

2. Soil Respiration Test

For efficient sampling, the soil respiration test is performed first, followed by the infiltration test (Chapter 3) without removing the 6-inch diameter ring. The best time to run the soil respiration test is when soil moisture is at field capacity (the amount of water the soil can hold after drainage). Otherwise, soil respiration should be measured before and after the infiltration measurement or soil wetting (6 to 24 hours after wetting).

Materials needed to measure respiration:

- **6-inch diameter ring**
- **lid with rubber stoppers**
- **hand sledge and wood block**
- **soil thermometer**
- **two sections of plastic tubing**
- **2 needles**
- **Draeger tubes**
- **140 cc syringe**
- **stopwatch or timer**

Did You Know?

Soil breathes! Soil respiration is an indicator of biological activity (i.e., microbial and root), or soil life. This activity is as important to the soil ecosystem as healthy lungs are to us. However, more activity is not always better; it may indicate an unstable system (i.e., after tillage).

Considerations: Microbial activity is greatest when the soil is moist (at or near field capacity). If the soil is dry, a second respiration measurement should be made at a minimum of six hours (preferably 16 to 24 hours later) after the infiltration test or wetting of the soil. If the soil is saturated, soil respiration is inhibited, and this test should not be run.

① Drive Ring into Soil

- Clear the sampling area of surface residue, etc. If the site is covered with vegetation, trim it as close to the soil surface as possible.
- Using the hand sledge and block of wood, drive the 6-inch diameter ring, beveled edge down, to a depth of three inches (line marked on outside of ring) **Figure 2.1.**
- If the soil contains rock fragments, and the ring can not be inserted to depth, gently push the ring into the soil until it hits a rock fragment. Measure the height from the soil surface to the top of the ring in centimeters (cm). [See note below]



Figure 2.1

NOTE: For a more accurate measurement of soil respiration, the chamber head-space should be measured. Inside the ring, take four measurements (evenly spaced) of the height from the soil surface to the top of the ring, and calculate the average. Record average on the Soil Data worksheet.

② **Cover Ring with Lid and Wait** 

- Cover the ring with the lid as depicted in **Figure 2.2** and note the time.
- Wait exactly 30 minutes* (to allow CO₂ to accumulate in the chamber).

[If this is the SECOND respiration measurement, briefly remove the lid and replace it before timing to allow the release of gases that have built up over the 6-24 hour waiting period. Proceed with Step 3.]



Figure 2.2

***NOTE: During the 30-minute wait, other tests such as Bulk Density (Chapter 4) can be run.**

③ **Insert Soil Thermometer**

- Insert the soil thermometer into the soil adjacent to the ring with lid (about one inch away from ring and one inch deep). If the thermometer can easily be inserted into the rubber stoppers, insert it into one of them to a 1-inch depth into the soil.

④ **Assemble Draeger Tube Apparatus**

- Assemble the Draeger tube apparatus just before the end of the 30-minute wait.
- Connect a needle to one of the sections of tubing.
- Break open **both** ends of a CO₂ Draeger tube, either by using the hole at the end of the syringe handle as depicted in **Figure 2.3**, or by clipping the tube ends with a finger nail clipper.
- Connect the Draeger tube to the **other** end of the needle's tubing. The arrow on the side of the Draeger tube should point **away** from the needle.
- With the second piece of tubing, connect the Draeger tube to the syringe as shown in **Figure 2.4**



Figure 2.3



Figure 2.4

5 **Insert Apparatus Needle into Stopper**

After 30 minutes, insert the Draeger tube apparatus needle into a stopper as shown in **Figure 2.5**. Insert a second needle into one of the other stoppers on the lid to allow air flow into the head space during the gas sampling. The second needle should be inserted just before the head space is sampled.



Figure 2.5

6 **Draw Head Space Sample**

Over a 15-second span, draw the syringe handle back to the 100 cc reading (1 cc = 1 mL) as shown in **Figure 2.5**. [If the reading is less than 0.5%, take four additional 100 cc samples of the head space through the same Draeger tube. To do this, disconnect the tube from the syringe to remove the air, and reconnect the tube to the syringe. Take another 100 cc sample. Repeat.]

7 **Record Soil Temperature and % CO₂**

On the Soil Data worksheet, record the temperature in Celsius at the time of sampling. On the Draeger tube, read the "n=1" column if 100 cc was sampled or the "n=5" column if 500 cc was sampled. The % CO₂ reading should be an estimate of the highest point that the purple color can be easily detected. Enter this reading on the Soil Data worksheet. In the example in **Figure 2.6**, the reading would be approximately 0.75%.




Figure 2.6

8 **Remove Lid**

Remove the thermometer, Draeger apparatus needle, air flow needle, and the lid from the ring.

If this is the **first** respiration measurement, leave the ring in the soil for the **infiltration measurement** (Chapter 3).

Maintenance Tips: Seal any holes in the chamber lid that may cause leakage. Also to prevent leaks, replace the stoppers in the lid if they become worn or loose.



CALCULATIONS:

$$\text{Soil Respiration (lb CO}_2\text{-C/acre/day)} = \text{PF} \times \text{TF} \times (\% \text{CO}_2 - 0.035) \times 22.91 \times \text{H}$$

PF = pressure factor = 1

TF = temperature factor = (soil temperature in Celsius + 273) ÷ 273

H = inside height of ring = 5.08 cm (2 inches)