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Reduced Tillage and Bio-stimulant Application Can Improve Soil Microbial Enzyme Activity in a Dryland Cropping System

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Abstract : Amongst other things, tillage and synthetic agrochemicals can be effective methods of seedbed preparation and pest control. Nonetheless, frequent and intensive tillage and excessive application of synthetic agrochemicals, such as herbicides and insecticides, can reduce soil microbial enzyme activity. A decline in soil microbial enzyme activity can negatively affect nutrient cycling and crop productivity. In this study, the effects of four tillage treatments; continuous mouldboard plough; shallow tine-tillage to a depth of about 75 mm; no-tillage; and tillage rotation (involving shallow tine-tillage once every four years in rotation with three years of no-tillage), and two rates of synthetic agrochemicals (standard: with regular application of synthetic agrochemicals; and reduced: fewer synthetic agrochemicals in combination with bio-chemicals/or bio-stimulants) on soil microbial enzyme activity were investigated between 2018 and 2020 in a typical Mediterranean climate zone in South Africa. Four different bio-stimulants applied contained: Trichoderma asperellum, fulvic acid, silicic acid, and Nereocystis luetkeana extracts, respectively. The study was laid out as a complete randomised block design with four replicated blocks. Each block had 14 plots, and each plot measured 50 m x 6 m. The study aimed to assess the combined impact of tillage practices and reduced rates of synthetic agrochemical application on soil microbial enzyme activity in a dryland cropping system. It was hypothesised that the application of bio-stimulants in combination with minimum soil disturbance will lead to a greater increase in microbial enzyme activity than the effect of applying either in isolation. Six soil cores were randomly and aseptically collected from each plot for microbial enzyme activity analysis from the 0-150 mm layer of a field trial under a dryland crop rotation system in the Swartland region. The activities of four microbial enzymes, β-glucosidase, acid phosphatase, alkaline phosphatase and urease, were assessed. The enzymes are essential for the cycling of glucose, phosphorus, and nitrogen, respectively. Microbial enzyme activity generally increased with a reduction of both tillage intensity and synthetic agrochemical application. The use of the mouldboard plough led to the least ($P<0.05$) microbial enzyme activity relative to the reduced tillage treatments, whereas the system with bio-stimulants (reduced synthetic agrochemicals) led to the highest ($P<0.05$) microbial enzyme activity relative to the standard systems. The application of bio-stimulants in combination with reduced tillage, particularly no-tillage, could be beneficial for enzyme activity in a dryland farming system.

Keywords : bio-stimulants, soil microbial enzymes, synthetic agrochemicals, tillage
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