# Checking out the Soil Quality Test Kit

Curtis Cavers and John Heard, Manitoba Agriculture, Food and Rural Initiatives

## Background

In response to farmer interest in assessing soil health, USDA has developed a simple field test kit designed to measure a range of soil physical and microbial properties (Fig 1).

Eleven (11) field measurements are based on established research methods, yet use readily available equipment, easy to follow methods and benchmark values for comparison.

A field testing of this kit was conducted on a number of Manitoba soils and cropping systems during 2003.

Figure 1. USDA Soil Quality Test Kit.

## Methods

Four (4) main field measurements were selected for evaluation.

1) Soil respiration as an indicator of soil microbial activity (lb CO2-C/ac/day)
2) Earthworm population (worms/sq foot)
3) Water infiltration (inches/hr)
4) Aggregate stability to resist erosion and crusting (%)

The kit was evaluated on 3 soils:

a) Red River clay soil at Kelburn Farm, S of Winnipeg
b) Dezwood clay loam at Deerwood (South Central MB)
c) Newdale clay loam at MB Zero Till Research Farm (N of Brandon)

Various tillage, cropping and landscape positions were evaluated.

## 1) Soil Respiration

Soil respiration is a measure of the biological activity of the soil. Activity is beneficial to recycle nutrients from crop residues but is less so if soil organic matter is being broken down.

Figure 2. An aluminum ring is driven into the ground and sealed. After ½ hour, the air in this enclosed chamber is drawn through a Draeger detection tube with a syringe.

The air stains the detection tube purple according to the concentration of CO2. Readings are adjusted for temperature and converted to lb CO2-C/ac/day

The USDA Test Kit suggests the following rating for respiration rates:

- <9 lb CO2-C/ac/day = low
- 10-16 lb CO2-C/ac/day = moderately low
- 16-32 lb CO2-C/ac/day = medium
- 32-64 lb CO2-C/ac/day = ideal
- >64 lb CO2-C/ac/day = unusually high

## 2) Earthworm Numbers

Earthworms improve soil quality through increasing infiltration and soil aeration, casts improve aggregate stability and their feeding speeds crop residues breakdown by encouraging microbial activity.


Figure 4. Soil is excavated from a 1 square foot hole to a depth of 1 ft (A). Soil is collected and hand sorted for earthworms (B). A mustard solution can be applied to the excavated hole to extract the deeper burrowing night crawlers. Generally 10 earthworms per sq ft is considered good for agricultural soils. Night crawlers are not common in agricultural soils in Manitoba.

## 3) Water Infiltration

Measures of water infiltration are very dependent upon soil texture (sand vs clay) and initial soil moisture content. Measurements could aid in detecting soil problems such as compaction and crusting. Typical infiltration rate for a clay soil is 0.04 to 0.2 inches/hr.


Figure 5. An aluminum ring is driven into the soil. Saran wrap is placed over the soil surface and 1" of water ponded on top. The saran wrap is pulled away to allow the water to start infiltrating (A), which is timed with the stopwatch (B). Measurements are done at least 2 times.


## 4) Aggregate Stability

Aggregate stability is the measure of the soil to resist breaking down into individual soil particles. Stable aggregates resist erosion and soil crusting thereby improving air and water movement in the soil. Stable aggregates also improve the physical environment for root growth and protect soil organic matter trapped inside from exposure to air and microbial breakdown.


Figure 6. Dry soil is pressed through a screen to sort to aggregate size (A). The soil aggregates are placed on a fine mesh, moistened by resting on a wet cloth (B), and shaken for 3 minutes in water (C). The aggregates that do not "melt" through the fine screen are considered "stable". The sample is dried (D) and weighed to determine the % of the aggregates that are stable.

The greater the % of water stable aggregates the better for soil quality. Suitable levels of aggregate stability vary by soil clay content and organic matter content.

## Results

Table 1. Results of early-mid June soil quality measurements (shading indicates meeting or exceeding the suitable standard).

| Location | Red River clay | | Dezwood clay loam | | Newdale clay loam | | |
|---|---|---|---|---|---|---|---|
| Management factor | Alfalfa | Wheat | Zero till | Conv till | Alfalfa | Flax | Peas |
| Respiration Lb CO2-C/ac/day | 19 | 8 | 9 | 9 | 20 | 43 | 16 (10-21) |
| Earthworm #/sq ft | 0 | 0 | 9 | 0 | 0 | 0 | 0 |
| Infiltration in/hr | 3.9 | 2 | 2.1 | 2.7 | 3.8 | 2 | 2.7 |
| Aggregate stability % | 75 | 82 | 81 | 72 | 85 | 71 | 75 (74-81) |

There was considerable variability associated with these field measurements. It is recommended to take at least 3 measurements if intending to make a comparison of different systems. Detailed research apparatus and more measurements would be required to make anything more than relative comparisons.

Much of the variability was due to the hot, dry summer of 2003. Compared to "normal" , dry soils cracked and tended to have much higher infiltration rates, less microbial activity and less earthworm activity. Measurements of respiration and infiltration varied through the season as soils warmed up and then dried out. Such dry conditions reduced the activity and population of earthworms. Measurements in a moister year (2005) indicated 19-80 earthworms per sq ft in clay loam soils prior to fall tillage.

From Table 1, it appears that forages had higher infiltration rates than annual crops. Due to dry soil conditions and soil cracks, all values exceeded that expected for clay and clay loam soils. This method was inferior to using a Guelph permameter to determine infiltration.

Aggregate stability met the suitable standards under wheat on the Red River, under zero till on the Dezwood and under alfalfa on the Newdale soils.

## Other Measures


Figure 7. Other chemical measures of soil properties, such as nitrate-N (A), salinity (B) and pH (C) can be conducted with the test kit, but are better determined through conventional soil test analysis.

## Summary

The test kit provided a good first step in assessing physical properties of the soil. In many instances it was able to show the expected relative differences between different tillage systems or cropping practices.

Variability in soils and weather does not allow comparisons among different areas. The greatest use may be in assessing soil and crop management differences on the same farm.

The excessively dry conditions under which the kit was tested in 2003, produced unexpected values for soil respiration, earthworm numbers and water infiltration.

This project was supported by the Greenhouse Gas Mitigation Program for Canadian Agriculture. Information on ordering the kit and price is at: http://www.gemplers.com/a/shop/product.asp?T1=RGM250