Exogenous Organic Matter Amendments

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Exogenous organic matter (EOM) is defined as the whole of the OM that is introduced into the soil in order to improve its fertility, quality and the potential of the land for non-agricultural use. EOM includes a very wide range of biowastes from various sources.

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1.Introduction

One of the most important soil components, which is closely related to the activity of microorganisms, is soil organic matter (SOM). SOM consists of all organic substances originating from living organisms in different phases of decomposition. The sources of organic matter in soil are mainly the dead parts of plants and animals, microorganisms and metabolites produced during their growth and decomposition, as well as humic compounds [1]. Microorganisms play an irreplaceable, crucial role in the decomposition of organic matter and the global cycle of elements, and they are involved in the breakdown of complex organic compounds into compounds, which are simple and more easily absorbed by plants. Organic matter (OM) is a key relevant factor responsible for the physical, chemical and biological properties of soil. The content of OM in agricultural soils is gradually decreasing as a result of its intensive use [2]. It is estimated that during the postindustrial era (since 1850) under the influence of cultivation and soil erosion on a global scale 42–78 gigatonnes (Gt) of carbon have already been lost [3]. Even a small loss of SOM may result in the deterioration of soil structure and decreases in soil quality. Furthermore, maintaining resources of OM at an appropriate level is important not only due to the production function of soils, but also due to the role of soil in the sequestration of carbon dioxide from the atmosphere, thereby contributing to a reduction in the greenhouse effect [2].

2. Specifics

Exogenous organic matter (EOM) is defined as the whole of the OM that is introduced into the soil in order to improve its fertility, quality and the potential of the land for non-agricultural use [4][5]. EOM includes a very wide range of biowastes from various sources [6]. Sources of EOM include: natural fertilizers (manure, slurry), post-harvest residues, green manures, composted materials from industrial and municipal waste, municipal and industrial waste (sewage sludge, digestate from biogas plants) or waste of animal origin (animal meal) [7][8]. These materials are characterized by different physical and chemical properties, different composition of the microbiome, differing humification rates and the abilities to produce soil organic matter. Recycling biowaste as an organic fertilizer gives an opportunity to decrease disposal at landfill, and also to reduce greenhouse gas emissions [9][10].

The annual production of biowaste in the European Union is estimated at 1.6 billion tons, of which 61% is waste produced by animal breeding, 25% originates from plant residues, 7% is industrial waste and 7% is municipal waste (sewage sludge, biowaste, plant waste). Despite such a large production of biowaste, the most common of all of the organic materials introduced into the soil (97%) is manure and slurry, with only a minor contribution made by industrial waste (2%) and sewage sludge (1%) [11]. The addition of OM to the soil beneficially affects the degree of aggregation and compaction, water infiltration and water-retention capacity, volumetric density as well as the resistance of the soil to water and wind erosion [12][13][14][15][16]. It is commonly known that the use of plant residues, manure and composts obtained from organic waste causes an increase of SOM, which in turn may have a positive effect on crop yields through direct nutrient supply or indirectly through the modification of soil physical properties [17][18]. SOM plays one more important function, influencing on the microbial biomass carbon (MBC) [12]. For this reason, it is necessary to conduct research concerning the impact of different types of EOMs on the functioning and properties of soil. Assessing the impact of various types of EOM amendments should be carried out on the basis of short and long-term experiments to determine the physical, chemical and biological properties of the soil.

The addition of OM may have an great influence on soil productivity, the availability of nutrients and processes associated with the mineralization of organic compounds [19][20]. Organic wastes, which are used as soil additives constitute a source of energy for microorganisms, and also cause changes in their diversity and activity [21][22]. An assessment of the effect EOM additives on soil microbiome diversity may be performed on the basis of genetic, metabolic and enzymatic activity assays [19][23] the results of which may be used as an indicator of the shifts that occur due to the influence of applied waste [24][25]. Unfortunately, the use of organic waste as a soil fertilizer also carries a certain risk as well as producing significant benefits. Organic fertilizers have been used for a relatively long period of time, but new types of waste are still being produced, for example digestate [26], which requires appropriate levels of control and monitoring. The recently development of laboratory techniques, including molecular biology methods, allows for the detailed analyses of the microbial properties of organic waste. Furthermore, the range and types of potential EOM risk depend on the characteristic raw material from which they were prepared. The main threats resulting from EOM application are: (i) chemical pollution: heavy metals, pesticides, polycyclic aromatic hydrocarbons (PAHs), phthalates, volatile organic compounds, phenolic compounds [26][27]; (ii) contamination with pathogenic and phytopathogenic microorganisms and toxins [19]; (iii) an unbalanced proportion of C and N [26]. All of these threats have given rise to the necessity to conduct detailed research monitoring the impact of applied EOM on soils suitable for agriculture. The assessment of soil biological activity as well as the genetic and functional diversity of the soil microbiome is an important approach in the context of shifts occurring in the soil environment and it could also be a biological indicator of its ecological status [22][28][29].

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