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The Influence of Various Agrotechnical Approaches on the Growth of Miscanthus Hybrid in Soil Contaminated with Trace Metals

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Abstract

Miscanthus plant establishment in the field may suffer as a result of natural pollution and climate change. This is especially important because biomass can be produced on uncultivated land without harming food crops. The chosen hybrid, the cultivation method, the climatic conditions, and the concentration of pollutants in the soil all have an impact on establishment success. During the first growing season and after the first winter, there are a number of ways to increase the chances that the plants will survive. Utilizing biochar and photodegradable plastic mulch, both of which have the potential to be a solution for polluted soils containing trace elements (TMEs), is one of them. For two Miscanthus hybrids planted by rhizome (TV1) and seedling plugs (GNT43) on soils contaminated with trace metal elements (Pb, Cd, and Zn), the purpose of this study was to investigate the application of plastic mulch and biochar separately and in combination at the planting stage. TV1 is not suitable for TME-contaminated field cultivation, as the survival rate was below 60% in the majority of the treatments studied. The survival rate did not rise with the chosen treatments. This parameter was significantly reduced when biochar and plastic mulch were combined, regardless of the hybrid under investigation. Pb and Cd in GNT43 were significantly higher in all treatments, but applied agrotechnology had no effect on TME accumulation in TV1's aboveground plant parts. During establishment on TME-contaminated soil or after the first growing season, neither biochar nor plastic mulch applied separately nor in combination increased survival or decreased the accumulation of toxic TMEs.

Keywords: Plantation Establishment; Biochar; Plastic Mulch; Cadmium

Introduction

Climate change has an impact on miscanthus varieties, making it one of the greatest threats to the establishment of perennial plants. is an excellent option for growing on uncultivated land where food production is either impossible or unprofitable due to other issues like polluted soil, poor soil quality, and waterlogging, even in the face of climate change. is thought to be a crop for energy. It has been reported that this plant's TMEs may be used for phytoremediation in addition to phytoextraction. Field tests on such contaminated soils have demonstrated that crops should be used for the phytostabilization process rather than phytoextraction in mature plantations due to the low concentration of TMEs in the aboveground biomass. Inappropriate establishment alongside susceptible varieties can result in significant financial losses when the plantation grows again in subsequent years. CO2 sequestration and storage in below-ground organs are the responsibility of this perennial grass that is native to Asia [1]. This risk is especially high in relation to a number of Miscanthus hybrids that investigated the advantages and disadvantages of various methods of Miscanthus propagation, such as directly sowing seeds, micropropagation, stem-derived plants, and rhizome planting. Because rhizome-derived plants have the highest survival success (>85%) and overwintering rate, the rhizome-derived plant technique and direct seeding were the most important propagation methods being studied at the time. However, the multiplication factor of seed propagation is the highest and the least expensive of the examined methods. The first method has many issues, including a slow rate of multiplication, sensitivity to water scarcity, spring frosts, and low germination rates in the field. proposed an alternative to direct sowing and micropropagation in which the seed is grown first in a greenhouse before being transferred to the field, where it is more likely that the seedlings will successfully adapt to the conditions of the field [2-5]. Regardless of the species, variety, annual or perennial type, the most common abiotic stressors for plant establishment are temperature and water availability. For energy crops grown on marginal soils, pollutants like polycyclic aromatic hydrocarbons (PAHs), trace metal elements (TMEs), and deficiencies in nutrients are additional stressors that may result in a cross-reaction in the plants. The application of transparent polymer photodegradable mulch films has been found to shorten the time it takes for newly seeded rhizome-based Miscanthus plants to reach mature biomass yields as well as their establishment and growth rates. This is one approach to circumventing the difficulties with endurance that Miscanthus plants initially encounter due to a lack of water or spring ice. Further. Reported that despite no increase in germination, direct seeding of Miscanthus reduced overwintering plant failure [6].

Properties of plants and soil

Soil samples were taken from each plot prior to planting. Soil samples were collected from various plot segments for the purpose of analysis and utilized as the foundation for the creation of additional spatial maps. The middle of each plot served as the analysis's sampling points. The soil's physicochemical parameters were measured on the material that went through a 2 mm sieve [7]. The pH of the soil at 20°C in H2O (ratio 1:2.5 m/v) and KCl was measured with a pH meter (CPC-551, Elmetron, Gliwice, Poland) and a combined glass/calomel electrode (OSH 10-10, METRON, Gliwice, Poland). The

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electrical conductivity (EC) was measured using an ESP 2ZM electrode (EUROSENSOR, Gliwice, Poland) in accordance with the Polish standard. The hydrometric method was utilized to evaluate the soil's texture in accordance with the Polish standard [8-10].

Conclusions

The studied Miscanthus hybrids' highly hybrid-dependent survival rates were significantly influenced by the specific planting method. In comparison to the seed-based GNT43, which had a survival rate of over 90% in the most effective treatment, which was the control for both hybrids, the TV1 planted with rhizomes had a lower survival rate (about 60%) and was characterized by weaker growth (height and number of stems). The agrotechniques used to speed up establishment were the opposite in this experiment. Regardless of hybrid, the treatment with biochar and plastic mulch resulted in the greatest number of plant losses. TV1 and GNT43 had identical element concentrations after the first growing season, but GNT43 had significantly higher concentrations of Pb and Cd than the control. Biochar and plastic mulch applied separately or in combination did not decrease the accumulation of toxic TMEs during establishment on contaminated soils or increase the survival rate, contrary to published research on uncontaminated soils. However, Miscanthus, particularly GNT43, grows extremely well with low offtakes once established. Because there are no other options, these slightly contaminated areas should be expanded with Miscanthus hybrids. To determine how Miscanthus hybrids establish in the first year after planting on difficult soils contaminated with TMEs, additional research employing a variety of methods is required. It is necessary to commercially develop agronomic innovations for various nations' slightly contaminated soils.

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