Available Online at EScience Press
Plant Protection
ISSN: 2617-1287 (Online), 2617-1279 (Print)
http://esciencepress.net/journals/PP

MICROENVIRONMENTAL ALTERATION BY THE USE OF SOME PLANTS FOR THE EFFECTIVE CONTROL OF ROOT-KNOT NEMATODE (*MELOIDOGYNE INCOGNITA*) ON BRINJAL

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ARTICLE INFO

Article history
Received: 30th August, 2018
Revised: 26th November, 2018
Accepted: 29th November, 2018

Keywords
Solanum melongena
Meloidogyne incognita
Azadirachta indica
Calotropis procera
Tagetes erecta
Datura stramonium

ABSTRACT

Eggplant is a tropical perennial plant often cultivated in temperate regions. It has significantly high nutritive values as well. Root-knot nematode (*Meloidogyne incognita*) is one of the major plant pathogens which causes huge losses in brinjal. The management of nematodes is mainly relied on synthetic nematicides which are hazardous. The current studies were, therefore, carried out to determine the effect of different leaves as soil amendments on the growth of brinjal. The soil was amended with leaves of *Azadirachta indica*, *Calotropis procera*, *Tagetes erecta* and *Datura stramonium* in concentrations of 25, 50 and 75 g/kg. The maximum increase in these parameters was recorded at the concentration of 75 g/kg of the soil. However, the amendment at 25 g/kg of the soil was the least effective. Similarly, an increase in these parameters was found to be higher at higher concentration of the amendments. A direct relationship was observed between the concentrations of the amendments and these parameters. *A. indica* and *C. procera* caused maximum reductions in number of galls and reproduction factor of the nematode resulting in the improvement of various growth parameters. It is concluded from the present studies that the amendments with antagonistic plants could be the possible replacement for synthetic nematicides.

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INTRODUCTION

Brinjal or eggplant (*Solanum melongena* L.) is one of the most important *Solanaceous* crops which grow best in warm climate. It has food and nutritive value and occupies 18th position in world ranking (FAO, 2009; Meah, 2003). Brinjal is rigorously damaged by root-knot nematode, *Meloidogyne incognita*, (Hussain et al., 2016; Kayani et al., 2017, 2018; Mukhtar et al., 2017a; Tariq-Khan et al., 2017). Nematodes are the round worms and the most abundant organisms in the soil that affect the roots of plants. The symptoms of nematode infection are the development of root galls which result in stunted growth, water stress such as wilting or leaf rolling, mineral deficiency, poor yielding plants (Abad et al., 2003).

Many nematicides have been found effective for the control of these nematodes. These nematicides are toxic and have adverse effects on the environment (Anastasiadis et al., 2008). Investigators had managed root-knot nematodes by using some plant extracts as organic amendments have been tested and have nematicidal properties (Sharma et al., 2004). The great losses caused by root-knot nematodes can be overcome by using different control strategies (Kayani and Mukhtar, 2018; Khan et al., 2017; Mukhtar, 2018; Mukhtar et al., 2017b; Vagelas and Gowen, 2012). The use of organic amendments in the soil is not only beneficial for nematode management but also increases the plant growth and productivity (Agyarko and Asante, 2005). Plants such as *Datura stramonium* (Solanaceae), *Calotrpis procera* (Asclepiadaceae), *Tagestes erecta* (Asteraceae) and *Azadirecta indica* (Meliaceae) are found in every parts of country and possess nematicidal properties. The present work was carried out to evaluate the effect of dry leaves of some selected plants against the root-knot nematode, *M. incognita*, infecting brinjal.

MATERIALS AND METHODS

Collection of plant materials for soil amendments: The plant material for the control of root-knot nematode (*Meloidogyne incognita*) was collected from different places of Bahawalpur and the Botanical Garden of Agricultural Extension Department, Model Town-A, Bahawalpur. The plant residues collected for the organic control of the root-knot nematode were *Calotropis procera* (Ak), *Datura stramonium* (Jimson weed), *Azadirachta indica* (Neem) and *Tagetes erecta* (Marigold).

Nematode inoculation and multiplication: The root-knot nematode (*Meloidogyne incognita*) was isolated from brinjal infected roots by Extraction Tray Method (Whitehead and Hemming, 1965). The nematode was multiplied on the highly susceptible variety of tomato (Money maker). Tomato seedlings were inoculated by making 3-4 holes around the stems and known volume of nematode was poured into these holes. The holes were then filled and the pots were kept under glass house at about 25^0C. The plants were watered as per requirement.

Soil used for experiment: The soil (sand 56%, silt19%, clay 24%, pH 7.6 and organic matter 1%) used in the pot experiment was sterilized with formalin. The soil was then sieved through a 3.5 mm pore size sieve to remove large stones and plant residues and then used in pots.

Assessment of the nematicidal activity: Leaves of *A. indica, C. procera, T. erecta* and *D. stramonium* were washed and dried under shade. The leaves of these plants were mixed with the soil @ 50, 75 and 100 g per kilogram of the sterilized soil. The soil without any amendment served as control. After two weeks, three-week-old seedlings of brinjal were transferred to the amended pots. The plants were inoculated with 2500 freshly hatched second stage juveniles of *M. incognita* collected from the infected roots of tomato. Treatments were replicated five times and watered when needed.

Data collection: After seven weeks, plants were uprooted and roots were excised from the shoots and data were recorded for different parameters like root-shoot lengths, their weights, numbers of galls and reproduction factors. The root-knot nematodes were also extracted by Whitehead and Hemming tray method (Whitehead and Hemming, 1965). The reproductive factor was calculated by dividing the final population by the initial one. The percent increases in growth parameters and decreases in nematode infestations were determined over control (Kayani et al., 2017).

Data analysis: The Completely Randomized Design was used in the experiment. All the data were subjected to Analysis of Variance (ANOVA) using GenStat package 2009, (12th edition) version 12.1.0.3278 (www.vsni.co.uk). The means were compared by Duncan's Multiple Range Test (DMRT) at 5%. Standard errors of means, trend lines, regression equations and R^2 were calculated in Microsoft Excel 2007.

RESULTS

The analysis of variance regarding effect of organic amendments on growth parameters of brinjal as well as number of galls and reproduction factor showed significant variations.

Root and shoot length: The analysis of variance regarding root and shoot lengths showed significant effects of organic amendments, their concentrations and the interaction between amendments and their concentrations. Root and shoot lengths were found to be the maximum in case of *A. indica* followed by *C. procera*. Similarly, maximum increase in these parameters was recorded at the concentration of 75 g/kg of soil. The amendment at 25 g/kg of soil was the least effective. It was observed that with the increase in concentration, there was a corresponding increase in these parameters over control. The individual root and shoot lengths and relationships between these parameters and concentrations of individual amendments are given in figures 1 and 2.

Fresh root and shoot weight: The analysis of variance regarding fresh root and shoot weights showed significant effects of the amendments, their doses and the interaction between them. All the amendments significantly increased percent fresh weights over their controls being the maximum in case of *A. indica* at 75 g/kg followed by 50 g concentration, while the 25 g concentration was the least effective in improving the said parameters. Similarly, increases in these parameters were higher at higher concentrations of the amendments. A direct relationship was observed between the concentrations of the amendments and these parameters which are shown with trend lines and equations in figures 3 and 4.

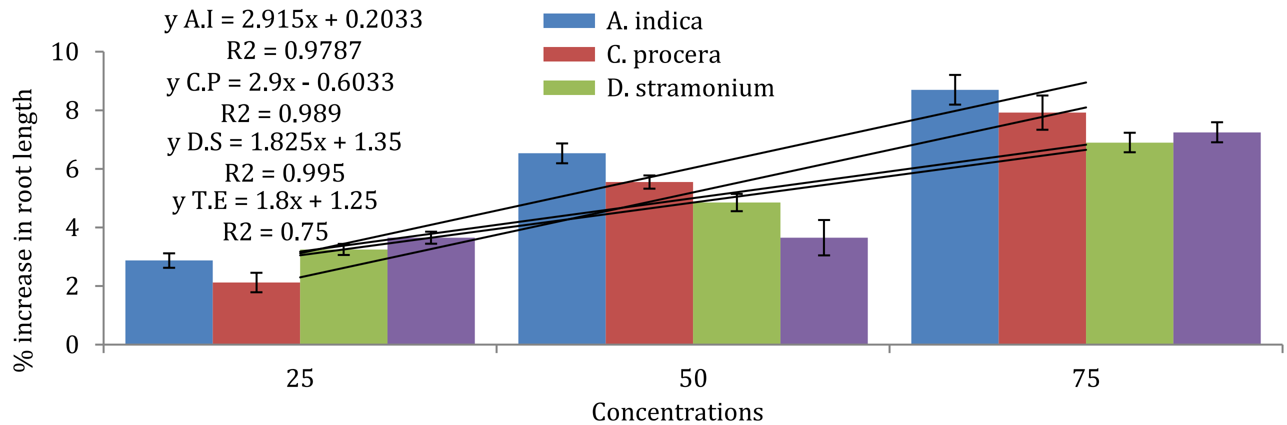

Figure 1: Effect of organic amendments at various concentrations on percent increase in root length.
D.S (*Datura stramonium*), T.E (*Tagestes erecta*), C.P (*Calotropis procera*) and A.I (*Azadirecta indica*)

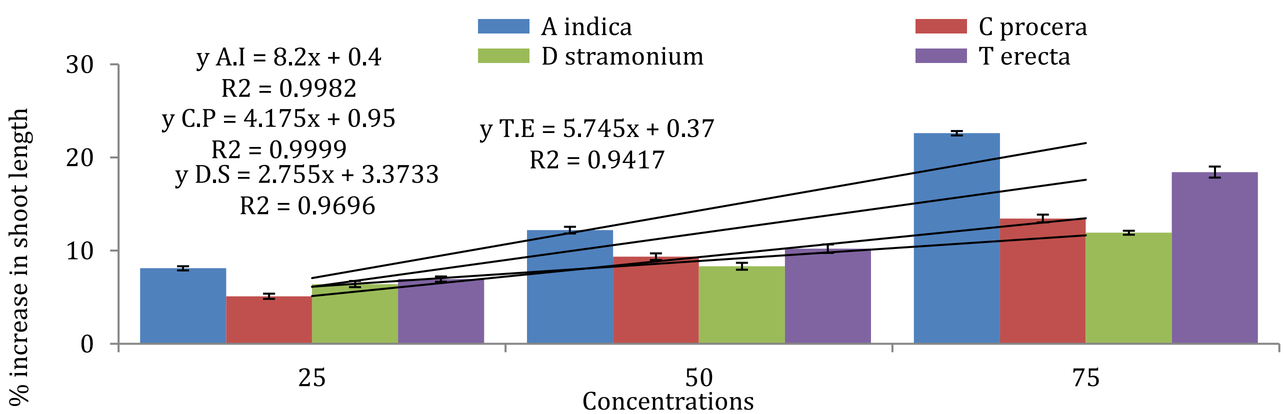

Figure 2: Effect of organic amendments at various concentrations on percent increase in shoot length.
D.S (*Datura stramonium*), T.E (*Tagestes erecta*), C.P (*Calotropis procera*) and A.I (*Azadirecta indica*)

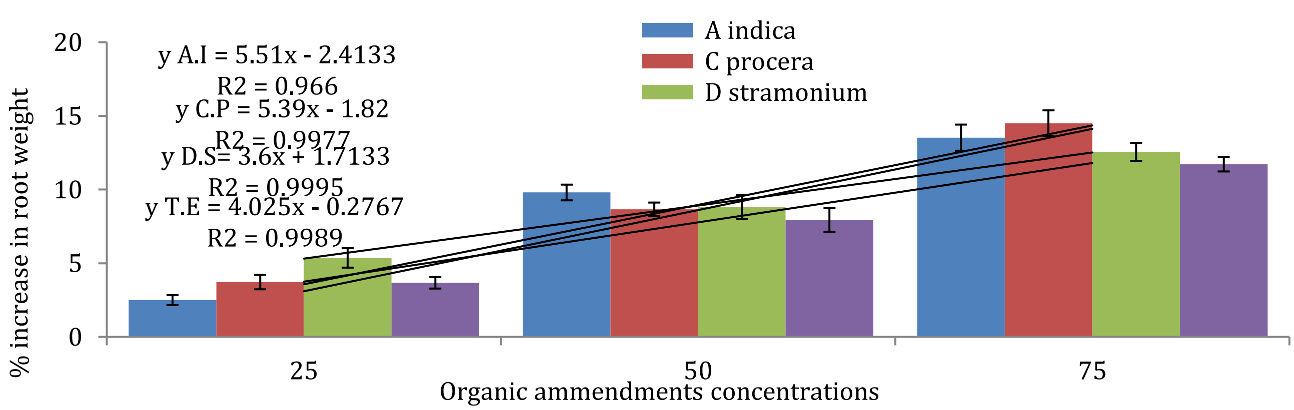

Figure 3: Effect of organic amendments at various concentrations on percent increase in fresh root weight.

D.S (*Datura stramonium*), T.E (*Tagestes erecta*), C.P (*Calotropis procera*) and A.I (*Azadirecta indica*)

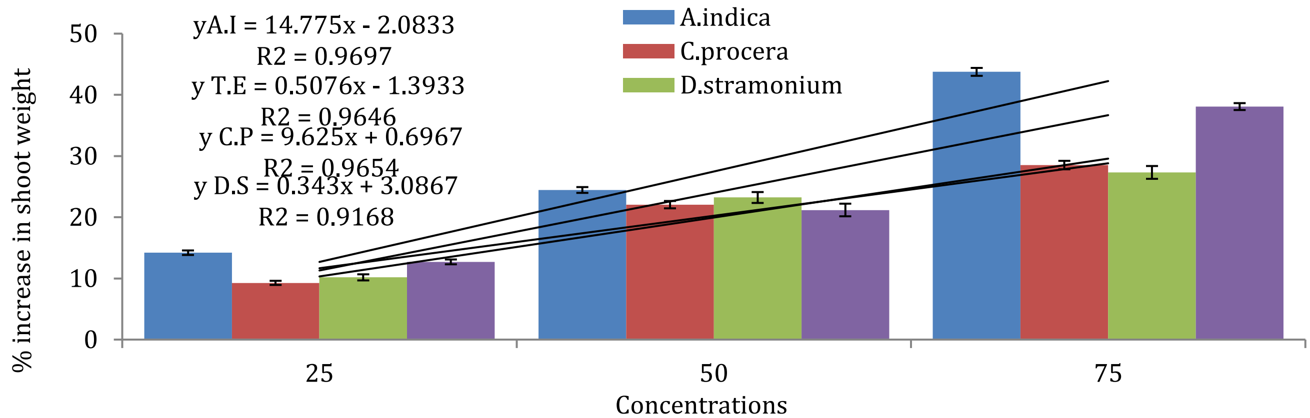

Figure 4: Effect of organic amendments at various concentrations on percent increase in fresh shoot weight.
D.S (*Datura stramonium*), T.E (*Tagestes erecta*), C.P (*Calotropis procera*) and A.I (*Azadirecta indica*)

Dry shoot weight: On the other hand, increase in dry shoot weight was also observed by the applications of amendments. The increase in dry shoot weights was remarkably higher in case of *A. indica* and *C. procera*. Similarly, the magnitude of increase increased with an increase in the concentration of amendments and this increase was found directly proportional to the dosage of the amendments applied. The relationships between doses of individual amendments and increase in dry shoot weight are shown with trend lines and regression equations in figure 5.

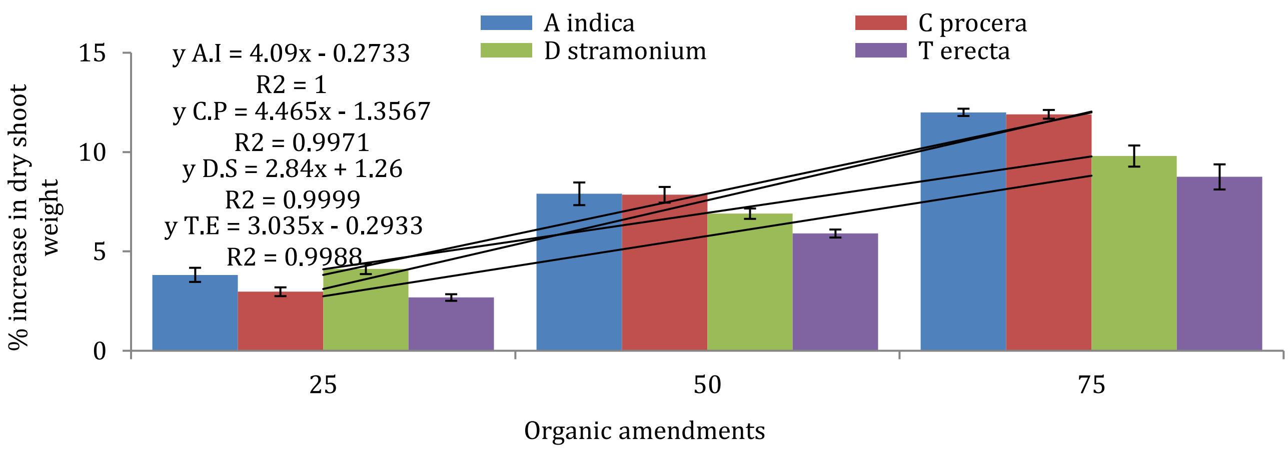

Figure 5: Effect of organic amendments at various concentrations on percent increase in dry shoot weight.
D.S (*Datura stramonium*), T.E (*Tagestes erecta*), C.P (*Calotropis procera*) and A.I (*Azadirecta indica*)

Number of galls and reproduction factor: The analysis of variance regarding number of galls and reproduction factor showed significant effects of amendments, their concentrations and the interaction between amendments and their concentration. All the amendments caused significant reductions in these parameters. Maximum reductions were observed in both parameters with *A. indica* followed by *C. procera* as compared to control (Figures 6 and 7). Similarly, higher concentrations of amendments caused maximum reductions in these factors. The reductions in these parameters were found directly proportional to the concentrations. These relationships are shown by trend lines and regression equations in figures 6 and 7.

DISCUSSION

All the amendments caused significant reductions in *M. incognita* infections resulting in increase in various growth parameters. Higher doses were more effective as compared to lower ones. The results are in line with the findings of Ploeg (2000) and Melakeberhan (2006). The use of organic soil amendments is the cheapest and effective way of controlling diseases caused by nematodes.

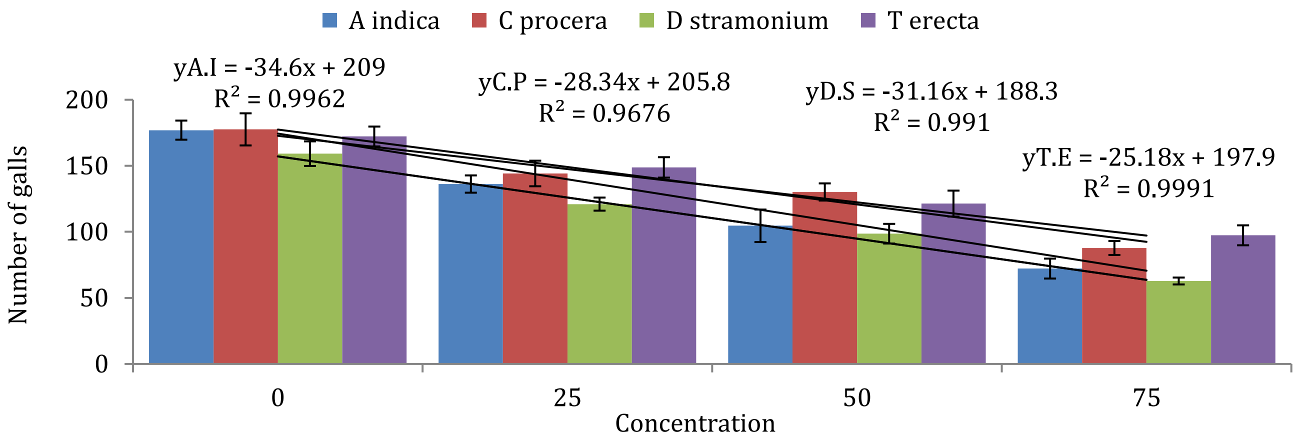

Figure 6: Effect of organic amendments at various concentrations in reduction in galls.
D.S (*Datura stramonium*), T.E (*Tagestes erecta*), C.P (*Calotropis procera*) and A.I (*Azadirecta indica*)

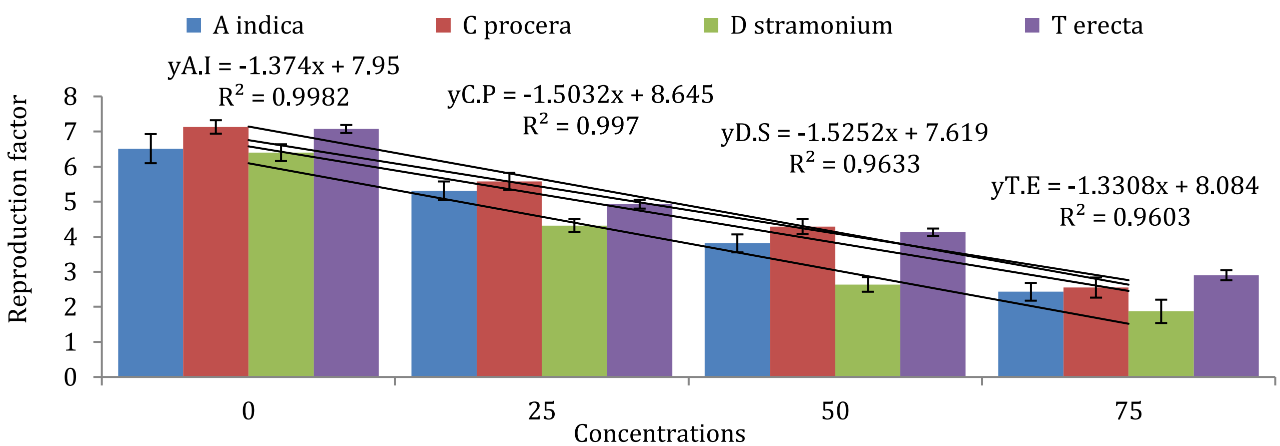

Figure 7: Effect of organic amendments at various concentrations in reduction in reproduction factor.
D.S (*Datura stramonium*), T.E (*Tagestes erecta*), C.P (*Calotropis procera*) and A.I (*Azadirecta indica*)

It not only changes the physical properties and other chemical reactions of soil but also develops a wide variety of antagonistic microorganisms like fungi, bacteria etc., which later on by the phenomenon of competition, antibiosis or parasitism retard the population of the plant disease inciting agents like fungi, bacteria and nematodes etc. The addition of soil amendments results in considerable increase in the liberation of CO_2 by the saprophytic activities of soil saprophytes which in return suppress the activities of disease causing agents (Ferraz and de Freitas, 2004). Due to rapid multiplication of microorganisms within the soil, the soil nitrogen, which is often scanty in soil, is utilized by the soil saprophytes rapidly and a huge scarcity of nitrogen is created by the soil saprophytes. The nitrogen deficiency reduces the growth of pathogens greatly.

It has also been reported that the nematodes' population may be reduced due to the accumulation of toxic substances, which are produced by the decomposition of organic amendments in soil (Wang et al., 2002). Oka (2010) postulated two hypotheses, which explain the effectiveness of soil amendments in two ways. Firstly, the decomposition products from amendments into soil are directly toxic to plant nematodes and secondly manipulation of soil microbial population by addition of amendments initiates a succession of events favoring the buildup of bacteria, nematode trapping fungi and other soil antagonists that destroy plant parasitic nematodes. According to Thoden et al. (2011) the organic matter is incorporated into soils by many organisms (from bacteria to earthworms) and ultimately forms humus. The breakdown of organic matter releases compounds into soil that may be toxic to nematodes. The microorganisms release simple organic acids such as acetic, propionic and butyric acids, which remains for several weeks in concentrations sufficient to kill some phytonematodes but are not toxic to free living species. From the present studies, it is concluded that the amendments with antagonistic plants could be the possible replacement for synthetic nematicides.

REFERENCES

Abad, P., Favery, B., Rosso, M., Castagnone-Sereno, P., 2003. Root-knot nematode parasitism and host response: molecular basis of a sophisticated interaction. Molecular Plant Pathology 4, 217-224.

Agyarko, K., Asante, J.S., 2005. Nematode dynamics in a soil amended with neem leaves and poultry manure. Asian Journal of Plant Sciences 4, 426-428.

Anastasiadis, I.A., Giannakou, I.O., Prophetou-Athanasiadou, D.A., Gowen, S.R., 2008. The combined effect of the application of a biocontrol agent *Paecilomyces lilacinus*, with various practices for the control of root-knot nematodes. Crop Protection 27, 352-361.

FAO, 2009. Faostat Database Collection.

Ferraz, S., de Freitas, L.G., 2004. Use of antagonistic plants and natural products, in: Chen, Z.X., Chen, S.Y., Dickson, D.W. (Ed.), Nematology: advances and perspectives: Nematode management and utilization. Tsinghua University Press, Beijing, China, pp. 931-977.

Hussain, M.A., Mukhtar, T., Kayani, M.Z., 2016. Reproduction of *Meloidogyne incognita* on resistant and susceptible okra cultivars. Pakistan Journal of Agricultural Sciences 53, 371-375.

Kayani, M.Z., Mukhtar, T., 2018. Reproductivity of *Meloidogyne incognita* on fifteen cucumber cultivars. Pakistan Journal of Zoology 50, 1717-1722.

Kayani, M.Z., Mukhtar, T., Hussain, M.A., 2017. Effects of southern root knot nematode population densities and plant age on growth and yield parameters of cucumber. Crop Protection 92, 207-212.

Kayani, M.Z., Mukhtar, T., Hussain, M.A., 2018. Interaction between nematode inoculum density and plant age on growth and yield of cucumber and reproduction of *Meloidogyne incognita*. Pakistan Journal of Zoology 50, 897-902.

Khan, A.R., Javed, N., Sahi, S.T., Mukhtar, T., Khan, S.A., Ashraf, W., 2017. *Glomus mosseae* (Gerd and Trappe) and neemex reduce invasion and development of *Meloidogyne incognita*. Pakistan Journal of Zoology 49, 841-847.

Meah, B., 2003. Integrated management of eggplant cultivation-1, USDA-Bangladesh Collaborative Research Project (Grant No. BG-ARS 106). IPM Laboratory, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh.

Melakeberhan, H., 2006. Fertiliser use efficiency of soybean cultivars infected with *Meloidogyne incognita* and *Pratylenchus penetrans*. Nematology 8, 129-137.

Mukhtar, T., 2018. Management of root-knot nematode, *Meloidogyne incognita*, in tomato with two *Trichoderma* species. Pakistan Journal of Zoology 50, 1589-1592.

Mukhtar, T., Arooj, M., Ashfaq, M., Gulzar, A., 2017a. Resistance evaluation and host status of selected green gram germplasm against Meloidogyne incognita. Crop Protection 92, 198-202.

Mukhtar, T., Hussain, M.A., Kayani, M.Z., 2017b. Yield responses of 12 okra cultivars to southern root-knot nematode (Meloidogyne incognita). Bragantia 76, 108-112.

Oka, Y., 2010. Mechanisms of nematode suppression by organic soil amendments—A review. Applied Soil Ecology 44, 101-115.

Ploeg, A., 2000. Effects of amending soil with *Tagetes patula* cv. Single Gold on *Meloidogyne incognita* infestation of tomato. Nematology 2, 489-493.

Sharma, J.L., Trivedi, P.C., Sharma, M.K., Tiagi, B., 2004. Control of root-knot nematode *Meloidogyne incognita* using fungus *Paecilomyces lilacinus* grown on dung. Journal of Phytological Research 17, 205-206.

Tariq-Khan, M., Munir, A., Mukhtar, T., Hallmann, J., Heuer, H., 2017. Distribution of root-knot nematode species and their virulence on vegetables in northern temperate agro-ecosystems of the Pakistani-administered territories of Azad Jammu and Kashmir. Journal of Plant Diseases and Protection 124, 201-212.

Thoden, T.C., Korthals, G.W., Termorshuizen, A.J., 2011. Organic amendments and their influences on plant-parasitic and free-living nematodes: a promising method for nematode management? Nematology

13, 133-153.

Vagelas, I., Gowen, S., 2012. Control of *Fusarium oxysporum* and root-knot nematodes (*Meloidogyne* spp.) with *Pseudomonas oryzihabitans*. Pakistan Journal of Phytopathology 24, 32-38.

Wang, K.-H., Sipes, B.S., Schmitt, D.P., 2002. Management of *Rotylenchulus reniformis* in pineapple, *Ananas comosus*, by intercycle cover crops. Journal of Nematology 34, 106-114.

Whitehead, A.G., Hemming, J.R., 1965. A comparison of some quantitative methods of extracting small vermiform nematodes from soil. Annals of Applied Biology 55, 25-38.