

## SOIL QUALITY FIELD RESULTS

Soil quality and soil tilth are defined as the “soil’s ability to perform basic functions” such as maintaining productivity, regulating water flow, filtering of pollutants and cycling and storage of nutrients. This project was initiated to look at the effects of tillage on soil quality indicators (water infiltration, CO<sub>2</sub> respiration, bulk density and aggregate stability). All of these indicators have a direct effect on crop growth and yield. Below is a summary table of soil quality indicators for eight fields in NE Iowa having tillage practices ranging from conventional to long term no-till.

**Summary Table for 2001 Soil Quality Sites Selected by Shannon Gomes**

Site	Tillage	Soil	Drainage	Respiration Standardized (lbs. CO <sub>2</sub> --C/ac/day)	Infiltration 2 <sup>nd</sup> inch (in./hr.)	Bulk Density (g/cm <sup>3</sup> )	WFPS %	Slake Rating
1B	Conventional	83B	MW	67.7	0.9	1.39	67.8	2.3
2R	Reference	83B	MW	138.6	4.9	1.24	38.9	3.5
3B	Conventional	407B	SWP		5.7	1.38	86.6	3.0
4R	Reference	407B	SWP		18.3	1.22	64.7	5.5
5C	No Till	120A	MW	54.0	0.7	1.29	67.7	5.3
6R	Reference	120A	MW	78.1		1.20	45.0	5.8
7A	Conservation	171B/ 782B	SWP	45.1	1.9	1.62	81.9	3.0
8R	Reference	171B/ 782B	SWP	228.6	17.8	1.33	52.4	6.0
9B	Conventional	398	P	30.5	0.9	1.40	61.5	6.0
10R	Reference	398	P	184.3	0.9	1.31	50.9	5.5
11C	No Till	398	P	164.0	3.0	1.25	64.2	
12B	Conventional	120B	MW	20.0	1.9	1.38	61.5	6.0
13C	No Till	120B	MW	155.1	3.2	1.25	53.5	6.0
14R	Reference	120B	MW	139.0	32.6	1.25	53.5	6.0

**NRCS staff: Kurt Hoeft, Cedar Valley RC&D; Acacia Bender, Soil Scientist; Stephanie Hill, Conservationist**

## Soil Quality interpretations:

**Soil Respiration** – is the production of carbon dioxide (CO<sub>2</sub>) resulting from biological activity by microorganisms, plant roots, earthworms and other insects. Higher soil respiration is indicative of high biological activity and is a good sign of organic residue decomposition into nutrients available to plants. In Table 1 below, respiration rates under 32 lbs. CO<sub>2</sub>-C/ac/day are considered less than ideal for plant growth. Ideal respiration is 32-64 lbs. CO<sub>2</sub>-C/ac/day.

Table 1: General <b>soil respiration</b> class ratings and soil condition at optimum soil temperature and moisture conditions		
Soil respiration (lb CO <sub>2</sub> /acre/day)	Class	Soil condition
0	No soil activity	Soil has no biological activity and is virtually sterile
<9.5	Very low soil activity	Soil is very depleted of available organic matter and has little biological activity.
9.5 – 16	Moderately low soil activity	Soil is somewhat depleted of available organic matter, and biological activity is very low.
16 – 32	Medium soil activity	Soil is approaching or declining from ideal state of biological activity.
32 – 64	Ideal soil activity	Soil is in an ideal state of biological activity and has adequate organic matter and active populations of microorganisms.
>64	Unusually high soil activity	Soil is at a very high level of microbial activity and has high levels of available organic matter, possibly from the addition of large quantities of fresh organic matter or manure.

**Soil Infiltration** – is the process of water entering the soil profile. When soil is in good condition or has good soil health, it has a stable structure and continuous pores (macro and micro) to the surface. Surface crusting often produces a low infiltration rate resulting from weak soil structure and non-existent macro pores. Soils that have reduced infiltration have increased water runoff and subsequent erosion. This excess water can contribute to flooding of streams and rivers. In addition, soils that have reduced infiltration become saturated at the soil surface causing anaerobic conditions, which reduce biological activity and increase nutrient deficiencies. If a soil has an infiltration of 1 inch /hour but receives a 2 inch/hour rainfall, that extra inch moves offsite, causing erosion and furthermore not replenishing the soil profile with moisture.

Infiltration Rate (min/inch)	Infiltration Rate (in/hour)	Infiltration Class
<3	>20	Very rapid
3-10	6-20	Rapid
10-30	2-6	Moderately rapid
30-100	0.6-2	Moderate
100-300	0.2-0.6	Moderately slow
300-1000	0.06-0.2	Slow
1000-40,000	0.0015-0.06	Very Slow
>40,000	<0.0015	Impermeable

### Bulk Density (Compaction)

Soil bulk density is a measure of weight per unit volume. Compaction of soil occurs when particles are pressed together reducing overall pore space. Soil compaction is caused by tilling and heavy axle loads when soils are wet. In general axle loads greater than 10 tons cause compaction below 12 inches. Soil organic matter plays an important role in reducing compaction – by promoting better soil particle aggregation and increased porosity and infiltration. For loam and silt loam soils, bulk density less than 1.40 (g/cm<sup>3</sup>) and 1.30 (g/cm<sup>3</sup>) are considered ideal. Bulk densities higher than ideal may affect root growth.

Soil texture	Ideal bulk densities (g/cm <sup>3</sup> )	Bulk densities that may affect root growth (g/cm <sup>3</sup> )	Bulk densities that restrict root growth (g/cm <sup>3</sup> )
Sands, loamy sands	<1.60	1.69	>1.80
Sandy loams, loams	<1.40	1.63	>1.80
Sandy clay loams, loams, clay loams	<1.40	1.6	>1.75
Silts, silt loams	<1.30	1.6	>1.75
Silt loams, silty clay loams	<1.40	1.55	>1.65
Sandy clays, silty clays, some clay loams	<1.10	1.49	>1.58
Clays (>45% clay)	<1.10	1.39	>1.47

## **Soil Slaking (Aggregate stability)**

Soil slaking is the process of aggregate disintegration occurring when aggregates are suddenly immersed in water. Repeated tillage causes fragmentation of soil aggregates into finer particles. In addition, the loss of organic matter causes decline in aggregate stability. Soil aggregates that fall into the classes 0 to 3 are relatively unstable and subject to erosion and crusting.

## **Results and Discussion**

The sites selected throughout NE Iowa used tillage practices ranging from conventional tillage to long-term no-till. At each site, measurements were replicated 3 times and averaged for the site. In addition, a reference site representing an undisturbed soil was located in the same soil type in order to measure soil quality attributes in a somewhat “virgin” setting. Due to lack of native prairie sites, most reference sites were located along old fence lines.

There was a positive trend in soil quality attributes as tillage was decreased. Most of the no-till sites showed a 2- 3-fold increase in infiltration versus conventional sites. Soil respiration rates were also on a positive trend as tillage decreased. This can be attributed to greater macro-pore space and less crusting. Compaction or bulk density measurements at no-till sites were either equal or very close to measurements at the reference sites, although none of the sites had a severe compaction problem that would inhibit root growth. Water filled pore space (WFPS) ideally should be around 60% for optimum root growth. WFPS above 80% indicates possible higher bulk density, less respiration and a condition that could result in anaerobic environment. The last measurement was the slaking test, which measures aggregate stability or how resistant the soil is to disintegration and erosion forces. Greater aggregate stability is positive for respiration, infiltration, and resistance to compaction. Again the trend was positive for no-till, with slake ratings greater than 5. Ratings for the conventional and conservation tillage sites varied more, with roughly half above 3 and half in the unacceptable 0-3 range. Furthermore, slake ratings for no-till sites were generally comparable to the ratings for their corresponding reference site, while ratings for conventional and conservation tillage sites were more likely to be below those for their corresponding reference sites.

This research will continue for the next 2 years on the same sites. We want to look at the effects of transitioning to no-till and the variability of measurements over time.