DOCTORAL THESIS

Interaction of earthworms and microorganisms on nutrient availability and crop growth

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Interaction of Earthworms and Microorganisms on Nutrient Availability and Crop Growth

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ABSTRACT

The present study aims to investigate the influence of earthworms and soil microorganisms on soil nutrient availability and plant growth.

The effects of applying pig-on-litter compost (POL) and vermicomposts derived from *Pheretima* spp. (VP) and *Eisenia fetida* (VE) on plant growth were compared. Germination of *Brassica parachinenesis* was promoted in all vermicompost-amended pots; with the highest germination rate in the 30% of the vermicompost produced by *E. fetida*. A poorer seedling growth was observed in the POL compost-amended pots than the control pots. The biomass of vermicompost-contained pots increased significantly (by 100% to 200%) over those grown in the control.pots This was due to the fact that more nutrients were available after the addition of vermicompost for plant uptake. It was also noted that soil amended with VE had significantly higher numbers of microbes (bacteria and actinomycetes) and increased enzyme activities, e.g urease, phosphatase and dehydrogenase which resulted in more plant nutrients being available for plant uptake.

The growth of soil nutrient-promoted bacteria [free N-fixing bacteria (NFB), P-solubilizing bacteria (PSB) and K-solubilizing bacteria (KSB)] were significantly stimulated by inoculation of earthworm castings. Inoculation of casting extracts resulted in 30% increase in NFB growth. Similar effects were also observed in the growth of PSB and KSB. This was probably due to the fact that castings consisted of energetic and easily metabolizable compounds, providing favorable physio-chemical conditions for microbial growth.

Inoculation of either nutrient-promoting bacteria (NFB, PSB or KSB) or earthworms (*Pheretima* spp.), as well as their combination had a significant effect on nutrient (N, P or K) transformations. The addition of earthworms and bacteria resulted in substantial accumulations of mineral N, available P and K in soil thus increasing the amount of bioavailable nutrients for plant uptake.

The introduction of nutrient-promoting bacteria (NFB, PSB and KSB) and earthworms exert beneficial effects on nutrient cycling and plant growth synergistically, with improved shoot yields when compared with control. Dual inoculation of different bacteria and earthworms (PSB+worms and KSB+worms) increased nutrient availability (available-P and K) contents increased by 80% and 90%, respectively), and enzymatic activities (urease and acid phosphatase activities increased by 66% and 62%, respectively) and plant growth increased by 40 to 75%. The performance of microbial inoculation was significantly enhanced with the introduction of earthworms.

The combined effects of root nodule bacteria (*Rhizobium* sp.), P-solubilizing bacterium (*Bacillus megaterium*), mycorrhizal fungi (*Glomus intaradices*) and earthworms (*Eisenia fetida*, Savigny) on the growth of soybean (*Glycine max* L. Merr) were assessed. Maximum mycorrhizal root colonization (17%) was observed in the treatment receiving VAM fungi and earthworms without organic amendment suggested that earthworms promoted the dispersal of fungi in soil. The introduction of earthworms also contributed a higher shoot yield, due to improved soil fertility. The combined inoculation of the three organisms, i.e. earthworms, mycorrhizal fungi (VAM) and PSB, was able to release more available P in soil. Adverse effects were observed on root VAM colonization after application of organic matter. Dual-inoculation of earthworms and VAM or earthworms and PSB or VAM and PSB performed better than inoculating all three organisms, suggesting that there might be other factors affecting the interaction, e.g. feeding habits of earthworms. It is therefore important to study the associated effects of these microorganisms. This may provide the basis for a new technology

employing earthworms to disperse beneficial microorganisms in soil.

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