Integrated Assessment of the Bio-preparations and Organic Fertiliser Effect on Soil Properties

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Introduction

The permanent and intensive use of soil for agricultural production changes natural soil processes and soil properties. In order to maintain soil fertility, it is necessary to implement timely human-managed soil improvement technologies. Soil improvement can be done using biological products and organic fertilisers. In crop production, biological preparations are used for different purposes, aiming at increasing the productivity of agricultural crops and improving soil properties. After spraying of biological preparations in the field, organic colloids in the soil forms. It changes soil temperature, which is affecting plant germination and yield (Jakiene et al., 2013). Another important factor is soil respiration, which depends on different soil properties, crop residues, depth of incorporation, decomposition, soil tillage, climatic conditions and other factors such as soil organic carbon, fertilisation systems and crop rotation (Carbonell-Bojollo et al., 2011; Buragiene et al., 2015). Air and soil temperatures influence the intensity of soil microorganism activity and, at the same time, determine the intensity of global warming causing CO2 emissions in the atmosphere (Buragiene et al., 2015). However, there is a lack of knowledge about the effect of biological preparations and their mixtures with organic fertilizers on the soil temperature, electrical conductivity, CO2 emissions, humidity, hardness, bulk density and porosity. Integrated assessment is a useful tool for the complex evaluation of different measures effect on multiple soil properties.

Material and method

Experiments were performed in 2015–2016 at the Experimental Station of Aleksandras Stulginskis University (54°53’ N, 23°50’ E) in Lithuania. This study aimed to investigate the influence of biological preparations and organic fertiliser (slurry) on soil properties and CO2 emissions from soil. The soil at the experimental site Calc(ar)i-Endohypogleyic Luvisol. Treatments of the experiment: 1) soil without measures application (Control); 2) soil with biological preparation application (Bio1); 3) soil with slurry application (S); 4) soil with slurry and biological preparation application (SBio2). Timing of soil properties measurements: 1) after measures application (beginning of experiment); 2) after 2 months (in autumn); 3) after 7 months (in spring); 4) after 14 months (in autumn). Experiment was carried out in three replications. Biological preparation Bio1 was used for the soil activation and composting, Bio2 – for aerobic conversion of slurry. The soil temperature and electrical conductivity was measured using Delta-T HH2 Moisture Meter, CO2 emission rate with ADC BioScientific LCpro+ System, soil hardness assessed using Eijkelkamp Penetrologer, moisture – by oven drying, soil bulk density – by field inspection vane tester, and porosity using Air Pycnometer. Integrated assessment of different soil properties performed based on G. Weinschenk et al. (1992), G. Lohmann (1994) and K. U. Heyland (1998) methodology, according to the formula:
where $EC_i$ is the evaluation score of a certain value for a given indicator; $X_i$ – certain value of a given indicator, $X_{max}$ – max value of a given indicator; $X_{min}$ – min value of a given indicator.

**Results and discussion**

Usually the impact of different treatments on soil properties is considered separately, without being integrated into assessment system. Therefore, it is difficult to assess which factor has the highest effect on the soil. This problem can be solved using the integrated assessment method. In order to transfer the values which are expressed in different units to one scale, EC of a certain values for various indicators were calculated. 1 point corresponded to the minimal value, 9 – for the highest value. All other values for the same indicator calculated according to the formula (1). Indicators recalculated into EC depicted in diagram (Fig. 1). The scale also shows the average value of individual indicators – an assessment threshold of 5 points. The efficiency of the treatment reflects the limited area of all its values expressed in EC.

**Figure 1:** Integrated assessment of soil properties. Integrated Assessment Index (IAI) consists of the average score, the standard deviation of the scores and the standard deviation of the scores that are below the assessment threshold.

Integrated assessment showed, that soil CO$_2$ emission, soil temperature, electrical conductivity, moisture and hardness were less influenced by biological preparations and slurry used, but soil bulk density, and especially total and air-filed porosity were influenced more. The soil bulk density in the soil treated with slurry and Bio1 were lower than in control and total and air-filed porosity were higher.

**Conclusion**

Integrated assessment is a useful tool for the complex evaluation of different treatments effect on multiple soil properties. Integrated assessment showed, that soil CO$_2$ emission, temperature, electrical conductivity, moisture and hardness were less influenced by biological preparations and slurry, but soil bulk density, and total and air-filed porosity were influenced more.

**References**