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Vermicompost as a component in potting mixes for growth promotion in ornamental plants

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Abstract

Vermicomposts are very important in crop production as they contain biologically active substances such as plant growth regulators. Two experiments were carried out at Wageningen University in 2007 to determine the effectiveness of vermicompost in uptake of nutrients by plants. In the first experiment, seeds of water-cress ***(Lepidium sativum L.)*** *and lettuce (Lactuca sativa L.) were germinated using different concentrations of Indole Acetic Acid and Gibberellic Acid then, extracts of vermicompost, green waste compost, and course peat with different dilutions. In the second experiment, root initiation in mungbean cuttings was assessed at different concentrations of Indole Acetic Acid and different dilutions of the compost extracts. Increased concentrations of Indole Acetic Acid depressed root growth in watercress and mungbean, whereas increased Gibberellic Acid concentrations promoted shoot growth in lettuce. Compost extracts positively? influenced root and shoot growth in the three plant species especially without any dilution. In lettuce shoot and root length increased with decrease in dilutions of compost extracts; in watercress, root length increased more than shoot length in all dilutions; while root initiation in mungbean increased with increase in dilutions apart from peat extract. Peat extract was most effective on root initiation in mungbean while vermicompost was most effective in both lettuce and watercress root/shoot length formation. Results from this study suggest that vermicompost, green waste compost and peat may contain plant growth regulators. The effects of compost extracts on plant growth and development were attributed to plant growth hormones produced by microbial activity during compost and peat formation.*

Key words: *Vermicompost, ornamental plants, growth regulators, compost extract, hormones, compost.*

INTRODUCTION

With the progressive increase in the size of the world's population and the adoption of intensive animal husbandry production, large volumes of organic wastes produced all over the world are creating a serious disposal problem and a major source of environmental pollution. These wastes require large quantities of land for disposal, release odor and ammonia into the air, could contaminate ground water with pollutants, and might present a healthy risk (Inbar et al, 1993). However some form of treatment of these wastes can make them suitable for land application and for safe disposal into the environment (Atiyeh et al., 2000).

The ability of some earthworms to consume a wide range of organic residues such as sewage sludge, animal wastes, crop residues, and industrial refuse have been fully established (Mitchell et al., 1980; Edwards et al, 1985; Chan & Griffiths, 1988; Hartenstein & Bisesi, 1989). Vermicomposts are products of organic matter degradation through interactions between earthworms and microorganisms (Edwards, C. A Burrows I 1988). In the process of feeding, earthworms fragment the waste, enhance microbial activity and accelerate rates of decomposition leading to a humification effect through which the unstable organic matter is oxidized and stabilized, as in composting, but by a non thermophilic process (Inbar, Y et al 1993). The end product termed vermicompost is quite different from the parent waste material in that they contain nutrients in forms that are readily taken up by plants such as nitrates, exchangeable phosphorus, and soluble potassium, calcium and magnesium (Edwards et al., 1988; Orozco et al,.1996). In the process, there is alteration of physical and chemical properties of the material.

In various sources of organic matter, vermicomposts have been recognized as having considerable potential as soil amendments (Norman et al., 2005). Several researchers have examined the physical and chemical properties of vermicomposts and reported that vermicomposts are finely divided peat-like materials with high porosity, aeration, drainage, and water holding capacity (Albanell, E et al 1988). Vermicomposts also have a very large surface area, providing strong capacity to hold and retain nutrients. Compared to their parent materials, vermicomposts have less soluble salts, greater cation exchange capacity and increased total humic acid contents (Albanell et al., 1988).

Utilization of earthworms to break down organic wastes is gaining increasing popularity in different parts of the world. In biological properties of Dissolve organic matter (DOM), auxin (IAA) and gibberellic acid (GA)- like activities are important since indoleacetic acid and gibberellic acid are important in controlling the important growth stages like seed germination as well as plant adaptation to environmental stress (Pizzeghello et al., 2006). In addition; there is indication that auxin and gibberellin are acting independently in hypocotyls' elongation. Thus auxin, ethylene, and gibberellin each regulate hypocotyls' elongation independently (Clare et al., 2000).

There has also been a growing movement to decrease rates of inorganic fertilizer applications to soils by using soil nutrients more efficiently and by the increased use of organic matter. It is well established that earthworms have beneficial physical, biological and chemical effects on soils and can influence plant growth and crop yields in both natural and managed ecosystems (Edwards & Bohlen 1996). Normally using organic fertilizers is advantageous in that it involves nutrient recycling which is becoming an increasingly important element of environmentally sound sustainable agriculture. This involves return to the soil of essential elements that are taken up by plants and then find their way into animal domestic and industrial products. Such recycling not only reduces the need for additional fertilizer elements, but simultaneously provides organic matter and soil cover that are essential for sustainable agriculture (Brady, 1990). However farmers have been lacking useful and cost effective fertilisers which not only increase crop production but also amend and improve soil structure in a sustainable way.

The goal of this study was to understand the hormone like activities in vermicompost in comparison to other well known composts that have been in use for growth regulation in crop production.

MATERIALS AND METHODS

Experiment 1: Watercress & lettuce assays

The auxin and gibberellin-like activities of the composts/ peat extracts were assessed by checking the growth reduction of water-cress (*Lepidium sativum* L) roots and the increase in the length of lettuce (*Lactuca sativa* L.) shoots, respectively (Audus, 1972) but also shoot length in watercress and roots in lettuce were also observed. Watercress and lettuce seeds were surface sterilized by immersion in 1% sodium hypochlorite for 15 minutes. After rinsing three times with sterile distilled water, 10 seeds were placed on a sterile filter in a sterile petri dish. For the watercress, the filter paper was wetted with 1.2 ml of 1 mM CaSO4 (control); or 1.2 ml of 20, 10, 10, 1.0, 0.1 mgL^{-1} indoleacetic acid to obtain the calibration curve; or 1.2 ml of 100%, 10%, & 1% of extracts from composts/peat. For lettuce, the experimental design was the same as for the watercress except that the sterile filter paper was wetted with 1.4 (not 1.2) ml of 1 mM CaSO4 (control) or of 100%, 10%, & 1% of extracts from composts/peat and the calibration curve was a progression of 100, 10, 1, & $0.1mgl^{-1}$ gibberellic acid. The seeds were germinated in the dark at 25 º C in a germination room. After 48 hours for watercress and 72 hours for lettuce, the seedlings were removed & the root or shoot length were measured. The data were recorded as concentrations of indoleacetic acid or gibberellic acid.

Experiment 2: Mung bean rooting bioassay

Mungbean seeds were soaked for 1 minute in 1% sodium hypochlorite solution. They were then removed and rinsed under running tap water for 15 minutes. The seeds were then planted at a depth of 1.5 cm in the moistened vermiculite of an 8 cm bed depth in the plastic trays. The trays were placed in the growth chamber maintained at 25 º C 65% RH for 11 days. When the seedlings had fully expanded unifoliate and unexpanded (rolled) trifoliate leaves in the bud, they were removed. The seedlings were then cut with a sharp razor blade 3 cm below the cotyledons. Four uniform seedling cuttings were selected and placed in each vial (three vials per treatment) containing 8 ml of distilled water or composts/peat extracts. The vials were placed back in the original growth conditions for 9 days. The solution (lost by transpiration) was brought back to its original level with water after every 24 hours. After the incubation period, the number of roots (longer than 1 mm) were counted on each hypocotyl. The number is directly proportional to the auxin concentration within assay range. Standard curve for comparison was IAA ranging from 0.0175 to 17.5 µg/ml.

RESULTS AND DISCUSSION

Experiment 1

In this study it was shown in Figure 3 that lettuce shoots increased with increase in gibberellic acid concentrations while watercress roots decreased with increase in IAA concentrations. Pizzeghello et al. (2006) also reported similar results when watercress and lettuce seeds were germinated in the dark room after being treated with different concentrations of indole-acetic acid on watercress and gibberellic acid on lettuce.

On the side of extracts the roots and shoots formed by the lettuce were almost of the same height (Fig 1) while on the side of watercress roots were longer than the shoots, indicating that in all the extracts there was small amounts of auxin as in experiments with IAA (Fig 4) where roots lengths increased with decrease in the [IAA].

In this study when compost/peat extracts were used there was production of both roots & shoots, but without following any trend meaning that there was interaction of other growth regulators not only gibberellic acid & auxin.

Generally vermicompost performed best as far as shoot lengthening is concerned in both seedlings, while course peat performed best with root lengthening.

With Watercress more root length was seen in all extracts and least shoot length. At both 100% and 10% vermicompost caused the lengthening of shoots most among the treatments and green waste on the other hand caused lengthening of roots more than the rest while at 1% a significant root length was seen in vermicompost.

Comparing the hormone like activities of these extracts with that of pure hormones, the extracts were performing even better than the pure hormones. Like in watercress root length the best was around 22mm in pure hormone Petri dish while with the extracts the best was around 59mm long. There is evidence suggesting that in the intact plant GA elicits a growth-response only in the presence of auxin (Brian & Hemming 1958). So there could have been an interaction of these two kinds of hormones in these extracts causing formation of both roots & shoots on both these kinds of seedlings.

Results presented in figure 6 pointed out that vermicompost initiated more roots at 10% & 1%, but just fewer at 100%, indicating that in this type of extract there was larger amounts of auxin which needed dilutions so as to reach a good concentration to allow the elongation of root length as in experiments with IAA where roots lengths increased with decrease in the [IAA].

Green waste compost initiated more roots at 10% while at 100% & 1% showed almost the same amount of roots. Natural auxins present in this compost just needed to be diluted up to 10% so that they can be effective and by making any dilution just made the effect of the hormone undetectable to initiate any more roots.

Caurse peat initiated more roots than all other extracts. It was able to initiate roots at all dilution levels; 100%, 10% & 1%. This could be as a result of it being with low pH/ acidic because more auxins are extracted from organic materials at low pH.

EXPERIMENT 1. **Watercress & lettuce assays**

Fig 1. The lettuce roots and shoots elongation as influenced by compost and Peat extracts

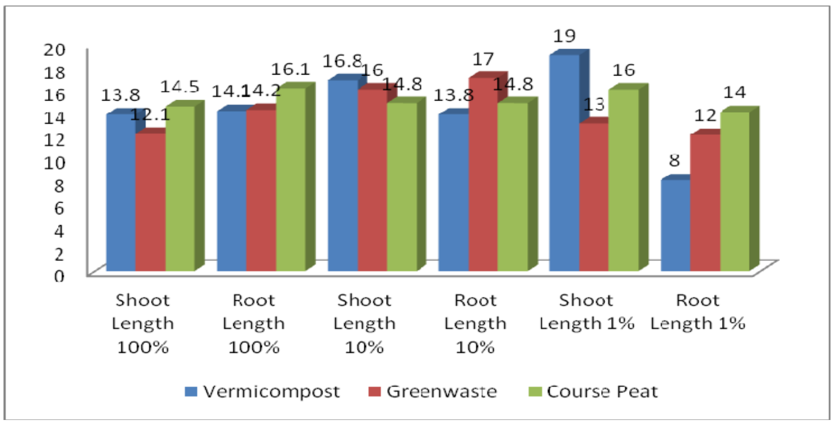
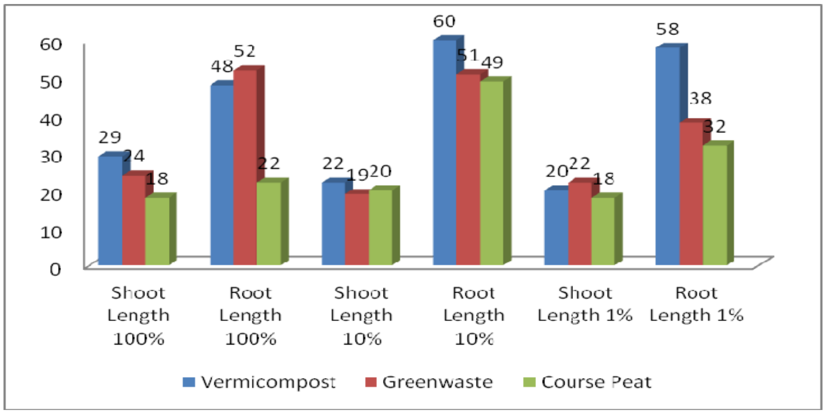


Fig 2. The watercress shoots and roots elongation as influenced by two compost types and peat extracts



EXPERIMENT 2. The Gibberellic acid & Indole Acetic acid assays

Fig 3. The lettuce shoots and roots initiation as influenced by different Gibberellic Acid (GA) concentrations

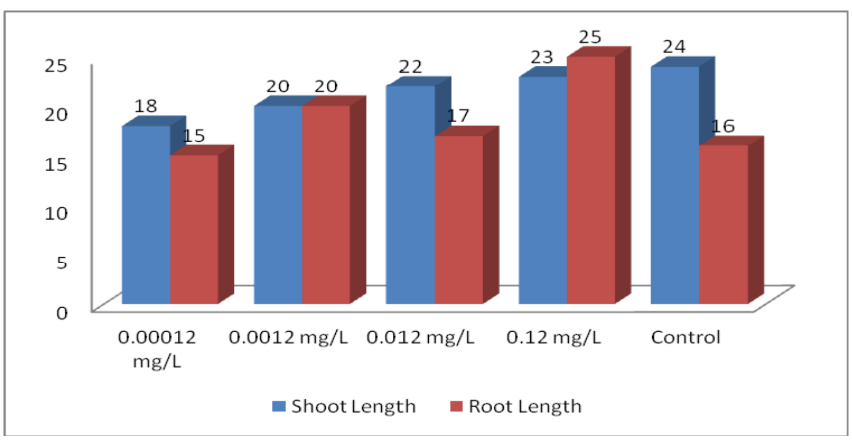
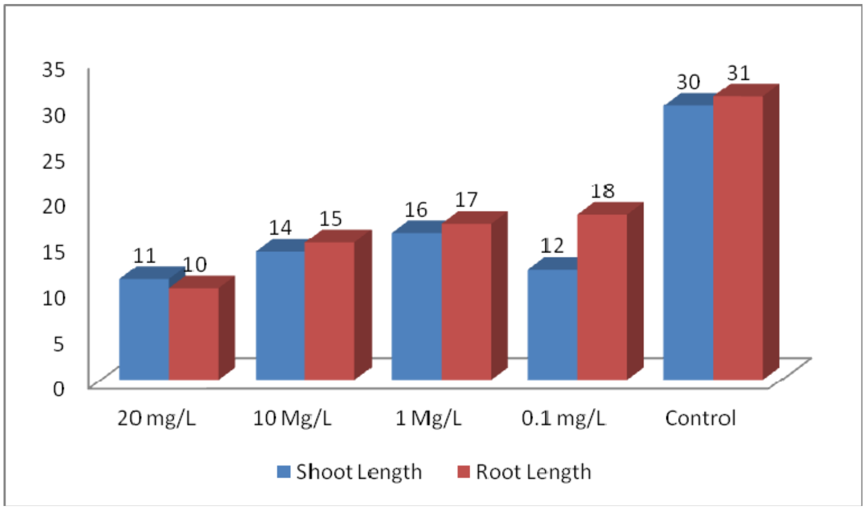


Fig 4. The shoots and roots long initiation in Watercress seedlings as influenced by different Indole Acetic acid (IAA) concentrations



Experiment 3: Mung-bean rooting bioassay

Fig 5. The Root initiation in mung bean seedling cuttings as influenced by different Indole-Acetic acid (IAA) concentrations

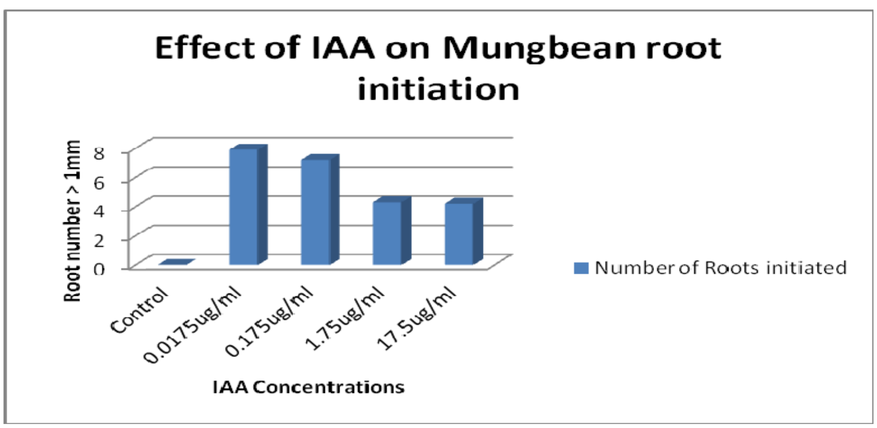
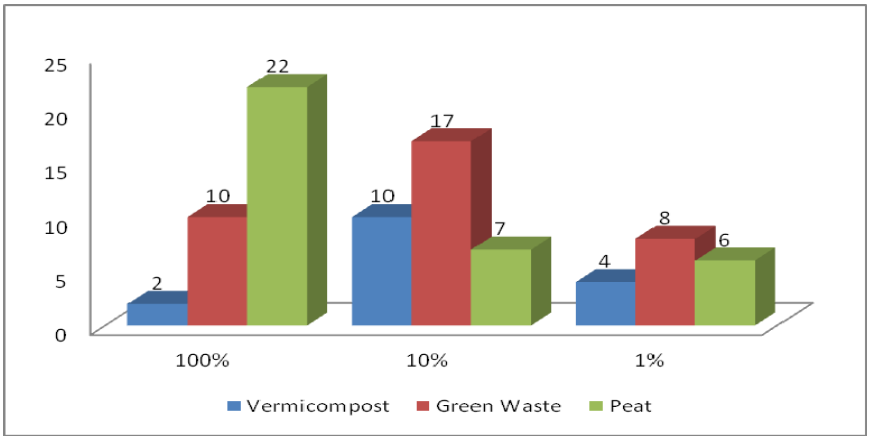


Fig 6. The Effect of two compost types (Vermicompost & Green waste compost) and Peat extracts on root formation in mung bean seedling cuttings



CONCLUSIONS

This study showed that organic fertilisers including vermicompost may positively influence root initiation and shoot elongation in plants as gibberellins and auxins. Compost, vermicompost, initiated root and shoot elongation in watercress and lettuce, and root in mung bean cuttings. Vermicompost was the best in terms of shoot elongation and course peat was the best in terms of root initiation.. Green waste compost extract also initiated roots and shoots in both watercress and lettuce following vermicompost and course peat as well.

The extracts were diluted and this dilution affected roots and shoots elongation in both watercress and lettuce plus root initiation in mung bean cuttings whereby diluting extracts could increase or decrease roots and shoots elongation by different extracts.

Use of organic extracts resulted in increasing root and shoot length, and root initiation and could be used to reduce the amount of artificial hormones required in plant growth regulation and use of expensive inorganic fertilisers.

Vermicomposting should be encouraged as the macro-organisms (Earth worms) used in the process are available at little cost.

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