



IBI Technical Bulletin #101

Quick tests to determine whether a biochar material contains compounds that are potentially harmful to plants

Biochar can be made from a wide variety of feedstocks and under a wide variety of conditions, yielding a wide variety of potential product characteristics. Not all biochars are suitable for soil application as supplied. This Technical Bulletin covers two rapid tests that can be used to assess the presence of toxic compounds in biochar:

1. Germination Test and
2. Worm Avoidance Test.

1.0 Germination test

Methodologies for germination tests are widely available. Basically, the goal is to determine whether adding biochar to soil has an effect on seed germination. It is assumed that a negative effect indicates the presence of undesirable compounds in the biochar material. Lettuce (*Lactuca sativa* L.) is the most widely recommended species to use, due to its sensitivity (US EPA 1994). Other species that could be used include radish (*Raphanus* L.) and clover (*Trifolium* L.). Here are recommended steps:

If possible, use soil from the experimental location where the field trial will take place. If soil from the trial area is not available, use another kind of soil. Remember that the same soil must be used in both the container with biochar and the one without.

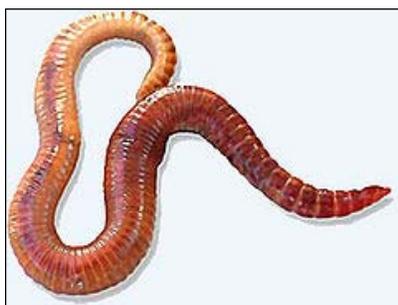
1. Obtain two containers with a dish-like shape. These can be plastic lids with a relatively high side, plastic or ceramic plates, etc.
2. In one container, place a given amount of soil (measure it out with a cup or other tool).
3. In the other, place the same amount of the same soil mixed with your biochar material. The rate of mixing of the biochar can be calculated to simulate the rate you intend on applying in the field, or you can use a ½ and ½ mixture if you don't plan to apply biochar uniformly to soil (but rather in planting holes, for example). In any case, you will have the same volume of soil or soil/biochar mixture in each container.
4. Spread the same number of seeds on the surface of the soil in each container. You must use many seeds (20 or more per container), since many seeds might not germinate under any circumstance, and to make sure you get a representative sample.
5. Place the containers in a location where good conditions for seed germination occur: normal room temperature is most important. Moisten the soil in each container and make sure it doesn't dry out. Placing a clear plastic bag around the containers helps to prevent drying out.
6. Check the containers daily for germination. Once significant germination is observed, count the number of seeds that germinated in each container. Don't wait too long to do this, as seedlings might become entangled and will be harder to count.
7. Compare the number of germinated seedlings in the containers with and without biochar, to see if there are differences. You might want to redo the test to convince yourself of the result. Having several replicates of each treatment (with and without biochar) would be even better.

2.0 Worm avoidance test

This is a more complex test, since it requires live worms to complete. However, it may be more sensitive than a germination test with plant seeds. A common type of worm used for this test is the white worm (*Enchytraeus albidus*). It is widely used as a live aquarium fish food and can be bought where aquarium supplies are sold, or on the internet. Alternatively, worm species *Eisenia fetida* and *Eisenia andrei*, commonly known as redworms, brandling worms, "tiger worms" and red wiggler can be used. Both species are used for vermicomposting and can be obtained from various suppliers.

Here are steps to follow for the test:

1. Obtain a flat container as described above. A round container would be best in this case. A diameter around 10 cm is ideal.
2. Cut a piece of cardboard or plastic sheeting, so that it will fit along the diameter of your container and to the bottom to split it in half. This will be used to physically separate the soil and soil/biochar mixture during test preparation and when looking for results.
3. Place the separator in the container. Using a pen or marker, mark the position of your separator on the edge of the container so you can insert it again at the same place later. In one half, place soil only, and in the other, the soil/biochar mixture. See instructions in #1 and #4 above. Again, use the same amount of soil on each side of the separator. The soil on both sides should be equally moist but not saturated. Beware of watering the soil after removing the separator, as mixing of the two sides might occur.
4. Remove the separator, and place 10 worms along the line where the separator was.
5. Place the container in an area where normal room temperature is maintained. To avoid drying, you may cover the container with a vented lid or plastic bag with holes in it.
6. After 48 hours, place the separator in the same position as before. Thoroughly observe the soil and count the number of worms on each side of the separator. If the worms have avoided the side of the container where biochar was applied, then the biochar should not be applied to soil without further investigation. Again, repeating the test more than once and/or using several replicates will give more conclusive results.



Redworm



White worms

Note: A standardized methodology for this test is available from the International Organization for Standardization (ISO 17512-1:2008), and can be downloaded from the internet for a fee.