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The durability of biodegradable water absorbing geocomposites

ABSTRACT

The issues concerning water scarcity, soil fertility decline and environmental pollution have received increasing attention in recent years. These phenomena involve many negative effects in agriculture and environmental engineering, where selected plant species serve as biotechnical insurance for earth structures. Developing new technologies in line with sustainable development is one of the methods to tackle these adverse effects and adapt to climate change. Given the specific problems that have been identified and current trends, the properties and effectiveness of an innovative technology in the form of a biodegradable water-absorbing geocomposite (BioWAG) were explored. BioWAGs are developed to store water in the soil to make it available to plants.

The aims of this doctoral dissertation were as follows: (1) to analyse the biodegradability in real-life conditions of selected BioWAG element materials and (2) to assess the potential of using BioWAG to support vegetation of selected grass species. In the course of field and laboratory tests, the physico-chemical properties of selected BioWAG elements were identified, plant material was also characterised, and selected soil parameters were determined.

The findings confirm the research hypothesis, proving that the use of biodegradable materials in the form of natural fibre-based nonwoven waste materials enables their gradual biodegradation in the soil with the simultaneous promotion of the vegetation of selected grass species. The research shows that waste fibres such as wool, jute and linen are characterised by suitable physical and chemical properties and represent an attractive material for the production of BioWAG. An increased soil fertility was noticed on the BioWAG sites. BioWAG had a positive impact on the vegetation of selected grass species for three growing seasons, boosting aboveground growth by up to 430% and the root system by up to 220% when compared to control sites.

The findings presented serve as a good reason to implement a solution that reduces the amount of irrigation and fertiliser necessary for the proper development of the selected grass species, while also considering the concept of circular economy and sustainability.

Keywords: biodegradable water absorbing geocomposite, natural fibres, sustainable technologies, vegetation support, climate change adaptation, circular economy