International Journal of Farming and Allied Sciences
Available online at www.ijfas.com
©2014 IJFAS Journal-2014-3-3/333-338/ 31 March, 2014
ISSN 2322-4134 ©2014 IJFAS

Effect of vermicompost on plant growth and its relationship with soil properties

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ABSTRACT: Vermicomposts are rich in microbial populations and diversity, particularly fungi, bacteria and actinomycetes. The continued use of chemical fertilizers causes health and environmental hazards such as ground and surface water pollution by nitrate leaching. Compost refers to organic constituents, usually wastes, that have been mixed, piled, and moistened and undergo thermophilic decomposition that alters or decomposes the original organic materials. Many studies have demonstrated the effectiveness of vermicompost inproviding protection against various plant diseases.

Keywords**:** yield, microbial activity, plant diseases

INTRODUCTION

Non-conventional sources of amending organic matter status of soil are acquiring much attention because of their easy availability, prompt response and feasibility in using over large area in less time. Excessive use of inorganic fertilizers creates environment related problems, and situation can be improved through the use of bio-fertilizers (Saadatnia and Riahi, 2009). Vermicomposts are finely-divided mature peat-like materials with a high porosity, aeration, drainage and water-holding capacity and microbial activity which are stabilized by interactions between earthworms and microorganisms in a non-thermophilic process (Edwards and Burrows, 1988). Vermicompost contains most nutrients in plant available form such as nitrates, phosphates and exchangeable calcium and soluble potassium (Edwards, 1998; Orozco, 1996). Vermicompost have large particulate surface areas that provide many micro sites for microbial activity and for the strong retention of nutrients (Shi-wei and Fu-Zhen, 1991). Vermicomposts are rich in microbial populations and diversity, particularly fungi, bacteria and actinomycetes (Edwards, 1998; Tomati, 1987). Due to their different production processes, compost and vermicompost might exhibit different physical and chemical features which might influence plant growth and morphology in diverse ways. Generally, after vermicomposting the organic material is ground up to a more uniform size which gives the final substrate a characteristic earthy appearance while the resulting material after composting has normally a more heterogeneous appearance (Ndegwa and Thompson, 2001; Tognetti, 2005). The use of compost in horticulture has shown to be occasionally limited by the high electrical conductivity and the excessively high amount of certain ions causing phytotoxicity (García-Gómez, 2002) as a consequence of the chemical properties of the initial waste and/or inadequate operation processes. These adverse effects, although possible, are less likely to occur when vermicompost is used as potting amendment (Chaoui, 2003). The continued use of chemical fertilizers causes health and environmental hazards such as ground and surface water pollution by nitrate leaching (Pimentel, 1996). So, reducing the amount of nitrogen fertilizers applied to the field without a nitrogen deficiency will be the main challenge in field management. One of the possible options to reduce the use of chemical fertilizer could be recycling of organic wastes. Compost as the organic waste can be a valuable and inexpensive fertilizer and source of plant nutrients. Positive effects of organic waste on soil structure, aggregate stability and water-holding capacity were reported in several studies (Jedidi, 2004; Odlare 2008; Shen and Shen 2001; Wells, 2000). Furthermore, compost has a high nutritional value, with high concentrations of especially nitrogen, phosphorus and potassium, while the contamination by heavy metals and other toxic substances are very low (Asghar, 2006). Zende, (1998) reported increased yields of sugarcane after amending soils with vermicomposts at rates of 5t/ha together with 100% of the recommended application rate of inorganic fertilizers. Mulberry (Muros sp) growth increased after amending soils with vermicomposts applied at rates of 10t/ha together with 100% of the recommended application rates of inorganic fertilizers to soils (Murakar, 1998). Flowering of China aster (Callistephus chinensis L.) increased when it was grown in soils amended with 10 t/ha vermicomposts, produced from farm manures, together with 100% of the recommended application rate of inorganic fertilizers. (Nenthra, 1999). Previous studies showed that the combination of compost with chemical fertilizer further enhanced the biomass and grain yield of crops (Sarwar, 2007; Sarwar, 2008; Cheuk, 2003). Furthermore, positive changes have been reported in the quality of wheat flour, because of increasing the amount of gluten after compost treatment (Gopinath, 2008). Further, several examples in the literature show that compost and vermicompost are able to enhance the growth of a wide range of plant species further what can be expected because of the supply of nutrients (Edwards, 2004; Grigatti, 2007). In the intermountain region of the Pacific northwest, much of the manure produced becomes compost. Compost refers to organic constituents, usually wastes, that have been mixed, piled, and moistened and undergo thermophilic decomposition that alters or decomposes the original organic materials (Soil Science Society of America 1997). To ease waste disposal, many local dairy owners compost manure, then recycle the compost as bedding for their cows. In many areas, landscapers, home gardeners, horticulturalists, and others prize compost (Richard 2005). DeLuca and DeLuca (1997) compared the nitrogen (N), phosphorus (P), and potassium (K) concentrations in composted manure with fresh manure and feedlot manure. The compost, and the processes used to produce it, have been described in detail (Richard 2005, Keener, 2000). Maheswarappa, (1999) reported increased amounts organic carbon, improvements in pH, decreased bulk density, improved soil porosities and water-holding capacities, increased microbial populations and dehydrogenase activity of soils in response to vermicompost treatments. Mycorrhizal colonization (Cavender, 2003), microbial activity (Domínguez, 2004) and suppressiveness of soilborne plant pathogens (Hoitink and Boehm, 1999; Szczech, 1999; Szcech and Smolinska, 2001; Scheuerell, 2005; Noble and Coventry, 2005; Termorshuizen, 2006) have shown to be enhanced through the addition of compost and vermicompost to a potting media or as a soil amendment. Furthermore, biologically active metabolites such as plant growth regulators (Tomati and Galli, 1995; El Harti, 2001) and humates (Atiyeh, 2002; Canellas, 2002) have been discovered in vermicomposted materials. Compared to manure, compost contains few viable weed seeds, less water, and occupies 30 to 60% less volume, thus decreasing transportation costs (Richard 2005). Fallah, (2006) carried out an experiment and concluded that organic composts such as sewage and city waste compost and cow waste increase the yield and yield components of corn, so that there was a significant increase in leaf area index, plant height and 1000-seed weight and seed yield. Mohamadian and Malakouti, (2003) evaluated effects of two types of compost on characteristics of soil and yield of corn and reported that consumption of chemical compost together with organic compost led to higher yield in comparison with use of chemical compost alone.

Effect of vermicompost on micronutrients in field soils

Reddy and Reddy (1999) reported significant increases in micronutrients in field soils after vermicompost applications compared to those in soils treated with animal manures. In other experiments, amounts of soil nitrogen increased significantly after incorporating vermicomposts into soils (Sreenivas, 2000; Kale, 1992; Nethra, 1999) and the amounts of P and K available also increased (Venkatesh, 1998). The organic composts create less environmental pollution than chemical composts due to their positive biological effect and modification of physical and chemical characteristics of the soil because their nutrients are released slowly to be used by the plant (Roe, 1997).

Influence of vermicompost on the physic-chemical and biological properties of soil

The results of several long-term studies have shown that the addition of compost improves soil physical properties by decreasing bulk density and increasing the soil water holding capacity (Weber, 2007). Moreover, in comparison with mineral fertilizers, compost produces significantly greater increases in soil organic carbon and some plant nutrients (García-Gil, 2000, Bulluck, 2002, Nardi, 2004, Weber, 2007). The use of organic amendments such as traditional thermophilic composts has been recognized generally as an effective means for improving soil aggregation, structure and fertility, increasing microbial diversity and populations, improving the moisture-holding capacity of soils, increasing the soil cation exchange capacity (CEC) and increasing crop yields (Zink and Allen, 1998). Vermicompost contains most nutrients in plant-available forms such as nitrates, phosphates, and exchangeable calcium and soluble potassium (Orozco, 1996). Vermicompost has been shown to have high levels of total and available nitrogen, phosphorous, potassium (NPK) and micro nutrients, microbial and enzyme activities and growth regulators (Parthasarathi and Ranganathan 1999; Chaoui, 2003) and continuous and adequate use with proper management can increase soil organic carbon, soil water retention and transmission and improvement in other physical properties of soil like bulk density, penetration resistance and aggregation (Zebarth, 1999) as well as beneficial effect on the growth of a variety of plants (Atiyeh, 2002). Vasanthi and Kumarasamy (1999) who found significant increase in CEC of the soil treated with vermicompost plus NPK. Decreased pH wasobserved in the soils treated with enriched compost of industrial wastes, after harvest of ragi and cowpea (Srikanth, 2000). Vasanthi and Kumarasamy (1999) and Srikanth, (2000) where the incorporation of various enriched compost, vermicompost. Increased available NPK in the soils were observed where the soils were treated, respectively, with enriched compost from different organic wastes, FYM, vermicompost and vermicompost plus NPK after the harvest of rice, ragi and cowpea (Vasanthi and Kumarasamy, 1999; Srikanth, 2000; Sailajakumari and Ushakumari, 2002; Chaoui, 2003). have been shown to have increased OC content in the soil.Manure application is known to stimulate and improve stable soil structure, fungal and bacterial population and biological activity (Chaoui, 2003). The greater pore volume in earthworm casts and compost amended soils have been shown to

increase the availability of both water and nutrients to microorganisms in soils (Scott, 1996). In addition to the changes exerted on the chemical and physical properties, composted materials have a clear impact on soil biological properties, such as increases in microbial biomass and activity (Knapp, 2010), as well as changes in the activity of soil enzymes (Garcia-Gil, 2000, Ros, 2006) and in the structure of the soil microbial community (Ros, 2006). In arid and semiarid area in additionsto local factors in precipitation, soilsurface conditionsuch as soil characteristics, plant cover and topography are the most important factors in produced runoff. In this areas reside ualmoisture in soil has great roll in conjunction with run off.(Arsham, 2008). One of the most importantadvantagesof vermicompost, is buffering that prevents from phocilation while plant element adsorption.(Bawman and Rink, 1991). Water and soil researchers did a lot of studies on the effects of vermicompost on physical and hydraulic features of the soil and concluded that vermicompost by making soil structure spongy (Mirzaei, 2009), improves bulk and real density (Ahmadabadi, 2011), porosity (Matos and Arrunda, 2003), increases aggregate's stability and soil structure, and increases the rate of water penetration in the soil and aeration (Mahdavi damghani, 2007).

Effect of vermicompost on microbial activity

Although it has been shown that earthworms utilize microorganisms as their main source of nutrition (Edwards and Fletcher 1988), there are usually greatly increased numbers of bacteria, actinomycetes and fungi in freshly-deposited earthworm casts than in the surrounding soil (Edwards and Bohlen 1996). Such increases may be due to enhancement of microbial populations, occurring during passage through the earthworm's intestine; either because the food selected by the earthworm forms a richer substrate for microbial activity or because fragmentation of organic matter in the earthworm's gizzard increases the available surface area for microbial activity (Dkhar and Mishra 1986, and Tiwari and, Mishra 1993). There is also evidence of earthworms increasing the overall metabqlic activity of the microbial biomass in soils (Wolters and Jorgensen 1992, and Schindler-Wessels, 1996). There is considerable research evidence that earthworms can stimulate the microbial decomposition of organic matter significantly, both during the passage through the earthworm gut and in their casts, for some time after the casts are deposited (Scheu 1987, and Daniel and Anderson 1992).

Effect of vermicompost on plant diseases

Many studies have demonstrated the effectiveness of vermicompost inproviding protection against various plant diseases (Chaoui, 2002; Arancon, 2002). Various studies have demonstrated the effectiveness of vermicompost in providing protection against various plant diseases. In vermin composting the active component involved in the biodegradation and conversion process during composting is the resident microbial community, among which fungi play a very important role (Sparling, 1982; Wiegant, 1992). The protective effect increased in proportion to the rate of application of vermicompost, vermicompost lost its activity after heating, sterilized extract of vermicompost added to potato dextrose agar stimulated the growth of F.oxysporum. This result indicated that microbial population that was present in vermicompost played an important role in decreasing the soil borne diseases in plants (Szczech, 1988).

MATERIALS AND METHODS

This paper is a review of the literature search on ISI, Scopus and the Information Center of Jahad and MAGIRAN SID is also abundant. Search library collection of books, reports, proceedings of the Congress was also performed. All efforts have been made to review articles and abstracts related to internal and external validity.

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