulvaney et al. (2006), and is also available from a growing number of N-response studies by other scientists (Klapwyk and Ketterings, 2006; Klapwyk et al., 2006; Ruffo et al., 2006).

REFERENCES

Table 1. Comparison of percentage distribution versus concentration for evaluating the effects of management and cropping practices on soil N composition in the Morrow Plots.

<table>
<thead>
<tr>
<th>Plot†</th>
<th>Total N</th>
<th>(NH$_4^+$ + AS)-N‡</th>
<th>Amino acid N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mg kg$^{-1}$</td>
<td>% of total N§</td>
<td>mg kg$^{-1}$</td>
</tr>
<tr>
<td>C-C unamended</td>
<td>1380</td>
<td>39.5</td>
<td>551</td>
</tr>
<tr>
<td>C-O-H manured</td>
<td>2540</td>
<td>34.3</td>
<td>871</td>
</tr>
</tbody>
</table>

†C = corn (Zea mays L.); O = oats (Avena sativa L.); H = alfalfa (Medicago sativa L.) hay.
‡(NH$_4^+$ + AS)-N = hydrolyzable N as NH$_4^+$ plus amino sugar, recovered by steam distillation with NaOH.
§% of total N. §As reported by Stevenson (1956).