Evaluating the Haney Test as a Tool in Soil Fertility Management in Minnesota

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INTRODUCTION:

Interest around soil health has increased greatly in recent years. A significant driver of this interest has been programs offered by the USDA-Natural Resource Conservation Service (NRCS) that provide incentives to farmers who adopt practices such as planting cover crops and/or reducing tillage to enhance soil health on their farms.

The Haney test is being utilized nationwide as a tool to measure soil health, and farmers are currently being offered financial incentives through programs like EQIP to collect soil samples on their farm for this analysis. This test uses water and a weak organic acid to extract N, P, and K from the soil (1,2), unlike standardized soil test procedures historically used in MN. Questions have arisen about using results of the Haney test to determine fertilizer application rates (3), and some soil testing lab reports include fertilizer recommendations based on Haney test results. However, correlation and calibration research, which provides meaning to soil test values in terms of nutrient sufficiency, fertilizer needs, and the likelihood of a yield response (4), has not been conducted on any significant scale in MN with the Haney test. Information is lacking regarding whether or not results from the Haney test can assist in making fertilizer application decisions.

Research conducted at Lamberton in 2015 in long-term tillage trials demonstrated that soil test levels for nitrate-nitrogen can vary dramatically between standard soil testing methods and the Haney test (5,6). This translated to significant differences in recommended fertilizer application rates. Previous U of MN research on the Solvita test (a component of the Haney test) found that the Solvita was a good indicator of mineralizable N and C, but not better than soil organic matter, inorganic nitrogen or permanganate oxidizable C (POXC) (7,8,9). Soil type and previous crop influenced results as well.

This study was initiated to help evaluate the Haney test as a tool in determining nitrogen fertility needs and recommended rates of nitrogen application. Specific objectives include: 1) Determine the correlation between soil test values for nitrate-nitrogen based on standard soil testing procedures and the Haney test; 2) Compare the Economic Optimum Nitrogen Rate (EONR) determined by nitrogen rate trials to results generated from the Haney test; and 3) Compare the sensitivity of the Haney test to standard soil sampling methods to changes in soil nitrogen levels over time.

MATERIALS AND METHODS:

To determine the correlation between soil test nitrate-nitrogen levels for standard soil testing procedures and the Haney test, soil samples were collected in the spring at 13 on-farm locations. Sampling sites were selected in order to represent prevalent soil types in the region as well as areas differing in productivity. Sites were georeferenced so that the same locations could be sampled in subsequent years. For the standard testing procedures, soil collected at a 0-6 inch depth was analyzed for: nitrate-nitrogen, P, K, pH, and OM. Soil was also collected at a 6-24 inch depth for nitrate-nitrogen. For the Haney test, soil collected at a 0-6 inch depth was analyzed for N (water extractable ammonical N, nitrate N, and organic N), P, K, organic C, pH, OM, and the Solvita 24 hour CO_2 burst. Soil collected at the 0-6 inch depth was mixed together and then split for analysis by either standard testing procedures or the Haney test. Pearson's correlation coefficient was calculated to determine the relationship between results from the Haney test and standard testing procedures.

To compare the Economic Optimum Nitrogen Rate (EONR) determined by nitrogen rate trials to results generated from the Haney test, samples were collected from Dr. Fabián Fernández's nitrogen rate trials at the Southern Research and Outreach Center (SROC) in Waseca and the Southwest Research and Outreach Center (SWROC) in Lamberton. Soil was collected for the Haney test at a 0-6 inch depth for N (water extractable ammonical N, nitrate N, and organic N), P, K, organic C, pH, OM, and the Solvita 24 hour CO2 burst. Soil was collected for standard testing procedures for nitrate-nitrogen and ammonium-nitrogen at a 0-6, 0-12, 12-24, and 24-36 inch depths. The check plots, where no nitrogen was applied, were sampled. Various rates of nitrogen were applied using urea in the nitrogen rate trials (40, 80, 120, 160, 200, and 240 lb N/acre), and corn yield response was determined. Statistical analysis was conducted to determine the EONR for each site. These results were compared to what the Haney test indicated were N needs to optimize yield.

We will need to conduct the trial for additional years to address objective number three, which is to evaluate the two soil testing methods in their sensitivity to changes in nitrate-nitrogen levels over time.

RESULTS:

On-Farm Evaluations:
Table 1 lists the soil types for each sample at the on-farm sites. A range of soil types were evaluated, and common soil types for the region were evaluated at two to three locations.

Table 1. On-farm sampling sites for Haney test evaluations – sample number and soil type, 2016.

Sample	
1	Canisteo clay loam
2	Webster clay loam
3	Normania clay loam
4	Amiret-Swanlake loams
5	Normania clay loam
6	Webster clay loam
7	Sverdup fine sandy loam
8	Marysland clay loam
9	Canisteo clay loam
10	Canisteo clay loam
11	Normania clay loam
12	Amiret loam

There was a very strong correlation (r=.9009) between the Haney test for water-extractable N and standard soil testing procedures for nitrate-nitrogen at the 0-6 inch depth (Fig. 1). By definition, the Haney test calls for soil samples to be collected from a 0-6 inch depth. At 10 of 12 sites when only the top 6 inches of soil were compared, the Haney test estimated there to be more nitrogen available in the soil than by standard soil testing procedures.

In contrast, there was only a moderate correlation (r=.5768) when results from the Haney test were compared to results from standard testing procedures at a 0-24 inch depth (Fig. 2), as is recommended in MN. Results varied anywhere from -16.6 to + 636 lb N/acre between the two tests. The largest difference was observed at site 8 where a Marysland clay loam soil was sampled, and 690 lb N/acre was detected in the 6-24 inch depth. Although this number is unusually high and could be considered an outlier, the amount of nitrate-nitrogen in the 6-24 inch depth at the other sites ranged from 33 to 189 lb N/acre. When the top 24 inches of soil were evaluated with standard testing procedures, results for N were greater with the Haney test at only 3 of 12 sites (4 to 16.6 lb N/Acre) when compared to standard soil testing procedures.

Fig 1. Comparison of results for nitrogen from Haney test (water-extractable total nitrogen) and standard soil sampling procedures (nitrate-nitrogen) at 0-6 inch depth at on-farm sites, 2016. There was a very strong correlation between the variables: r=.9009, n=12, p=.0001.

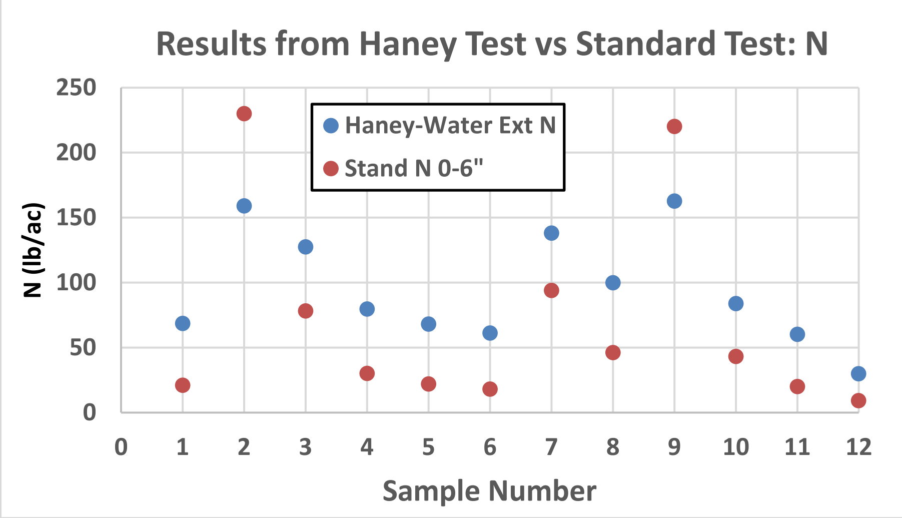
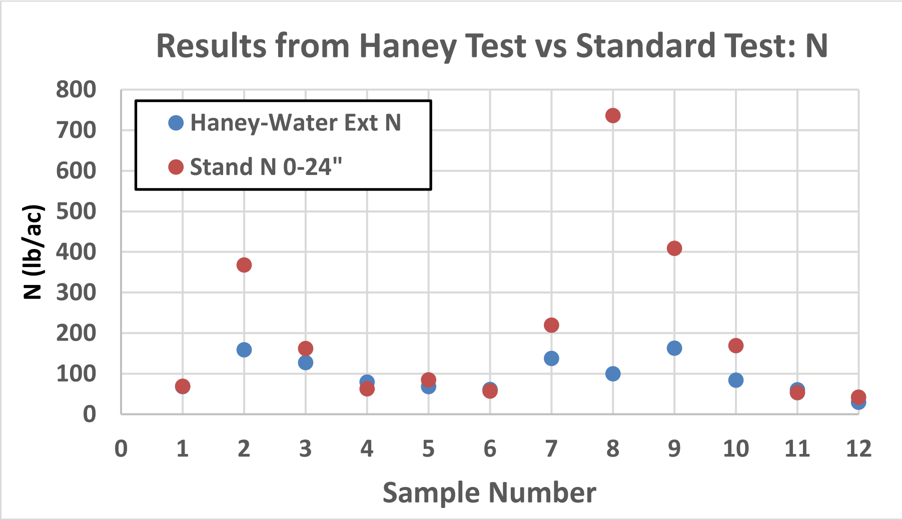


Fig 2. Comparison of results for nitrogen from Haney test (water-extractable total nitrogen), which by definition is done at a 0-6 inch depth, and standard soil sampling procedures (nitrate-nitrogen) at the standard recommended 0-24 inch depth, at on-farm sites, 2016. There was a moderate correlation between the variables: r=.5768, n=12, p=.0496.



Results for P (Fig. 3), and K (Fig. 4) are also presented. The correlation for P between the Haney test and standard testing procedures was moderate (.4009). Of note is that the Haney test uses one extractant for P, unlike standard testing procedures which uses the Bray or Olsen test based on soil pH. The correlation between the Haney test and standard testing procedures was very strong for K (r=.8598), although standard testing procedures detected more K at every single site (63 to 244 ppm K/acre) than the Haney test did. This would translate to much more K_20 being recommended in fertilizer applications if one used the Haney test vs standard soil testing procedures to generate fertilizer recommendations.

Fig 3. Comparison of results for phosphorus from the Haney test and standard soil sampling procedures (0-6 inch depth) at on-farm sites, 2016. There was a moderate correlation between the variables: r=.4009, n=12, p=.1965

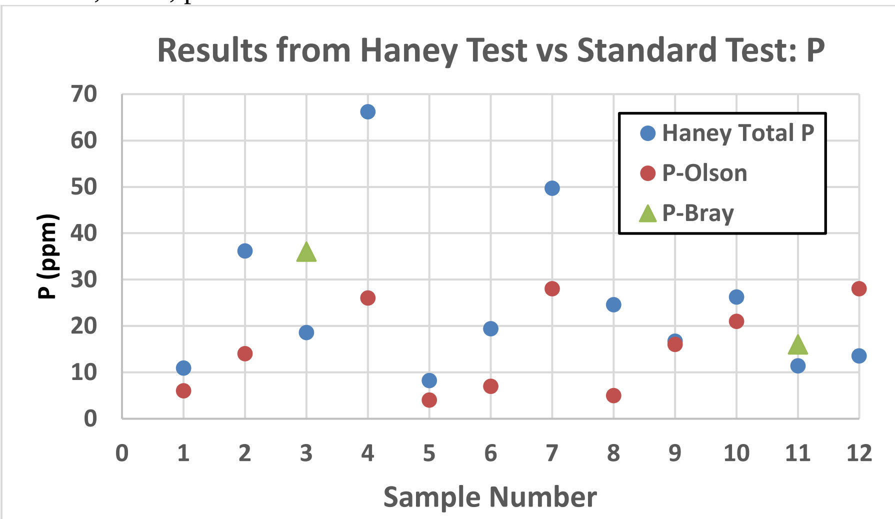
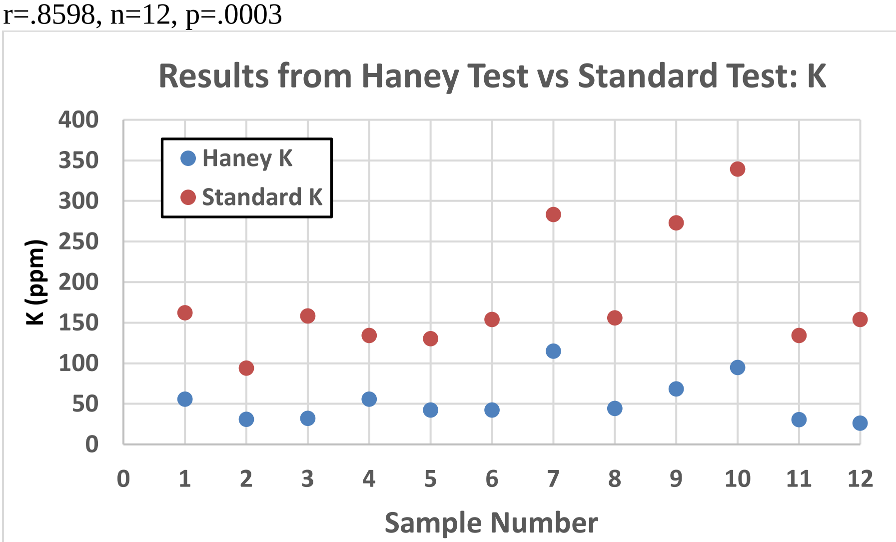


Fig 4. Comparison of results for potassium from the Haney test and standard soil sampling procedures (0-6 inch depth) at on-farm sites, 2016. There was a very strong correlation between the variables: r=.8598, n=12, p=.0003



N-Rate Trial Results:

The Haney test was evaluated for spring applications of N in N-rate trials at Lamberton and Waseca. Results for fall N applications are presented for comparison.

At Lamberton, the Haney test for a yield goal of 197 bu/a (highest yield obtained for spring application of 240 lb N/ac) indicated that we would need 143 lb N/ac to optimize yield. This underestimated the need for N. The fact that spring applications had a linear response to N (Fig. 5) indicates that there was N loss (yield was never maximized). There was 35 lb N/ac (ammonium plus nitrate) in the soil at the beginning of the growing season. It is possible that the Haney test either overestimated the capacity of the soil to supply N through mineralization or underestimated the potential for N loss. The Soil Health Score for this soil was 13. The mineralizable N (amount of N that will be mineralized during the growing season) was estimated to be 13 lb N/ac. Table 2 represent corn grain yield results for various N application rates of urea applied in the spring or fall.

At Waseca, the Haney test for a yield goal of 234 bu/a (yield at the EONR of 202 lb N/ac) indicated that we would need 208 lb N/ac. In this case where the yield was maximized, the test provided a good estimation of the needs for N (Fig. 6). There were 2 lb N/ac (ammonium plus nitrate) in the soil at the beginning of the growing season. The fact that there was such little N present in the soil would indicate that N needs would have to be supplied almost entirely by fertilizer N. In this situation the Haney test appears to predict N needs well. The Soil Health Score for this soil was 16. The mineralizable N (amount of N that will be mineralized during the growing season) was estimated to be 33 lb N/ac. Table 3 represent corn grain yield results for various N application rates of urea applied in the spring or fall.

Fig 5. Nitrogen-rate trial results at Lamberton, continuous corn, 2016.

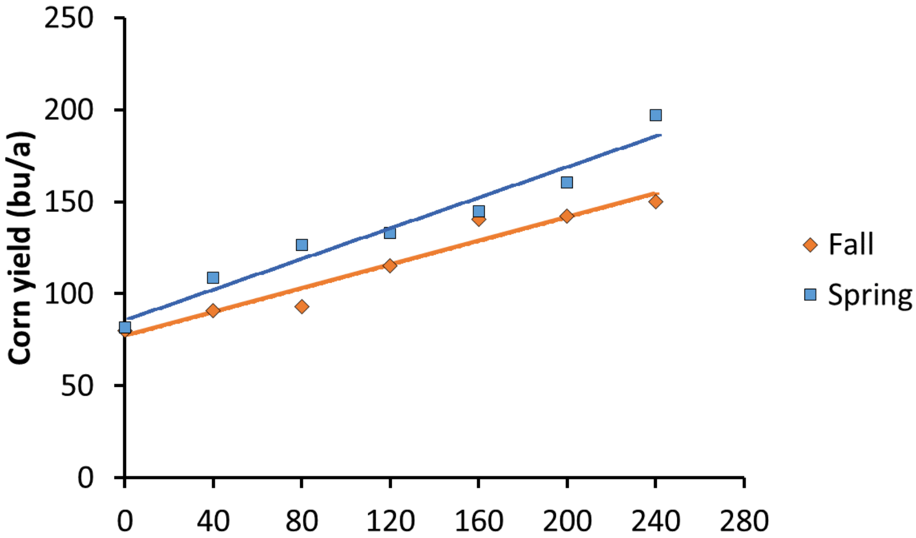


Table 2. Corn grain yield results from nitrogen-rate trials at Lamberton in continuous corn, 2016. Urea was applied at various rates in the spring or fall.

lb N/ac	Spring	Fall
	Bu/ac	
0	82	80
40	109	91
80	127	93
120	133	115
160	145	140
200	160	142
240	197	150

Fig 6. Nitrogen-rate trial results at Waseca, continuous corn, 2016. The blue dot is the EONR and yield at the EONR calculated at a price ratio of 0.1.

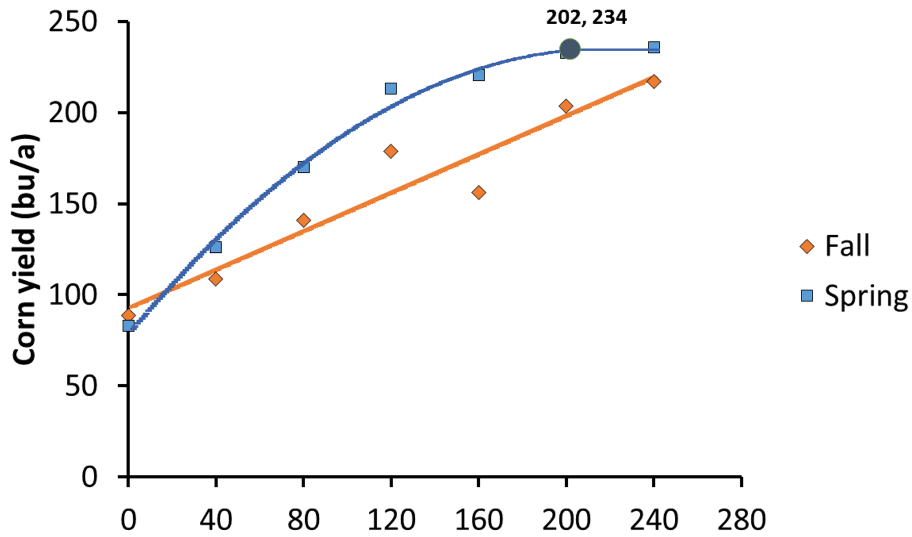


Table 3. Corn grain yield results from nitrogen-rate trials at Waseca in continuous corn, 2016. Urea was applied at various rates in the spring or fall.

lb N/ac	Spring	Fall
	Bu/ac	
0	83	89
40	126	109
80	170	141
120	213	179
160	221	156
200	233	204
240	236	217

CONCLUSIONS:

Results of this project to date demonstrate that soil test levels for N can vary dramatically between standard soil testing methods and the Haney test. This in turn, can have a significant impact on recommended fertilizer rates and economic and environmental impacts due to over- or under-application of nutrients. Impacts of using the Haney test on P and K application rates was also studied and preliminary results were published in a U of MN Extension fact sheet in 2016 (10).

We plan to continue this work over the next couple of years to help compare the sensitivity of the Haney test and standard soil sampling methods to changes in soil nitrogen levels over time. Collecting this information over a variety of soil types and over several years will also help determine if further correlation and calibration work is warranted with the Haney test.

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