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An automated setup to investigate the $^{12/13}CO_2$ evolution of soils or by soil additive degradation via Cavity Ring-Down Spectroscopy (CRDS)

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In many countries, the application of soil additives is regulated by law. For example, according to the amendment of the German law in 2013 regulating possible additives for soils (Düngemittelverordnung), additive manufacturers have to approve their complete biodegradability in the future. The investigation of soil decomposition processes via the measurement of gaseous CO_2 evolution through microbial respiration is a well known method to confirm biodegradability. Combined with C-labelled soil additives as microbial substrates, degradation can be monitored and separated from non-labelled substrates. The only prerequisite is, that a certain part of the additive has to be degraded gaseous. For isotopic labelling stable or unstable (radioactive) isotopes can be used. If stable isotopes like ^{13}C are used, the investigations are cost effective and secure. Furthermore no specific training for the people operating the setup is required as compared to the use of radioactive material.

A new automated setup for the investigation of the biodegradability has thus been developed using commercially available and in house manufactured components. By using microcontroller technique the setup is able to analyze 24 soil samples in parallel, but in general more sample lines can be added. The gas measurement is performed as a so called closed chamber method. Each soil sample is stored in a temperature regulated glass bottle connected to a valve interface and continuously vented by a membrane pump. During measurements the 3/2-way valves are switched, so the venting of the bottles is interrupted and the CO_2 increase is monitored per bottle every 30 min over a 2 hour period. Closer time and sampling frequency is depending on the activity of soils. Pressure compensation is realized through a tube and the atmospheric dilution in the bottle is mathematically compensated for. Gas samples are analyzed using a cavity ring-down spectroscope (Picarro Inc., Sunnyvale, CA, USA). In opposite to commonly used spectroscopic methods like FTIR spectroscopy, this type of analyzer is able to measure the $^{13}CO_2$ and $^{12}CO_2$ concentrations distinctly at relatively low costs. Thus the decomposition of ambient and added carbon sources can be distinguished via their specific CO_2 evolution.

The automated setup as well as first results will be presented. These results show, that it is possible to divide the whole generated CO_2 amount into its subfractions and thus to demonstrate the biodegradation of the ^{13}C labelled additive. In general, the method presented can be used to detect differences in decomposition rate for all soil components that differ in the isotopic $^{13/12}C$ composition.