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Effects of vermicompost on the levels of selected minerals in the leaves of vegetable lady's finger plant, *Hibiscus esculentus* L (var COBh H1) grown in the soil infested with the root-knot nematode, *Meloidogyne incognita* (Kofoid & White)

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Abstract

The mineral levels of leaves of vegetable plant, lady's finger, *Hibiscus esculentus* L (var COBh H1) grown (under pot culture set up) in control soil, vermicompost amended soil, nematode inoculated soil and nematode inoculated soil with vermicompost were investigated in order to understand the suppressive effect of vermicompost on the root knot nematode, *Meloidogyne incognita* (Kofoid and White). The levels of minerals such as calcium, magnesium and iron were estimated in the leaves of plants grown for 15 and 30 days in all the above mentioned conditions. The higher magnitudes of reduction in leaf calcium and magnesium levels of plants grown in nematode inoculated soil amended with vermicompost probably indicated the suppressive effect of vermicompost on nematode infestation thereby aiding a possible increased growth of the plant. The higher magnitudes of elevation in the leaf iron content of plants grown in NIV conditions probably indicated the suppressive effect of vermicompost on the root-knot nematode by way of increasing the absorption of higher levels of iron which could be of adaptive value for increased biochemical reactions in plant tissue to enhance the plant growth.

Keywords: Lady's finger plant, *Hibiscus esculentus*, root-knot nematode, *Meloidogyne incognita*, vermicompost, minerals, calcium, magnesium and iron.

Introduction

Suppression of plant disease incidence and of pathogen suppression were recorded in the earlier studies involving 28 species of crop plants grown in vermicomposts (Edwards and Burrows, 1988 and Scott, 1988). Nakamura (1996) reported suppression of tomato late blight, *Plasmodiophora brassicae* and *Phytophthora nicotianae* and tomato Fusarium wilt, *Fusarium lycopersici* by vermicomposts. The suppression effect of *Fusarium lycopersici* and *Phytophthora nicotianae* on tomatoes was also reported by Szczech, (1999) and Szczech *et al*., (2002). Rodriguez *et al*. (2000) demonstrated general suppression of fungal diseases of gerbera plants such as *Rhizoctonia solani*, *Phytophthora drechsleri* and *Fusarium oxysporum* by incorporation of vermicompost into the growth media. Aqueous extracts of vermicomposts is reported to inhibit mycelial growth of *Botrytis cinerea, Sclerotinia sclerotiorum, Corticium rolfsii, Rhizoctonia solani* and *Fusarium oxysporum* (Nakasone *et al.*, 1999). The suppression of plant disease, *Phythium* (damping-off), *Rhizoctonia* (root rot) and *Verticillium* (wilt) by vermicomposts was reported by Chaoui *et al.,* (2002).

Suppression of insect pest on plants by vermicompost amendments is also reported by few authors. Rao *et al.*, (2001) reported decreased incidence of leaf miner, *Aproaerema* on groundnuts in response to field treatments of soils with vermicomposts. The pest controlling effect of vermicomposts with reference to the sucking pests to groundnut was reported by Ramesh, (2000). Rao, (2002) reported the decreases in attacks by jassid *(Empoasca verri)* and aphids (*Aphis indica*) and changed predator populations in response to field application of vermicompost. The controlling effect of vermicompost on arthropod pest population in vegetable crops was also reported in the greenhouse research of Soil Ecology Laboratory at Ohio State University, USA. The influence of vermicomposts on plant growth and pest incidence was studied by Edwards *et al.*, (2004). Arancon *et al*., (2005) studied the suppression of insect pest populations and plant damage by vermicomposts. A possible pesticidal effect of vermicomposts for a healthy vegetative growth of the plant was also reported by Sivapandian *et al.*, (2009) in *Hibiscus esculentus.* A survey of literature reavealed that the suppressive effect of vermicompost on the effect of the root-knot nematode *Meloidogyne incognita* was studied only with reference to own yield. Hence, the present study includes the impact of vermicompost on the effect of root-knot *Meloidogyne incognita* with special reference to the inorganic mineral content of the leaves of the vegetable lady's finger plant, *Hibiscus esculentus* L (var COBh H1).

Material and Methods

Seedlings of lady's finger plant, *Hibiscus esculentus* L (var COBh H1) were grown for 15 and 30 days in pot culture set up in control soil, vermicompost amended soil, in nematode inoculated soil and nematode inoculated soil with vermicompost. Chemical analysis of selected minerals such as calcium, magnesium and iron were carried out in the leaves of *Hibiscus esculentus* of control plants and of the plants grown in amended soils for 15 and 30 days of growth.

Preparation of fresh leaf extract for mineral analysis

Fresh leaf extract was prepared by the modified method of Swain (1966). One gram of fresh leaf was cut into small pieces and ground with 1 ml of distilled water in a mortar and pestle. The homogenate was filtered using Whatman filter paper and the filtered fresh leaf extract was kept ready for the further chemical estimation of minerals such as calcium, magnesium and iron.

Estimation of calcium

The calcium content of leaves of control and experimental plants was estimated by Arsenazo III method of Smith and Paul, (1979) and represented as percentage.

Estimation of magnesium

The magnesium content of leaf of control and experimental plants was estimated by the Calmagite method of Gindler and Heth, (1971) and given as percentage.

Estimation of iron

The iron content of fresh leaves of control and experimental plants was estimated by the Ferrozine method of Siedel *et al.,* (1984) and given as percentage.

Statistical analysis

In the present study, all the investigations carried out for a particular parameter were repeated six times and mean values were calculated. The change (either increase or decrease) in a particular parameter of plants in amended soils from that of plants grown in control soil was calculated as percentage. The significance of the difference between the mean values of plants grown in control soil and of plants grown in amended soils were analyzed by Student's'*t*' test (Steel and Torrie, 1960). The mean levels of control and experimental groups of a particular growth period were separately analyzed (for their significance among themselves) by Analysis of Variance (ANOVA or 'F' test) (Multiple 'F' test) and Duncan's Mulitiple Range Test (DMRT) (Duncan, 1955).

Results and Discussion

Table 1 to 3 and provide the data on the chemical analysis of selected minerals such as calcium, magnesium and iron in the leaves of plants grown for 15 and 30 days in control and amended soils.

Calcium

In plants, calcium is absorbed as divalent Ca^{2+} ions and it plays an important role in the structure and permeability of cell membranes. Calcium is essential for cell elongation and cell division in plant growth (Havlin *et al*., 2010).

The data on the calcium content in the leaves of *Hibiscus esculentus* grown in control and experimental soils for 15 and 30 days in the present study (Table 1) clearly demonstrates significant reduction in the leaf calcium content in all experimental plants compared to control levels. The reduction in the calcium content of leaves in all experimental conditions probably indicates the possible utilization of calcium towards increased proliferation of cells at the meristematic tissue levels (at the shoot tip and root tip) leading to a possible the increased growth of above ground and below ground growth parameters.

Table – 1: Calcium content (as percent wet weight of leaf) in the leaves of *Hibiscus esculentus* grown (under pot culture) in control soil (C), in vermicompost amended soil (VA), in nematode inoculated soil (NI) and in nematode inoculated soil with vermicompost (NIV) for 15 and 30 days after sowing. Values are means of six observations ± S.E. Percent changes from control level are given in parenthesis.

Period of growth	Grown in Control soil	Grown in amended soils			'F' Value
		VA	NI	NIV	
15 days	2.152 ± 0.01[d]	1.99 ± 0.09[c] (– 8) NS	1.08 ± 0.04[b] (– 50) S	0.87 ± 0.01[a] (– 60) S	125.08 HS
30 days	1.72 ± 0.01[d]	1.43 ± 0.01[c] (– 16) S	1.01 ± 0.01[b] (– 41) S	0.92 ± 0.01[a] (–47) S	96.45 HS

(+) - Denotes per cent increase from control level.
(-) - Denotes per cent decrease from control level.
S - Statistically significant, $P<0.05$.
HS - Statistically highly significant, $P<0.01$.
NS - Statistically not significant, $P>0.05$.
In a row, mean values followed by a common letter are not significant at 5% level by DMRT.

Table - 2: Magnesium content (as percent wet weight of leaf) in the leaves of *Hibiscus esculentus* grown (under pot culture) in control soil (C), in vermicompost amended soil (VA), in nematode inoculated soil (NI) and in nematode inoculated soil with vermicompost (NIV) for 15 and 30 days after sowing. Values are means of six observations ± S.E. Percent changes from control level are given in parenthesis.

Period of growth	Grown in Control soil	Grown in amended soils			'F' Value
		VA	NI	NIV	
15 days	1.87 ± 0.12[d]	1.07± 0.07[c] (-43) S	0.98 ± 0.04[b] (- 48) S	0.56 ± 0.01[a] (- 70) S	114.80 HS
30 days	1.26 ±0.03[d]	1.16 ± 0.05[c] (-8) NS	1.00 ± 0.01[b] (-21) S	0.44 ± 0.02[a] (-65) S	108.20 HS

(-) - Denotes per cent decrease from control level.
S - Statistically significant, $P<0.05$.
H S - Statistically highly significant, $P<0.01$.
NS - Statistically not significant, $P>0.05$.
In a row, mean values followed by a common letter are not significant at 5% level by DMRT.

Table – 3: Iron content (as percent wet weight of leaf) in the leaves of *Hibiscus esculentus* grown (under pot culture) in control soil (C), in vermicompost amended soil (VA), in nematode inoculated soil (NI) and in nematode inoculated soil with vermicompost (NIV) for 15 and 30 days after sowing. Values are means of six observations ± S.E. Percent changes from control level are given in parenthesis.

Period of growth	Grown in Control soil	Grown in amended soils			'F' Value
		VA	NI	NIV	
15 days	21.51 ± 0.03[a]	28.21 ± 0.53[b] (+31) S	31.10 ± 0.26[c] (+45) S	33.08 ± 0.61[d] (+54) S	128.50 HS
30 days	26.52±0.07[a]	34.84 ± 0.06[c] (+16) S	34.14 ± 0.37[b] (+29) S	36.07 ± 0.03[d] (+36) S	48.40 S

(+) - Denotes per cent increase from control level.
S - Statistically significant, $P<0.05$.
H S - Statistically highly significant, $P<0.01$.
In a row, mean values followed by a common letter are not significant at 5% level by DMRT.

Magnesium

In plants, magnesium (Mg^{2+}) ion is more important as a primary constituent of the chlorophyll molecule and without chlorophyll the autotrophic green plants would fail to carry on photosynthesis. Chlorophyll usually accounts for about 15 to 20% of the total magnesium content of the plants. Magnesium also serves as a structural component in ribosomes, stabilizing them in the configuration necessary for protein synthesis. As magnesium is involved in a number of physiological and biochemical functions, it is important throughout the plant metabolism (Havlin *et al*., 2010).

In the present study, the magnesium content of leaves showed significant reductions to different magnitudes in all the experimental plants (excepting that of plants grown in vermicompost amended soil for 30 days) (Table 2). The reduction in the magnesium content of leaves could be taken to suggest that magnesium is utilized for synthesis of higher chlorophyll contents in the plants. The higher magnitude of reduction in magnesium content of the plants grown in nematode inoculated soil with vermicompost after 15 and 30 days of growth probably indicates the suppressive effect of the vermicompost on the parasitic effect of nematodes.

Iron

Iron (Fe) is the most important inorganic mineral component of the plant tissues, very much involved in the synthesis of chlorophyll in young leaves. The normal iron content of plant tissues is between 50 and 250 ppm. The chemical properties of Fe make it an important part of oxidation and reduction reactions in plant tissues. Fe is a structural component of porphyrin molecules such as cytochromes, hemes, hematin, ferric chrome and leghemoglobin which are involved in oxidation and reduction reactions in respiration and photosynthesis. About 75% of the total cell Fe is associated with the chloroplast and up to 90% of the Fe in the leaves occurs with lipoprotein of the chloroplast and mitochondrial membranes (Havlin *et al*., 2010).

In the present study, from Table 3, it could be observed that the iron content of leaves of *Hibiscus esculentus* showed varying magnitudes of changes in plants grown in vermicompost amended soil, nematode inoculated soil and in nematode inoculated soil with vermicompost compared to control plants after 15 and 30 days of growth. The higher magnitude of elevations (to about +54 percent following 15 days and to about +36 percent following 30 days) in leaf iron content in plants grown in nematode inoculated soil with vermicompost compared to the lesser significant elevations (+45 percent following 15 days and +29 percent following 30 days) in plants grown in nematode inoculated soil clearly indicates the suppressive effect of the vermicompost on the parasitic effect of root-knot nematode, *Meloidogyne incognita* with reference to the leaf iron content. Addition of vermicompost to nematode inoculated soil probably resulted in the absorption of higher levels of iron which could be of adaptive value for increased biochemical reactions in the plant tissue to enhance the growth thereby suppressing the parasitic effect of nematode on the plant.

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