

Mesocosm Installation for N Fixation in Switchgrass

Carmella Vizza and Sarah S. Roley

School of the Environment, Washington State University, Tri-Cities

Abstract:

Stainless steel mesocosms are installed in plots of the KBS LTER Interactions Experiment to measure N fixation rates on minimally-disturbed switchgrass under field-relevant conditions. To install mesocosms, soil is excavated using a backhoe and the bucket contents are separated by soil horizon; mesocosms are placed in the excavated pits, leveled, and then filled-in by soil horizon while ensuring proper infiltration and accounting for settling.

Note: Soil depths and horizons given in the protocol are specific to KBS and are based on the Kalamazoo soil series; they will vary depending on site and across plots.

Materials:

- Spade shovels (1 shovel per person)
- Tarps (2 for 2-person crew, 4 for 3- or 4- person crew)
- 5-gallon buckets (2 for 2-person crew, 4 for 3- or 4- person crew)
- Rake
- Hedge trimmer with charged 20 V battery
- Scissors for plant trimming
- Meter sticks and meter tape (1 for 2-person crew, 2 for 3- or 4- person crew)
- Water-based spray paint and flags for marking
- Dead blow hammer
- Mesocosms (0.5 m long by 0.5 m wide by 0.76 m deep)
- Backhoe with 9" bucket (23 cm with ~17,000 cm³ holding capacity)
- Sand tamper
- Level
- Pea gravel
- Fiber glass window screen
- Clipboard and pencil
- Datasheets on write-in-the-rain paper
- Straps for backhoe (necessary for removal of mesocosm only)

Procedure:

1. If plot is not harvested, trim switchgrass to a harvest height of 6" or less using hedge trimmer and/or scissors. Trim the surrounding area as well so the person operating the backhoe can see.
2. Mark off a 70 cm by 70 cm square area that includes several switchgrass clumps using water-based spray paint. The switchgrass in the interaction plots is not as mature as other areas, so be sure to locate at least a couple of good-sized clumps. The total area of the clumps should be at least 0.25 m² or half of the area of the mesocosm. For efficiency, the plot should be larger than the mesocosm to avoid too much hand digging. The backhoe will naturally create a more rectangular plot with longer dimensions along the digging axis.



3. Place a tarp to the immediate right and left of the plot within range of the backhoe. To maximize power and maneuverability, the front of the backhoe should be about 2 m away from the center of the intended mesocosm area.
4. With the first scoop of the backhoe, remove the switchgrass root clump, which is about a 15-20 cm intact layer, and set it on the first tarp. The root clump will most likely have to be helped into the bucket. Record depth of hole and dimensions of switchgrass clump (if using a single large clump).



5. The second scoop will contain soil up to 30 cm in depth. Set it right next to the first scoop on the tarp. Record depth. The Ap layer (0-30 cm) of the Kalamazoo series is a loam characterized by 40% sand and generally higher levels of carbon and nitrogen. Try to keep this layer as separate as possible.



6. The third and fourth scoops will contain soil up to 40-45 cm in depth; the color will change where clay and sand are more common. Place each scoop next to the other in succession on the tarp. Try to keep the top soil layers as separate as possible. Record the depth of each scoop to inform filling process. The E layer (30-41 cm) is a loam characterized by 40% sand but has less organic matter available than the Ap layer.
7. Once you hit the Bt1 layer, record depth and switch to the other tarp. The Bt1 layer (41-69 cm) is a sandy clay loam characterized by 50% sand. Record the depth of this transitional layer and keep it separate, but once sand dominates in the 2Bt2 layer, all future scoops can be combined. The 2Bt2 layer (69-88 cm) is a sandy loam characterized by 80% sand. There is a deeper 2E/Bt layer (88-152 cm) characterized by pure sand, but we are unlikely to reach this layer because the mesocosm is only 76 cm deep.



8. With backhoe dig to a depth of about 80 cm. Placing the mesocosm into the pit will require some digging with a spade shovel. Make the edges of the pit square and ensure that there is room for the mesocosm's beveled edges. Test out depth with mesocosm.



9. To help ensure a perfect fit, tamp the soil down inside the pit. Then, with at least 2 people, manually lift the mesocosm into the pit. The lip of the mesocosm needs to be about 4 cm above the ground's surface, because it will sink farther into the ground as it is filled in. Use a level and dead blow hammer to make sure the mesocosm is level with the ground's surface.



10. Place 1-2 layers of fiberglass window screen in the bottom and then fill with 3 cm of pea gravel to ensure proper filtration throughout mesocosm.



11. An initial trial showed that approximately 10 cm of settling occurred after simulating a big rain or snow melt by dumping buckets of water into a filled-in mesocosm which completely saturated the soil and maxed out infiltration. To account for settling, the switchgrass clump/soil crown is built up 10 cm above the mesocosm and to ensure each soil layer is represented proportionally, the depth of each layer is increased using a scaling factor of 1.14, which is 83 cm (depth of mesocosm – pea gravel depth + settling depth) divided by 73 cm (depth of mesocosm – pea gravel depth).



12. Begin filling mesocosm with 2Bt2 soil. First put about 10 cm of the 2Bt2 layer in the mesocosm and pack it with the sand tamper to hasten any settling. Do this successively for each 10 cm of soil added until the depth of the 2Bt2 layer multiplied by the scaling factor is reached.
13. Put about 10 cm of the Bt1 layer in the mesocosm and pack it by hand. Do this successively for each 10 cm of soil added until the depth of the Bt1 layer multiplied by the scaling factor is reached.
14. Repeat step 13 successively for the remaining E and Ap layers. For the Ap layer, leave room for the switchgrass clumps.
15. Finally place the switchgrass clumps on top so that the crown is built up to approximately to the settling height of 10 cm.

16. Fill in around the surrounding clump with top soil from the Ap layer as needed. Build it as tall as the root clump. Reserve some Ap soil in a bucket in case settling and erosion of the root clump's surrounding top soil occurs.
17. Then fill in the space between the pit and mesocosm with the remaining soil starting with the sandy layers at the bottom and working up. No need to be as fastidious with the layering here, but make sure to start with sand at the bottom and there is top soil at the mesocosm's surface. Build up the surrounding soil 4 cm above the surface so that it is flush with the mesocosm.



18. Using remaining soil to fill in divets from the backhoe or to build up surrounding areas of mesocosms within the same plot.