Accuracy of Quick Soil Nitrate Tests in Montana

Evette Allison and Clain Jones
Montana State University, Bozeman, Montana

Introduction

Optimizing nitrogen (N) fertilizer rates based on soil nitrate results is critical for maximizing yields, increasing fertilizer use efficiency, and decreasing N leaching. Performing frequent, accurate nitrate testing would provide current soil nitrate data, allowing producers to adjust fertilizer rates at seeding and top dressing times. Testing more than once per season is not often done due to time, labor and budget constraints. While several relatively inexpensive home test kits are available, and some studies showed good correlation to lab analyses (Hartz 1994, Hartz et al. 2000), there have been no studies of these "quick" tests in Montana. The objectives of this study were to correlate nitrate levels of three different quick test kits to laboratory analyses to determine their accuracy, and if found accurate, to refine procedures and calculations for rapid easy use.

Methods

Eighty-nine soil samples were collected from 52 sites in Montana representing 9 counties, with 0-6 in. and 6-24 in. samples collected at most sites. The MSU Soil Testing Lab (Bozeman, MT) analyzed nitrate-N (NO_3-N), pH, soil water content, and texture, while MDS Agronomic Services Laboratory (Lincoln, NE) analyzed NO_3-N only. All soils were extracted with a H_2O:soil ratio of 3:1 (v/v), shaken for one minute. A flocculent of ¼ tsp of Epsom salt was added to the solution and shaken for 10 seconds. Solutions settled for 2 hours before they were tested.

The test strip (WaterWorks™ Sensafe, 480009) required dipping the strip into solution and comparing the strip color to a chart after 1 minute. The color disc (Hach™ NI-11) required adding a cadmium (Cd) reagent to a measured amount of solution, mixing, and comparing color to the disc after 1 minute. The colorimeter (Hach Pocket Colorimeter™ II) also required adding a Cd reagent to a measured amount of solution, mixing and reading the NO_3-N level with the instrument after 5 min.

All data analyses used average soil mass and moisture content because most end users of these methods would not have access to a scale. The kits measured NO_3-N in mg/L so these data were converted to ppm for a direct comparison to averaged lab results in ppm.

Results

Of the three kits, the color disc results had the highest correlation to lab average NO_3-N, with decreasing correlation for the test strip and colorimeter, respectively (Figure 1). The color disc's greater accuracy may be a result of the continuous range of color on the color disc itself, reducing the need for interpolation. In comparison, the test strips had coarse color gradations on the provided chart. The poor correlation with the colorimeter results was attributed to instrument malfunction or interference.

Error between lab and quick test NO_3-N concentrations, for the test strips and color disc, was compared to soil water content, clay content and pH to determine if these variables were affecting quick test NO_3-N readings. Soil moisture content was the only factor to significantly affect NO_3-N results. This indicated that with increased soil water content, NO_3-N concentrations became diluted resulting in lower readings than lab results.

Correlations between quick test total NO_3-N (lb/ac) in the upper 2 feet and lab NO_3-N (lb/ac) were better than single sample measurements. Summing NO_3-N (lb/ac) over two depths smoothed the data and more heavily weighted the 6-24 in. depth where lower NO_3-N concentrations resulted in less error (data not shown). Even though accuracy did improve, the data showed a 35 to 45% probability of under or over-estimating laboratory NO_3-N by at least 15 lb/ac (Figure 2) when using these methods.

When the test strip and color disc were verified by five individuals, correlations to lab analysis were comparable to the original data set (Figure 3); however, slopes between lab and quick tests ranged by factors of up to 2.2 and 1.8 for the test strip and color disc methods, respectively. This data shows that individual interpretation of color could result in errors of up to a factor of 2 if a correction factor from one user was used by another.

To increase the accuracy of these quick tests, an individual could perform a simple regression on their readings as compared to lab nitrate-N results. The comparison should correct his/her data. Once calibrated, these kits could likely provide end users fairly accurate data on soil nitrate-N levels, but should not be used as a replacement of laboratory analyses.

Fertilizer Facts

Fertilizer √off

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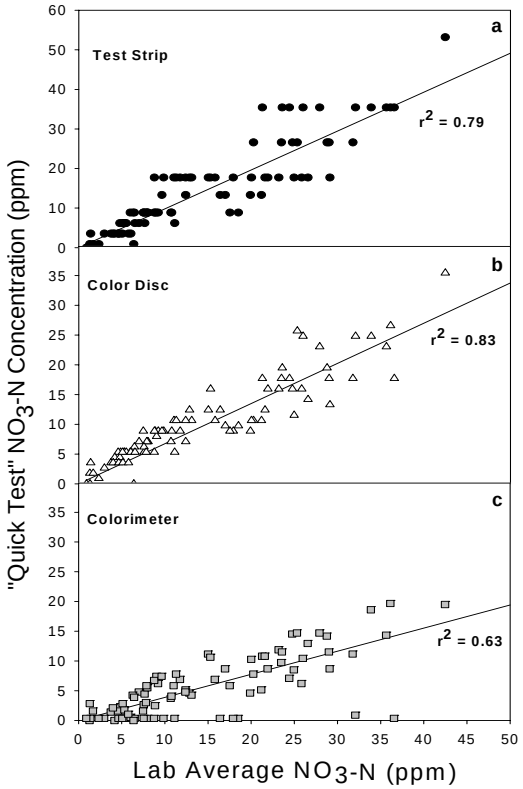

Figure 1. Comparison of nitrate-N concentrations, expressed as dry weight, between three quick tests and lab analyses (a two lab average).

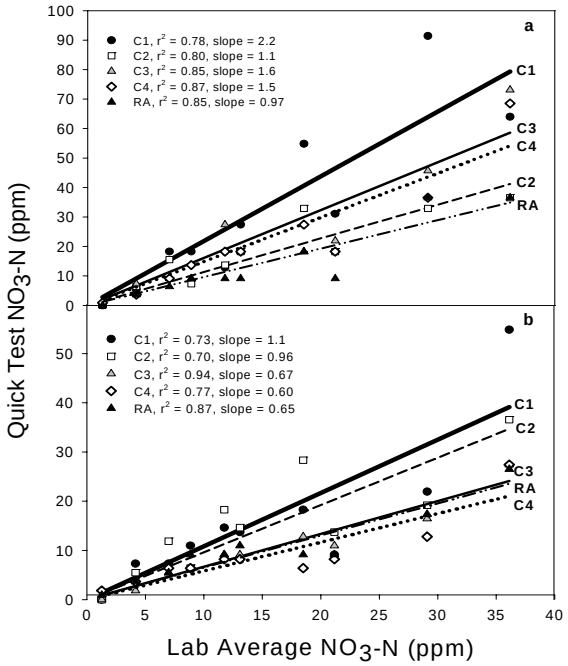

Figure 3. Variability of results in using either test strip (a), or color disc (b) methods. Ten soils, selected by double blind, random sampling were tested by 4 volunteers (C1- C4) and the project research associate (RA).

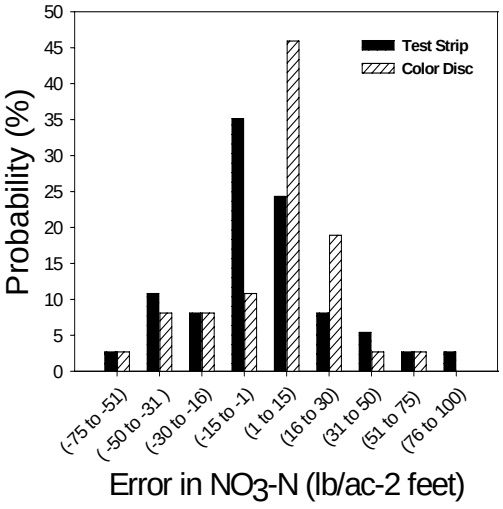

Figure 2. The probability of under or over estimating soil nitrate-N (lb/ac) using the test strip and color disc kits.

Of the kits evaluated, the test strip and color disc had consistently better correlations with lab analyses. Correlations across all tests were likely too low to have confidence in these methods due to the possibility of introducing a relatively large error in NO_3-N (lb/ac). Soil moisture content was found to significantly affect NO_3-N readings and could be corrected for if the user had a gravimetric scale. These quick tests need to be used in conjunction with laboratory NO_3-N analyses to be somewhat reliable.

Fertilizer Facts:

- Quick test kits for NO_3-N are available, yet must be used with caution and not relied on as accurate. Soil water content can further affect readings.
- Individuals can increase the accuracy of these quick tests by following a consistent methodology and calibrating their readings to lab analysis. These kits could augment, but should not replace regular lab soil testing.

References

Hartz, T.K. 1994. A quick test procedure for soil nitrate-nitrogen. Commun. Soil Sci. Plant Anal. 25 (5&6): 511-515.

Hartz, T.K., W.E. Bendixen, and L.Wierdsma. 2000. The value of presidedress soil nitrate testing as a nitrogen management tool in irrigated vegetable production. Hort. Sci. 35 (4): 651-656.

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