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Short Communication

Findings in Soilless Growth Media for the Identification of Microbiological Communities and Naturally Occurring Radionuclides: The Effects of Bio-char on Pepper and Tomato Growth and Productivity in Fertilised Soilless Media at Various Bio-Char Concentrations were Investigated

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Abstract

The pyrolysis of plant materials to produce bio-char has the potential to promote plant growth in soilless media. The effects of bio-char amendments on soilless growth media, the makeup of the microbial community, and the fate of chemical constituents in the media are all, however, poorly understood. This study used meta-genomics and gamma spectroscopy to investigate the chemical components of the microbial composition and soilless media after adding various quantities of bio-char to each (Barns SM et al., 2007).

Under ideal fertigation circumstances, the effects of additions (1–5% by weight) of a nutrient-poor, wood-derived bio-char on pepper (Capsicum annuum L.) and tomato (Lycopersicum esculentum Mill.) plant development and production were studied. When compared to the unaltered controls, pepper plant development in the bio-char-treated pots was significantly improved. Most measured plant metrics, including leaf area, canopy dry weight, number of nodes, and yields of buds, flowers, and fruit, all increased across the board as a result.

Along with the observed improvements in plant growth and production, pepper plants supplemented with bio-char also had significantly larger abundances of culturable microorganisms from well-known soil-associated groups in their rhizospheres. Based on 16S rRNA gene analysis, phylogenetic analysis of unique bacterial isolates revealed that 16 of the 20 isolates from the char-amended growing mix's roots and bulk soil were connected to previously documented plant growth-promoting and/or bio-control agents.

Keywords: Soilless media, Bio-char, Pepper, Plant growth promotion, Bio-char, radioactivity, Thermal stability, Pyrolysis

INTRODUCTION

To minimise net greenhouse gas emissions and diversify energy sources, there is a global push to provide inexpensive energy from renewable resources. Due to its availability, high energy value, and adaptability, biomass outperforms many other renewable energy sources. However, due to substantial inputs of fossil fuels for agricultural production, much first generation biofuel production—i.e., ethanol from sugar and starch crops and biodiesel from oil crops—in temperate regions is nearly totally carbon positive. Therefore, there is ongoing interest in creating second and third generation biofuels that are at least carbon neutral and maybe even carbon negative (Suriya J et al., 2016).

Over the past 55 years, the use of soilless substrate as a plant growth medium has garnered significant interest on a global scale. Individually, in combination, and with additional ingredients like fertilisers, soilless substrates made of organic (peat, compost, coir, bark, and wood fibre) and inorganic (Rockwool volcanic rock, tuff, expanded clay granules, vermiculite, zeolite, and pumice) materials have been used. Peat has always been the main component of container agriculture. Recent worries about its financial burden and environmental effects, however, have led to the adoption of renewable organic materials as replacements (Kumar V et al., 2017).

A carbon-rich charred organic material called bio-char is produced by pyrolyzing waste biomass in the absence or with very little oxygen. A lot of research has been done on adding bio-char to conventional or mineral soil, including reviews and studies. The physicochemical characteristics of bio-char are influenced by the kind of biomass used, the pyrolysis temperature, and the storage conditions. By raising soil pH to enhance soil fertility, altering soil bulk density, and enhancing organic C and cation exchange capacity, bio-char affects the physicochemical parameters of soil. Water retention in the soil, better nutrient retention to boost crop output, and changed microbial populations and activities in the soil are further advantages of bio-char. Bio-char's resistance to microbial decomposition has been noted; this controls the amount of carbon dioxide (CO2) that is released into the atmosphere to slow down climate change (Ventura M et al., 2007).

The amount and activity of microorganisms in soil are influenced by a variety of environmental conditions, including temperature, moisture content, and organic matter. The microbial populations in the soil are essential for the uptake of nutrients. Because of their sensitivity to abiotic changes, soil quality, and plant cover, microbial communities are regarded as key biological indicators of stress in terrestrial ecosystems. It's important to comprehend how microbial community diversity and composition relate to environmental factors. By adding bio-char to the soil, it is possible to change and improve the structure and activity of the vital microbial population (Lee SH et al., 2008).

The causes and implications of global population growth, fixed land area, and Agriculture land degradation has been discussed elsewhere. Anthropogenic activities are changing the natural land cover of the world into ecosystems that are controlled by people. According to reports, there were around 13 million hectares of natural land cover. Every year between 2000 and 2010 was changed to different land uses. Though as a Potential soilless-bio-char mitigating method for agricultural land degradation worldwide interest in agricultural amendment systems is growing.

DISCUSSION

Our findings reveal trends that characterise the microbial abundance of the Proteobacteria phylum in the bio-char modified growth medium, notwithstanding the complexity of ambient microbial ecosystems. Proteobacteria have been shown to be consistently abundant in several examined sites, and their relative abundance was high when compared to other bacterial phyla, independent of the amount of bio-char added to the growth media. Proteobacteria are known to aid in nutrient uptake and disease defence while also encouraging plant development. Therefore, in an agricultural context, a low relative abundance of Proteobacteria can have a significant impact on the health of the medium and plant productivity. Proteobacteria have a significant part in the carbon cycle, which is compatible with their high abundance due of the high carbon content in bio-char (Lugtenberg B et al., 2009).

It is necessary to do additional study to comprehend how bio-char soil additions affect plant growth promotion. The majority of research to date has been on the direct or indirect effects of bio-char on plant nutrition. Here, we show that bio-char amendment has a favourable influence on plant response for two crops (pepper and tomato) in a well-structured soilless growing medium, with no function for bio-char in terms of direct or indirect impacts on nutrient content, soil physical characteristics, or water holding capacity. Therefore, it is clear that other mechanisms have a significant impact on the bio-char's reported stimulatory effect, sometimes known as the "charcoal effect." There are two potential explanations for this phenomenon: either the bio-char stimulated the growth of advantageous microorganisms that facilitated plant growth, or the chemicals in the bio-char directly induced beneficial plant responses. Studies are now being conducted to determine the possible role of isolated microorganisms and compounds found in bio-char in stimulating plant growth and inducing disease resistance in these settings.

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