The Application of NIRS for Soil Analysis on Organic Matter Fractions, Ash and Mechanical Texture

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The amounts of organic matter present in soil and the rate of soil organic matter (SOM) turnover are influenced by agricultural management practice, such as rotation, tillage, forage plow down direct seeding and manure application. The amount of nutrients released from SOM is highly dependent upon the state of the organic matter. If it contains a large proportion of light fractions (low-density) more nutrients will be available to the growing crops. However, if it contains mostly heavy fractions (high-density) that are difficult to breakdown, then lesser amounts of nutrients will be available. The state of the SOM and subsequent release of nutrients into the soil can be predicted by NIRS as long as a robust regression equation is developed. The NIRS method is known for its rapidity, convenience, simplicity, accuracy and ability to analyze many constituents at the same time. Our hypothesis is that the NIRS technique allows researchers to investigate fully and in more detail each field for the status of SOM, available moisture and other soil properties in Alberta soils for precision farming in the near future.

One hundred thirty one (131) Alberta soils with various levels (low 2-6%, medium 6-10%, and high >10%) of organic matter content and most of dry land soils, including some irrigated soils from Southern Alberta, under various management practices were collected throughout Northern, Central and Southern Alberta. Two depths (0 – 15 cm and 15 – 30 cm) of soils from Northern Alberta were also collected. These air-dried soil samples were ground through 2 mm sieve and scanned using Foss NIRSystem 6500 with transport module and natural product cell. With particle size above 150 microns only, the "Ludox" method (Meijboom, Hassink and van Noorwijk, Soil Biol. Biochem.27: 1109-1111, 1995) which uses stable silica, was used to fractionate SOM into light, medium and heavy fractions with densities of <1.13, 1.13 – 1.37 and >1.37 respectively. The SOM fraction with the particle size below 150 microns was discarded because practically, this fraction with very fine particles can't be further separated by wet sieving based on density. Total organic matter content, mechanical texture, ash after 375^0 C, and dry matter (DM) were also determined by "standard" soil analysis methods. The NIRS regression equations were developed using Infra-Soft-International (ISI) software, version 3.11.

The correlation coefficients, R^2, between actually analyzed and NIRS predicted results for DM, total SOM, sand, silt, clay, ash375, and light, medium and heavy organic fractions were 0.89, 0.91, 0.89, 0.46, 0.94, 0.91, 0.60, 0.87 and 0.46 respectively. At the present time, it may not be feasible to analyze accurately by NIRS technique for one of mechanical texture parameters, silt, and light and heavy organic matter fractions. The method used for soil mechanical texture analysis is based on precipitation rate of particle sizes to calculate sand (coarse), silt (medium fine) and clay (fine). Silt with R^2 of 0.46 does not correlate very well between actually analyzed data and NIRS predicted results. One reason for that low R^2 for light (0.60) and heavy (0.46) organic matter fractions is the possibility of higher errors with wider ranges of density, <1.13 for the light fraction and >1.37 for the heavy fraction. The lower errors would be expected with defined density range of 1.13 to 1.37 for the medium heavy fraction with R^2 of 0.87. Furthermore, NIRS technique responses and includes all SOM; While, organic matter fraction with particle sizes less than 150 microns are discarded during the first step of soil wet sieving according to the Meijboom et al's procedure. A new chemical and physical procedure is being researched for determining all SOM fractions for NIRS calibration.