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Suppression of insect pest populations and damage to plants by vermicomposts

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Abstract

The effects of commercial vermicomposts, produced from food waste, on infestations and damage by aphids, mealy bugs and cabbage white caterpillars were studied in the greenhouse. Vermicomposts were used at substitution rates into a soil-less plant growth medium, MetroMix 360 (MM360), at rates of 100% MM360 and 0% vermicompost, 80% MM360 and 20% vermicompost, and 60% MM360 and 40% vermicompost to grow peppers (*Capsicum annuum* L.), tomatoes (*Lycopersicon esculentum* Mill.) and cabbages (*Brassica oleracea* L.), in pots. Groups of 10 pots containing young plants were distributed randomly in nylon mesh cages (40 cm × 40 cm × 40 cm). Groups of 10 pepper seedlings in a single cage were infested with either 100 aphids (*Myzus persicae* Sulz.) or 50 mealy bugs (*Pseudococcus* spp.) per cage. Similar groups of tomato seedlings were infested with 50 mealy bugs per cage. Groups of four cabbage seedlings in pots in cages were infested with 16 cabbage white caterpillars (*Pieris brassicae* L.). Populations of aphids and mealy bugs were counted after 20 days and the shoot dry weights of peppers, tomatoes and cabbages were measured at harvest. Numbers of cabbage white caterpillars and loss in shoot weights were measured after 15 days. The substitution rates of 20% and 40% vermicomposts suppressed populations of both aphids and mealy bugs on peppers, and mealy bugs on tomatoes, significantly. Substitutions with vermicomposts into MM360 decreased losses of dry weights of peppers, in response to both aphid and mealy bug infestations, decreased losses in shoot dry weights of tomatoes after mealy bug infestations significantly. There were significantly decreased losses in leaf areas of cabbage seedlings in response to the cabbage white caterpillar infestations.

Keywords: Vermicompost; Aphids; Mealy bugs; Cabbage white; Caterpillars; Tomatoes; Peppers; Cabbage; Pest suppression

1. Introduction

Vermicomposts are stabilized organic soil amendments that are produced by a non-thermophilic process, in which organic matter is broken down through interactions between earthworms and microorganisms, under aerobic conditions. Vermicomposts have been demonstrated to be valuable soil amendments that offer a balanced nutritional release pattern to plants, providing nutrients such as available N, soluble K, exchangeable Ca, Mg, and P that can be taken up readily by plants (Edwards, 1998; Edwards and Fletcher, 1988). Because the breakdown of organic wastes by earthworms is a non-thermophilic process, vermicomposts have much greater microbial biodiversity and activity than conventional thermophilic composts (Edwards, 1998, 2004).

There is an extensive scientific literature (Buckerfield and Webster, 1998; Atiyeh et al., 2000a–d; Arancon et al., 2003a,b, 2004; Edwards and Arancon, 2004a,b) demonstrating that additions of low application rates of vermicomposts, into bedding plant container media in the greenhouse, or as amendments to field soils, improve plant growth and yields significantly, independent of nutrient supply. For instance, Atiyeh et al.

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(2000e) reported increases in the rates of germination, growth and yields of tomato plants, grown in a range of concentrations of a soilless commercial container medium MM360, that was substituted with a corresponding range of concentrations of pig waste vermicomposts. Subler et al. (1998) demonstrated improvements in the germination and growth of petunias, marigolds, bachelor buttons, poinsettias, bell pepper and tomatoes in response to similar vermicompost substitutions into bedding plant container media. The potential of vermicomposts to improve plant growth may be due to changes in the physico-chemical properties of soils, overall increases in microbial activity or to the effects of plant growth regulators produced by the micro-organisms.

Organic farmers have long claimed that plants grown with organic amendments are much more resistant to insect pests and diseases than plants grown with synthetic inorganic fertilizer amendments. This is supported by a scientific literature that provides evidence of suppression of specific insect attacks by various forms of organic amendments (Patriquin et al., 1995). For instance, reports have demonstrated that field applications of thermophilic composts can suppress attacks by insect pests such as aphids and scales (Culliney and Pimentel, 1986; Yardim and Edwards, 1998; Huelsman et al., 2000). Additionally, Biradar et al. (1998) showed that additions of vermicomposts to the medium in which *Leucaena lecocephala* was grown affected the extent of infestation by *Heteropsylla cubana*. Ramesh, 2000 reported that field treatments with vermicomposts decreased the occurrence of leaf miner, *Aproaerema modicella* on groundnuts.

The objectives of our investigations were to study the incidence of aphids (*Myzus persicae* Sulz.) and mealy bugs (*Pseudococcus* spp.) on tomatoes (*Lycopersicon esculentum* Mill.) and peppers (*Capsicum annuum* L.), and cabbage white caterpillars (*Pieris brassicae* L.) on cabbage (*Brassica oleracea* L.) in response to vermicompost substitution and to assess the damage caused by these pests. The experiment used a range of substitution rates of food waste vermicomposts, into a soilless plant growth medium (MM 360), compared with the same parameters on plants grown in Metro-Mix 360 only. We hypothesized that the vermicompost substitutions would provide resistance to insect attacks and decrease the extent of pest damage.

2. Methods

The experiments were conducted in the Biological Science Greenhouse at The Ohio State University, Columbus, Ohio in March 2003 and the experimental plants were tomatoes, peppers and cabbages. The growth medium was a soilless commercial greenhouse container bedding plant medium, Metro-Mix 360 (MM360), and the experiments involved substitutions of MM360 (Scotts, Marysville, OH) with one of two concentrations of a commercial food waste vermicomposts. The food waste vermicomposts used contained 1.3% N, 2.7% P and 9.2% K. MM360 is a preparation of vermiculite, Canadian sphagnum peat moss, bark ash, sand and has a starter nutrient fertilizer in its formulation.

Two tomato, pepper or cabbage seeds were sown into each 10 cm diameter pot, containing either 100% MM360, or 80% MM360 mixed with 20% vermicompost or 60% MM360 mixed with 40% vermicompost. Seedlings were thinned out to one seedling per pot seven days after transplanting. The vermicompost and pest treatments were: (1) Tomatoes or peppers grown in MM360 soilless growth medium (no pests); (2) Tomatoes or peppers grown in MM360 soilless medium (exposed to pests); (3) Tomatoes or peppers grown in a 20% food waste vermicompost and 80% MM360 mixture (exposed to pests); (4) Tomatoes or peppers grown in 40% food waste vermicompost and 60% MM360 mixture (exposed to pests).

Each experimental treatment, except for cabbage, involved 10 replicate pots for each plant species, confined in a single mesh cage. There were four experimental pest treatments in each cage for a total of 40 pots per pest species. The seedlings were raised in an insect-free environment for four weeks. In the fifth week, plants were arranged in groups of 10 pots, in mesh (0.2 mm aperture) cages 40 cm × 40 cm × 40 cm, on greenhouse benches. Batches of caged plants were placed on capillary mats for ease of watering under the mesh cages. Control plants were placed in similar cages without insect infestations, to use as a basis for the calculations of dry weight losses, for comparison with those of plants that were artificially infested with insects. The pest arthropods released into the cages were reared under controlled conditions (20 °C) in a greenhouse insectary.

Adult aphids (*Myzus persicae*) and mealy bugs (*Pseudococcus* spp.) and cabbage caterpillars (*Peiris brassicae*) were collected from the insectary. Each cage, containing either pepper or tomato plants, was infested with either 100 aphids or 50 mealy bugs. Cabbage seedlings were exposed to white cabbage butterflies (*Pieris brassicae*) in cages in glasshouse for four hours for egg laying. Young caterpillars were removed from the seedlings after three days except four young caterpillars left on each cabbage seedling, which were subsequently confined in similar cages in groups of four pots per cage, one seedling per pot, for each vermicompost/MM360 mixture, with four replicates of each pest treatment. After 20 days plant heights, leaf areas and dry shoot weights were measured and increases or decreases in these parameters were recorded and compared with similar parameters on non-infested plants. Numbers of adult aphids and mealy bugs were counted on each plant