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Vermicompost Leachate Alleviates Deficiency of Phosphorus and Potassium in Tomato Seedlings

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Abstract*. As a result of the growing concerns about the adverse effect of chemicals on the environment, agricultural practices involving organic and environmental-friendly compounds are gaining acceptance globally. Tomatoes remain one of the most popular and widely grown vegetable crops. However, their growth requires a high supplement of nitrogen–phosphorus–potassium (NPK) fertilizer. The effectiveness of vermicompost leachate (VCL) as a potential replacement for the three elements (N, P, and K) during the growth of greenhouse tomatoes was evaluated. Morphological appearance of the tomato seedlings was remarkably enhanced when Hoagland's nutrient solution (50%) was supplemented with VCL (1:10 v/v). In the absence of both P and K, the addition of VCL significantly ($P = 0.05$) increased various growth parameters such as shoot length, leaf number as well as shoot and root fresh weight compared with the control tomato seedlings. The detrimental effect of N deficiency on the growth of tomato seedlings was not alleviated with the addition of VCL to the nutrient solution. The photosynthetic pigment content in P-deficient and VCL-supplemented tomato seedlings was significantly higher than the untreated control. The presence of VCL alleviated the detrimental effects caused by deficiency of P and K during the growth of the tomato seedlings. Overall, the use of VCL was beneficial with either complete nutrient solution or in the absence of P and K. Findings of this study suggest that VCL could serve as a potential substitute for P and K deficiency.

The human population is continuously increasing and by the year 2050, the global population is projected to be 50% larger than the current figure. The available natural resources such as arable land and water required to support the human race are limited. To further worsen the situation, most of the soils in sub-Saharan African countries are characterized by low organic matter content and low fertility coupled with essential macro- and microelement deficiency. Thus, there is a need for efficient use of the available land and water for sustainable agricultural production (Tilman et al., 2002; Welch and Graham, 1999). Inevitably, the nutrient-deficient soils need to be supplemented with fertilizers to promote growth and yield of major crops to curb possible food shortages. Besides, intensive high-yield agriculture production depends on the application of fertilizers, especially industrially produced ammonium and nitrate (Lyson, 2002; Tilman et al., 2002). In most developing countries, however, the inorganic fertilizers are expensive and not easily accessible to many small-scale farmers (Welch and Graham, 1999). Furthermore, an increase in the use of inorganic fertilizers for improved crop production has been linked to increased health hazards to humans and livestock as well as causing severe environmental problems such as water and soil pollution, which are generally considered detrimental (Alam et al., 2007).

Good agricultural practices determine the level of food production and, to a great extent, the state of the global environment (Lyson, 2002). The use of sustainable agricultural practices that entail the conservation of resources and the environment remains a viable option to increase agricultural product output (Lazcano et al., 2011). Consequently, scientists are continuously exploring means of improving crop yield and quality without compromising environmental integrity or public health (Lockie et al., 2002; Sangwan et al., 2010; Tilman et al., 2002). Recently, there has been an increase in demand for such naturally derived agroproducts for sustainable farming systems (Campitelli and Ceppi, 2008; Suthar, 2010).

Reliance on organic nutrient sources is an essential characteristic of organic farming. For instance, the use of organic fertilizers, in the form of vermicompost, is one such practical example of a compound used for sustainable agricultural farming (Alam et al., 2007; Gutiérrez-Miceli et al., 2008). Vermicomposts including their leachates, teas, and other extracts are produced by the activity of earthworms from a wide range of organic wastes (Gutiérrez-Miceli et al., 2008; Ievinsh, 2011; Padmavathiamma et al., 2008; Wang et al., 2010). They are products of non-thermophilic biodegradation of complex organic waste resources into peat-like humus, which are finely divided and odorless (Arancon et al., 2003; Sangwan et al., 2010). There is rising acceptance of vermicompost as a result of numerous benefits derivable from their use as plant growth media and soil ameliorants (Bachman and Metzger, 2008; Tomati et al., 1990; Wang et al., 2010). Recently, the positive effect of soil drenching with vermicompost leachate on the growth of greenhouse-grown 'Williams' bananas was demonstrated (Aremu et al., 2012).

Globally, tomato is recognized as one of the most popular and widely grown vegetable crops. It is easily grown in greenhouses, responds well to the application of fertilizers, and is known to be a heavy consumer of N–P–K fertilizer (Hebbar et al., 2004). Different approaches have been geared toward improving the growth of tomatoes (Lammerts van Bueren et al., 2011; Roosta and Hamidpour, 2011; Sato et al., 2006). The current study evaluated the effects of vermicompost leachate drenching treatments on the growth of tomato seedlings under greenhouse conditions as a potential replacement of essential macroelements such as N, P, and K. The effect of vermicompost leachate on growth parameters and its influence on the photosynthetic pigment contents were evaluated.

Materials and Methods

The experiments were conducted using commercial seeds of tomato (*Lycopersicon esculentum* Mill. 'Heinz-1370') purchased from McDonald's Seed Company, Pietermaritzburg, South Africa. VCL was obtained from Wizzard Worms, Rietvlei, KwaZulu-Natal, South Africa. Hoagland's nutrient solution (50%) was used for the experiment (Hoagland and Snyder, 1933). Three other test solutions were prepared by eliminating N, P, or K from the Hoagland's nutrient solution. On 27 Jan. 2012, three tomato seeds were sown at a depth of 1 cm in each pot (100 mL) containing perlite as a substrate. Thereafter, pots were regularly watered for 3 weeks for raising seedlings. Subsequently, a single seedling was retained in each pot by uprooting the other two seedlings. Each treatment had 10 pots with four replicates

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