

Decomposition study using tea bags

A method to study soil quality

Large amounts of plant biomass are degraded back to their basic mineral components in the soil. To investigate how fast and complete this degradation occurs, there is a simple method. Green tea decomposes fast in the soil, rooibos tea is more difficult to degrade. Comparing the degradation of these two tea types allows the calculation of the *tea bag index*. This provides information on the capability of the soil to transform organic residues into nutrients for plants and to build soil humus. The technique is simple to use. Bury tea bags of those 2 tea types and leave them in the soil for 3 months to see how much is left. During this time, the hardworking little helpers in the soil will release nutrients from the tea to feed the nitrogen-fixing root nodules of a new generation of plants.



Teatime for soil organisms

After photosynthesis, decomposition in the soil is the second most important ecological process. Photosynthesis of plants produces biomass from CO₂, water, minerals and solar energy. Nature recycles these substances. Animals feed on it, excrete some of it again, and in the end soil organisms decompose the remains of the plants' biomass, but also

of dead animals, leaving behind the minerals that support plant growth.

Tea bags, which are made of non-biodegradable nylon mesh, provide a very convenient tool for studying the decomposition of plant material in the soil. The tea leaves are degraded over time by soil organisms. This reduces the mass of the tea. Therefore the weight loss is a measure of the decomposition by the soil organisms. The tea bags contain a relatively uniform organic material and are produced under standardised conditions. For the study, two different tea varieties, rooibos and green tea, are used.

Green tea decomposes quickly, while soil organisms are slow to decompose rooibos tea. Using these two different types of tea, makes it possible to compare the rates and stabilisation factors of decomposition between fields and soils. This approach is part of a global study of geoclimatic effects on decomposition.



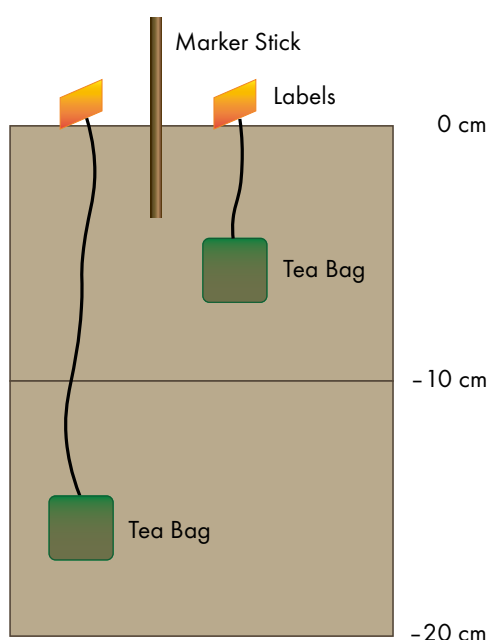
In biologically active soil, soil organisms decompose tea faster than in soil of poor quality.

Investigation method

Keuskamp et al. (2013) had the idea to use tea bags. Instead of sewing litter bags for their experiments themselves, they tested non-biodegradable nylon tea bags. In this way, they found a simple and affordable method that anyone can use without much effort or technology.

You too can observe how the tea is broken down into its basic elements in your own field, garden, flower pot or compost pile.

Figure 1: Analysis of decomposition in two soil layers



Thanks to the ease of implementation, the decomposition of the 2 tea varieties is followed as well in a global study: www.teatime4science.org.

If you want to compare your data with others, you should choose certain types of tea. If you choose others, they may contain variable proportions of flavoring flowers or even flavours, depending on the manufacturer. Also the recommended tea bags can vary depending on the origin and mixture of the raw materials. However, the tea must be enclosed in non-degradable nylon bags – a cellulose bag would degrade as would the tea.

The tea bags may be dirty after being buried for so long in the soil, which will affect the weight of the tea bag. Soil particles must be removed as best as possible before weighing the tea bag. For correct results and accurate scientific studies, the tea is burned at the end of the experiment, which is a big part of the work.

Materials needed

- Green tea: Lipton Green tea bag, product number EAN 87 10908 90359 5
- Rooibos tea: Lipton Rooibos tea bag, product number EAN 87 22700 18843 8
- Permanent marker
- Shovel
- Stick or twig
- Drying oven (max. 60 °C)
- Ceramic crucible
- Muffle furnace (600 °C)
- Scale with an accuracy of 0.000 grams

Simple procedure

Weigh 5 tea bags each of green and rooibos tea, including the label and the string.

- Number the labels with a permanent marker.
- Record the starting weight.

Dig an 8 cm deep hole, disturbing the soil as little as possible.

- Place the tea bags in it side by side, but leave the label on the soil surface.
- Mark the location well so you can find it later.
- Make a note of the date and location.

Excavate the tea bags after 90 days.

- Remove any soil that has adhered and carefully dry the tea bags in the sun.
- Weigh the tea bags after drying.
- Record the final weight.

Elaborate procedure

Weigh 5 tea bags each of green and rooibos tea, including the label and the string.

- Number the labels with a permanent marker.
- Record the starting weight.

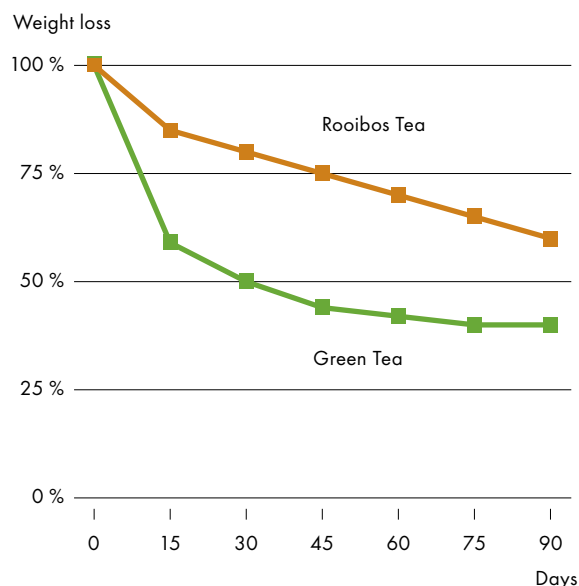
Dig an 8 cm deep hole, disturbing the soil as little as possible.

- Carefully make 5 holes of 8 cm depth with 20 cm spacing, e.g. with a 30 mm auger drill. Do not compact the soil and keep the disturbance as low as possible.
- Bury the two tea types in pairs at a depth of 8 cm.
- You can also investigate the degradation at several soil depths (see Figure 1, page 2).
- Fill the hole with the soil.
- Keep the labels visible on the soil surface.
- Mark the location with a stick.
- Note the date, geographic location (GPS or field map), and important site information like soil type, crop, fertiliser, fertiliser use and tillage.

Excavate the tea bags after 90 days. In warmer climates, this time may be shorter. Note the date and any additional information.

- Remove any adhering soil and carefully dry the tea bags in the sun or at a maximum of 60 °C in the oven.
- Weigh the tea bags after drying.

Figure 2: Decomposition process of green and rooibos tea in soil over 90 days.



To account for the additional weight of the soil in the tea bag, open each bag and pour the contents into a separate ceramic crucible. Heat the crucibles for 4 hours at 600 °C in a muffle furnace.

- Weigh the crucibles with tea before (A) and after (B) combustion and record the weight. When doing this, make sure that the tea is completely dry before burning.
- Also burn a few original tea bags (C).

The difference (A) minus (B) plus (C) is the weight of the soil in the tea bag.

More ways to test soil quality with tea bags

The simplest method is to leave the tea bags in the soil for 90 days and then weigh them. But to study the biological activity of your soil you need a comparison or reference. For example, you can compare a site that has reduced plant growth to a site where plants are growing normally. Similarly, you can compare your lawn to a vegetable patch, a recently ploughed field to a no-till field, etc.

Please provide your results to [teatime4science: www.teatime4science.org](http://teatime4science.org).

Different soil depths, seasonal effects, process steps

- You can investigate different soil depths for their degradation potential (see Figure 1).
- You can test seasonal effects by examining the degradation of the tea at different times of the year.
- You can test the decomposition process in more detail by removing the bags from the soil after defined storage times (see Figure 2).

Interpretation of the results

After 90 days, the tea leaves have darkened and lost their original structure. How much weight and structure the tea loses depends on the different soil conditions: dry, wet, cold, warm, compacted or well-structured.

The loss of structure depends on the woody fibre content of the tea

The two types of tea decompose at different rates. Green tea decomposes fast in the first 2 weeks. Rooibos tea has a more woody structure that is more difficult for soil organisms to decompose. Therefore,

even after 3 months, rooibos still shows its original shape and the decomposition process is not yet complete.

The weight loss of the tea indicates the biological activity of the soil

Depending on the activity of your soil and the organisms living in it, the tea may have lost about 50 % of its original mass after 3 months in the soil.

The more material is lost, the more active are the soil organisms that break down organic material.

What conclusions can be drawn?

Do you have problems with plant growth in certain areas? Perhaps one of the reasons is poor soil quality, as evidenced by delayed decomposition of the tea bags. Compare the decomposition of the two types of tea in the problem area with those from an area where the plants grow normally.

The *tea bag index* calculation can be used as a tool to evaluate management or treatment effects such as effects from pesticide and fertiliser, or drought and flooding.

Scientific studies use the degradation of tea bags as an indicator of soil health. Likewise, the tea bag method can also be used to develop other sophisticated test systems and soil analyses: such as an analysis of the soil organisms in the tea bags or an analysis of the biochemical composition of the tea residue after 3 months.

References

Keuskamp J.A., Dingemans B.J.J., Lehtinen T., Sarneel J.M., Hefling M.M. (2013): Tea Bag Index: a novel approach to collect uniform decomposition data across ecosystems. *Methods in Ecology and Evolution* 4, pp. 1070-1075.

Further Information

For more information on the Tea Bag Index and how you can provide your own data for the global study, visit www.teatime4science.org.

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Fertility Building Management Measures in Organic Cropping Systems - FertilCrop is a project funded CORE Organic Plus Funding Bodies, being partners of the FP7 ERA-Net project CORE Organic Plus. The overall aim of FertilCrop is to develop efficient and sustainable management techniques aimed at increasing crop productivity in organic farming systems. More information about FertilCrop is available at www.fertilcrop.net.

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