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Suppressive effect of vermicompost on the root-knot nematode, *Meloidogyne incognita* (Kofoid & White) on the growth parameters of the vegetable lady's finger plant, *Hibiscus esculentus* L (var COBh H1)

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Abstract

The suppressive effects of vermicompost on the root-knot nematode, *Meloidogyne incognita* (Kofoid and White) with reference to above ground and below ground growth parameters were studied in a selected vegetable plant, lady's finger, *Hibiscus esculentus* L (var COBh H1) under pot culture experiment in different soil conditions such as in control soil, vermicompost amended soil, nematode inoculated soil and nematode inoculated soil with vermicompost. The suppressive effect of vermicompost on the parasitic effect of the root-knot nematode was well pronounced by significant elevation in the number of flowers and fruits, shoot length, leaf length and leaf area of *Hibiscus esculentus* grown in nematode inoculated soil with vermicompost compared to those in plants grown in nematode inoculated soil. The primary root length also showed significant increase in plants grown in vermicompost amended nematode inoculated soil which might help the plant to grow deeply thereby avoiding the parasitic effect so as to enhance the uptake of nutrients from deeper soil.

Keywords: Lady's finger plant, *Hibiscus esculentus*, root-knot nematode, *Meloidogyne incognita,* vermicompost, growth parameters

Introduction

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. 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.*

Compared to the reports on the suppressive effect of vermicomposts on the insect pest, reports on the suppressive effect of vermicompost on plant parasitic nematodes are less. Szczech *et al.,* (1993) studied the suppressive effect of commercial earthworm compost on some root infecting pathogens of cabbage and tomato. Swathi *et al*., (1998) reported that 1.0 kg m^{-2} of vermicompost suppressed attacks of the root-knot nematode, *Meloidogyne incognita* in tobacco plants. Ribeiro *et al*., (1998) reported that vermicompost decreased the number of galls and egg masses of *Meloidogyne javanica*. Arancon *et al*., (2002) reported the management of plant parasitic nematode populations by use of vermicomposts. Arancon *et al.,*(2002 and 2003) reported significant suppression of plant parasitic nematode by field applications of vermicompost,

ranging from 2 to 8 kg/ha applied to tomotes, peppers, strawberries and grapes crops.

A survey of literature indicates that the suppressive effect of vermicompost on the root-knot nematode is studied only based on the crop yield. However, the effect of vermicomposts on the growth parameters of plants under control and root-knot nematode-infested conditions is not studied in detail so far. Hence, an attempt is made in the present study to comprehensively investigate the suppressive effect of vermicompost on the root-knot nematode, *Meloidogyne incognita* (Kofoid and White) with reference to growth parameters of a selected vegetable plant, lady's finger, *Hibiscus esculentus* L (var COBh H1).

Material and Methods

Collection of vermicompost

A bulk sample of vermicompost (prepared by the vermicompost of leaf litter by an epigeic earthworm, *Eudrilus eugeniae)* was obtained from the Vermitechnology Unit of Department of Zoology, Government Arts College, Coimbatore, Tamil Nadu, India. The collected vermicompost was stored in polythene bags to be used for soil amendment in pot culture growth studies.

Biology of root- knot nematode, *Meloidogyne incognita*

The root-knot nematodes are the most important and most cosmopolitan of nematode pests of vegetables and the principle symptoms of root-knot nematodes are root "galls" or "knots" were observed many centuries ago. Among the species of root-knot nematodes known to infest vegetable plants, three species namely, *Meloidogyne incognita* (Kofoid and White,1919; Chitwood, 1949), *Meloidogyne javanica* (Treub, 1885; Chitwood, 1949) and *Meloidogyne arenaria* (Neal, 1889 and Chitwood, 1949) are commonly prevalent in Tamil Nadu (India) and among them, *Meloidogyne incognita* is the most predominant species (Muthukrishnan *et al*., 1969).

The root-knot nematode, *Meloidogyne incognita* (selected for the present study) is known to infest a variety of pulses, fruits and vegetable crops including bhendi (lady's finger). The root-knot nematode, *M. incognita*, also known as the southern root-knot nematode, is a microscopic worm that lives in soil and feed on the roots of many garden crops. The important host crops of *M. incognita* are lima and hyacinth bean, celery, ginger, onion, pea, cow-pea, pepper, sweet potato, tomato, bhendi and yam. The root-knot nematode, *M. incognita* is a major limiting factor for the successful cultivation of bhendi, often causing serious wilting problems thereby rendering the crop uneconomical. *M. incognita* is a sedentary root and tuber endoparasite. The females are swollen, and do not develop into persistent brown cysts but deposit all the eggs as external egg-mass. Hatching occurs when the physical conditions are suitable and is not dependent on a hatching factor from the host roots. Males may be present but are not necessary for reproduction, as sex is environmentally determined (Weischer and Steudel, 1972).

Preparation of egg sample of *Meloidogyne incognita*

The infested tomato roots were collected from the nearby cultivated farm in Coimbatore. The collected roots were carefully removed, washed in water and cut into small pieces. The small pieces of roots were kept in a glass petridish with 200ml of water. After 7 days, the root-knot nematode egg masses were carefully collected and kept in petridish for hatching for further inoculation in the soil in pot culture.

Pot culture experiments

Soil used for the pot experiments in the present study was red loam, clay soil with pH ranged from 7.2 to 7.8 and moisture holding capacity (MHC) of 48 %. The soil was sterilized by applying formalin to remove any pathogens in the soil. Earthern pots of uniform size of (15 litre capacity) were selected for pot culture study of lady's finger, *Hibiscus esculentus* L. (var COBh H1) under different soil conditions. The following four different pot set ups were prepared for sowing of seeds (Table- 1)

The soil in the pots (containing control and amended soils as prepared above) was well turned repeatedly for a week before the sowing of seeds and eight pots (two pots per each soil condition of C, VA, NI and NIV) were kept ready for sowing of seeds. The seeds of lady's finger, *Hibiscus esculentus* (var COBh H1) were obtained from Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. Six healthy seeds were sowed in each pot with proper spacing. From the day of sowing, the pots were watered regularly for germination and growth of the seedlings. Proper care was taken to avoid any

predators/damage to the pot set ups. The germination and emergence of seedlings of *H. esculentus* were carefully observed. All the seeds sowed in all the experimental pot culture set ups were observed to be germinated within 2 to 4 days and these observations quite conformed with those of Sathish Kumar (2004). Of the seedlings grown in the pots, 6 healthy seedlings of each soil condition (3 in each of the pot set up) only were retained for further growth and observation of flowering, fruiting and growth parameters following 15 and 30 days of growth.

Table -1: Preparation of four different pot set ups for sowing seeds of *H. esculentus* (var COBh H1)

Control soil	C	3 kg of soil only
Soil amended with vermicompost	VA	3kg of soil + 500gms of vermicompost mixed with soil.
Soil inoculated with Nematode	NI	3kg of soil + 50 ml of prepared egg sample of nematode to be inoculated after one week of sowing.
Soil inoculated with nematode and amended with vermicompost	NIV	3 kg of soil + 500 gms of vermicompost + 50 ml of prepared egg sample of nematode are inoculated after one week of sowing.

Inoculation of soil with egg sample

On the 7th day of growth after germination, the soil of pots NI and NIV alone were inoculated with egg sample of *Meloidogyne incognita*. 50 ml of prepared egg sample of *M. incognita* was applied at the roots of each plant in NI and NIV pots only. The above ground and below ground growth parameters were obtained from the seedlings of *Hibiscus esculentus* grown for 15 and 30 days in control and amended soils in pot culture.

Observation of above ground growth parameters

The seedlings grown in control soil (C), vermicompost amended soil (VA), nematode inoculated soil (NI) and nematode inoculated soil with vermicompost (NIV) were carefully observed and the data on the above ground growth parameters such as flowering, fruiting, shoot length, leaf length and average leaf area were collected and recorded.

Flowering and fruiting

In the present pot culture experiments, all the sowed seeds of *Hibiscus esculentus* in all the soil conditions were observed to be germinated within 2 to 3 days after sowing. In all the selected seedlings (6 seedlings each) in the four (C, VA, NI and NIV) soil conditions, flowering was observed only between 16th to 18th days after germination. The number of flowers and fruits in each plant were counted and recorded.

Measurement of shoot length

Shoot length of seedlings of *Hibiscus esculentus* grown in control soil (C), in vermicompost amended soil (VA), in nematode inoculated soil (NI) and in nematode inoculated soil with vermicompost (NIV) under pot culture were periodically measured (in cm) from the soil level to the tip of the main stem of plants by using a measuring scale on 15th and 30th days after sowing and the measured values were recorded for each plant. The average shoot length was calculated from the data obtained for 6 plants.

Measurement of leaf length

Leaf length was measured (in cm) from the base of the petiole to the tip of the leaf. Leaf length of 6 seedlings of *Hibiscus esculentus* grown in control soil, in amended soil with vermicompost, in nematode inoculated soil and nematode inoculated soil with vermicompost, under pot culture were measured on 15th and 30th days after sowing and the average leaf area of 6 selected leaves of plants in each soil condition was calculated.

Measurement of leaf area

The leaf area of *Hibiscus esculentus,* grown in control soil, in amended soil with vermicompost, in nematode inoculated soil and nematode inoculated soil with vermicompost was estimated by standard graph paper tracing method as described by Obeifuna and Ndubizu, (1979).

Observation of below ground growth parameters

The selected roots of plants grown for 30 in each pot set up were uprooted, carefully washed and the data on the below ground parameters such as

number of secondary and tertiary roots and the length of primary root (in cm) were collected from plants in all the control and experimental set ups after 30 days of growth.

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 Multiple Range Test (DMRT) (Duncan, 1955).

Results and Discussion

The observed data on the number of flowers and fruits in plants grown for 30 days are given in Table 2. The plant growth parameters such as shoot length, leaf length, leaf area, primary root length, number of secondary and tertiary roots of control and experimental plants are presented in Tables 3 to 6.

Table- 2: Number of flowers and fruits in *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 30 days. Values are means of 6 observations ± S.E. The percent changes from control level are given in parenthesis.

Parameter	Grown in Control soil	Grown in amended soils			'F' Value
		VA	NI	NIV	
Flowers	5 ± 1 [b]	4 ±1 [a] (-20) S	8 ±2 [c] (+60) S	12 ± 2 [d] (+140) HS	24.87 S
Fruits	7 ± 1 [b]	9 ±2 [c] (+29) S	6 ±1 [a] (-14) S	16 ± 3 [d] (+129) HS	38.54 S

(+) - Denotes per cent increase from control level; (-) - Denotes per cent decrease 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.

Table- 3: Shoot length (in cm) 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 30days 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	7.18 ± 0.72[a]	7.33 ± 0.61 [b] (+2) NS	7.80 ± 1.02 [c] (+9) S	8.08 ± 0.31[d] (+13) S	14.80 S
30 days	12.81 ± 1.70 [a]	14.60 ± 1.21[d] (+14) S	13.58 ± 1.95 [b] (+6) S	14.28 ± 52 [c] (+11) NS	17.40 S

(+) - Denotes per cent increase from control level; (-) - Denotes per cent decrease from control level.
S - Statistically significant, P<0.05; 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 - 4: Leaf length (in cm) 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	8.11 ± 1.10 [d]	8.05 ± 0.95 [c] (–1) NS	7.66 ± 0.81[a] (–6) NS	7.85 ± 0.81[b] (–3) NS	28.42 S
30 days	14.45 ± 2.32[b]	15.45 ±1.32[c] (+7) S	14.36 ± 0.56[a] (–1) S	18.64 ± 1.85[d] (+ 29) S	27.56 S

(+) - Denotes per cent increase from control level; (-) - Denotes per cent decrease from control level.
S - Statistically significant, P<0.05; 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 – 5: Leaf area (cm^2) 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	29.21 ± 3.88[d]	24.59 ± 4.59[b] (-16) NS	23.25 ± 3.59[a] (-24) NS	26.32 ± 3.01[c] (-13) NS	48.50 S
30 days	77.51 ± 2.04[b]	87.91 ± 1.23[c] (+13) S	67.57 ± 5.46[a] (-13) S	103.86 ± 1.66[d] (+34) S	112.80 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 – 6: Number of secondary and tertiary roots and primary root length (in cm) (below growth parameters) 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 30 days after sowing. Values are means of six observations ± S.E. Percent changes from control level are given in parenthesis.

Below ground growth parameters	Grown in control soil	Grown in amended soils			'F'Value
		VA	NI	NIV	
Number of secondary roots	23 ± 3[b]	24 ± 2[c] (+4) NS	21 ± 3[a] (-9) NS	25 ± 3[d] (+9) NS	46.50 S
Number of tertiary roots	43 ± 5[b]	48 ± 8[d] (+12) NS	39 ± 6[a] (-8) NS	47 ± 3[c] (+10) NS	126.50 HS
Primary root length (cm)	17.33 ± 1.89[a]	28.50 ± 3.37[d] (+64) S	20.33 ± 2.47[b] (+11)	24.83 ± 1.01[c] (+37) S	118.45 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.

The results obtained in the present study involving pot culturing of the vegetable plant, *Hibiscus esculentus* in control soil, vermicompost amended soil, nematode inoculated soil and nematode inoculated soil with vermicompost showed comprehensive exhibition of the suppressive effect of the vermicompost on the parasitic effect of the root-knot nematode, *Meloidogyne incognita* with reference to plant growth.

The suppressive effect of vermicompost on the parasitic effect of the root-knot nematode was well pronounced by significant elevation in the number of flowers and fruits shoot length, leaf length and leaf area of *Hibiscus esculentus* grown in nematode inoculated soil with vermicompost compared to those in plants grown in nematode inoculated soil (Tables -2 to 5). The primary root length also showed significant increase in plants grown in vermicompost amended nematode inoculated soil (Table -6). This observed increase in primary root length, probably stimulated by vermicomposts, in spite of the reduced number of secondary and tertiary roots, (under NI condition) perhaps indicates the adaptive response of the plants to grow into deeper soil. This adaptive response (aided by the stimulatory effect of vermicompost) by increasing the primary root length might help the plant to grow deeply thereby avoiding the parasitic effect might with enhance the uptake of nutrients from deeper soil.

Based on the present study, it could be concluded that the application of vermicompost might result in increased crop yield not only by growth promoting substances in the vermicompost (widely reported by many researchers) but also by the suppressive effect of vermicompost when there is an incidence of parasitic infestation in the agricultural fields.

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