Pakistan Journal of Phytopathology
Published by:
Pakistan Phytopathological Society
www.pakps.com
www.pjp.pakps.com
info@pakps.com

Pak. J. Phytopathol.,
Vol 24 (1):01-05, 2012.

EFFECT OF ORGANIC AMENDMENTS ON NEMATODE GALLING INDEX AND EGG MASSES PRODUCTION IN POTATO INOCULATED WITH ROOT KNOT NEMATODE

A. Hayat*, N. Javed*, S. A. Khan*, A. S. Gondal* and H. U. Khan**
***** *Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan*
****** *Pakistan Science Foundation, Islamabad, Pakistan*
Corresponding author: amjadshahzad@live.com

ABSTRACT

The effect of organic amendments on susceptible potato cultivars FD-8-1 inoculated with *Meloidogyne incognita* was investigated using sugarcane bagasse, kanair leaves, neem seeds powder, saw dust and caster cake in pot experiment. Number of galls and egg masses were found less on the roots of the plants planted in all amended soils. Plants grown in amended soils with kanair leaves, neem seed powder, saw dust and caster cake had same number of galls and egg masses, higher than that of plants in sugarcane bagasse. The neem seed amended soil was most effective in lowering the number of female. The production of egg masses by the adult female was 60.6% less on the roots of plants in neem amended soil. Neem amendment was 1.5, 1.2, 1.5 and 1.1 times more effective to that of sugarcane bagasse, kanair leaves, saw dust and caster cake respectively. The plants in the soil amended with neem and saw dust produced 58.4% and 33.7% less root galls, respectively. The lower number of galling and egg masses in neem amended soil indicated to be best amendment.
Key words: *Meloidogyne incognita*. organic amendments, potato.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is a prominent cool season vegetable crop that is being grown all over the world. The area under the production in 2009-10 was 138.5 thousand hectares giving the total production of 3141.5 thousand tons (FAO, 2010). Potato has high nutritional value and provides a balanced source of proteins, carbohydrates, vitamins like niacin, riboflavin, thiamin, vitamin C and most of the trace elements needed to maintain good human health (Rowe, 1993). Due to very high starch and sugar contents potato crop is susceptible to wide range of diseases and pest attack due to which a significant part of the produce is lost (Kelman, 1984; Perombelon, 2002). Root knot nematode (*Meloidogyne incognita*) play an important role in eliminating the average yield of potato (Anwar et. *al*, 2009). Root knot nematode (*Meloidogyne* spp.) was first discovered in England on cucumber in a greenhouse (Berkeley, 1855). Annual losses recorded due to *Meloidogyne* spp. were up to 95% (Bourne *et al.*,2004). *Meloidogyne* spp. also form synergy with pathogenic bacteria and fungi which cause significant yield losses (Rivera and Aballay, 2008). Presence of *Meloidogyne incognita* was found to be 85% in Punjab (Anwar *et al*., 2007). The use of synthetic pesticides is the major control measure for nematode diseases (Barker and Koenning, 1998). The use of these chemical pesticides often leads serious environmental problems besides affecting the health of the users and consumers. They also eliminate the natural enemies of other pathogens, creating a need for more pesticides, increasing production costs and the development of insecticide resistance. Insecticide resistance, environmental degradation, human health impacts, resource losses, and agronomic concerns, have thus triggered moves to discourage chemical control to avoid environmental pollution (Hassan *et al.,* 2001) and develop a growing interest in alternate management techniques (Tabassum and Shahina, 2004). Higher organic contents enhance the activity of naturally occurring biological organisms that compete with nematodes in the soil (Peet, 2001). Addition of organic materials to soil has been obviously confirmed as acceptable control method against nematode infestation (Stirling, 1991). Amendments may also give a favorable substrate for the sustenance of soil microfauna and micro flora (Linford, 1937; Linford *et al.,* 1938) that are direct predators of nematodes that suppress the soil nematode population through enzyme production, toxic metabolites such as antibiotic bacterial agent (Rodriguez-Kabana *et al.,* 1983; Galper *et al.,* 1990). In Pakistan, there is a little research on plants growing on amended soils for disease management. This study is carried out to evaluate the effect of different organic amendments on

suppressing the root knot nematode in the soils and roots.

MATERIALS AND METHODS

Collection of infested diseased potato plants: Potato plants with typical symptoms of root knot disease were uprooted gently from fields and infested root samples were kept in rubber band tightened polythene bags stored at 15 ^{O}C in the laboratory for nematodes isolation.

Isolation of root knot nematodes: Isolation of root knot nematodes from the samples was done by observing root knots under stereoscopic microscope and Baermenn funnel method. The samples were washed and cut into ±1 cm sized pieces. Sub-samples of approx. 10 g were wrapped in a piece of cheese cloth and were hung in a Baermenn funnel. Nematodes crawled down out of the material into the water and settled.

Identification of root knot nematodes: Typical knots of the potato roots were dissected longitudinally with a fine blade in a watch glass containing sterilized water. A fully developed female was placed on a glass slide and posterior half of the body was cut off using a surgical scalpel. The lower piece of the cuticle was trimmed in a square pattern and perineal pattern portion was transferred to another glass slide having a drop of glycerin. The cover slip was gently placed and sealed with paraffin. The pattern was examined under stereoscopic microscope. *Meloidogyne incognita* was identified by studying the typical female perineal pattern (Taylor and Netscher, 1974). The perineal pattern of the isolated mature females resembled to *Meloidogyne incognita* (Kofoid & White, 1919).

Effect of organic amendments on nematode gall development and egg mass production: To assess the effect of organic amendments on nematode gall development and egg mass production in potato plants, a pot experiment was conducted at the research area of Department of Plant Pathology, University of Agriculture, Faisalabad. Susceptible potato plants of cultivar FD-8-1 were raised in sterilized loamy soil in 20-cm diameter earthen pots and were allowed to grow for 4 weeks. Sugarcane bagasse, kanair leaves, neem seed powder, saw dust and caster cake were used as amendments by mixing at 75, 150 and 250 g/pot with steam sterilized sandy soil (1.5 kg/pot), two weeks after sowing. One and half month old potato plants were transplanted into amendment containing soils in pots. 3-4 holes of 3-cm depth around each plant were made using a piece of pointed wood. Approximately 2000 eggs held in a small volume of egg suspension were pippetted in the holes. The holes were covered with soil to prevent drying. The plants were carefully watered next day to prevent loss of eggs leaching or excess drying. The experiment was laid out as completely randomized design with four replicates.

Observations: The plants were carefully uprooted after 60 days to determine fresh root and shoot length (cm), root and shoot weight (g), number of knots, females, males and larvae/plant. The root systems were rated for galling index on 0-5 scale (Taylor & Sasser, 1978), where 0 = no gall or egg mass, 1 = 1-25, 2 = 26-50, 3 = 51-75, 4 = 75-100 and 5 = > 100 galls/plant.

Data analysis: The recorded data was analyzed for analysis of variance and computing $P < 0.05$ and 0.01, using SAS statistical software (SAS Institute, Cary, NC, USA). The significance of differences within treatments was tested using Duncan's multiple range tests (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Effect of organic amendments on gall development and galling index: The development of galls on potato roots, by root knot nematode, *M. incognita* was reduced when the plants were grown in soil amendments. The minimum galls/plant (25.3) was recorded in case of soil amended with seeds of neem as compared to non-amended control soil. Three organic amendments viz. kanair leaves, saw dust and caster cake produced almost similar number of eggs, more as compared to grinded seeds of neem, but less than sugarcane bagasse and control. Plants grown in soil amended with sugarcane baggause produced high number of galls (40.5) among all amendments. On the basis of galling index, sugarcane bagassse, saw dust and control had the same galling index (4) whereas caster cake, ground seed of neem and kanair leaves had the similar galling index (3). Maximum decrease in number of galls was observed in the amendment with ground seeds of neem that was 58.4%. In kanair leaves 51.4% and caster cake 51.1% reduction as compared to control was observed. The least percent decrease was observed in sugarcane bagasse that was 33.3%. It concludes that these organic amendments are better in controlling *Meloidogyne incognita* as compared to other organic amendments and control.

Effect of organic amendments on egg mass production and egg mass index: Plants grown in soil amended with ground seeds of neem produced less number of egg masses (34.3) as compared to all other organic amendments and control. Organic amendments viz. kanair leaves, saw dust and caster cake produced the similar number of egg masses but these were more as compared to ground seeds of neem and less than sugarcane bagasse and control. Among the organic amendments, sugarcane bagasse produced the most number of egg masses (51.3), so it was least effective.

On the basis of egg mass index, all treatments and control were same (4), however the most number of egg masses were produced in control. Maximum decrease in number of egg masses (60.6%) was observed in amendment with grind seeds of neem. In kanair leaves 51.4% and caster cake 54.3% reduction as compared to control was observed. The least percentage decrease (40.5%) was observed in saw dust.

The number of galls and egg masses were found less on the roots of the plants planted in all amended soils than those planted in the non-amended soils. The lower no.

Table 1. Effect of organic amendments on the production of root galls and galling index on the roots of potato.

Soil Amendments	No. of galls*	Gall index**	Decrease in control over control (%)
Sugarcane bagasse	40.5b	4	33.3
Kanair Leaves	29.5bc	3	51.4
Ground seed of neem	25.3c	3	58.4
Saw dust	40.3bc	4	33.7
Caster cake	29.7bc	3	51.1
Control (Nematodes only)	60.7a	4	

*Means within a column followed by the same letter are not significantly different according to Duncan's multiple range test at P = 0.05

** Scale used for gall and egg mass indices: 0-5 scale; where 0 = no gall or egg mass, 1 = 1-25, 2 = 26-50, 3 = 51-75, 4 = 75-100 and 5 = > 100 galls or egg mass/plant.

Table 2. Effect of organic amendments on the production of egg mass and egg mass index on the roots of potato cv. FD-8-1

Soil Amendments	No. of egg masses*	Egg mass index**	Decrease in egg mass over control (%)
Sugarcane bagasse	51.3 b	4	41.1
Kanair Leaves	42.3 bc	4	51.4
Ground seed of neem	34.3 c	4	60.6
Saw dust	51.8 c	4	40.5
Caster cake	39.8 bc	4	54.3
Control (Nematodes only)	87.0 a	4	

*Means within a column followed by the same letter are not significantly different according to Duncan's multiple range test at P = 0.05

** Scale used for gall and egg mass indices: 0-5 scale; where 0 = no gall or egg mass, 1 = 1-25, 2 = 26-50, 3 = 51-75, 4 = 75-100 and 5 = > 100 galls or egg mass/plant.

of galls production with neem amendment provided the evidence that the neem was the best treatment. The lower production of galls is a tissue response; suggesting that the neem was absorbed by the root tissues (Javed *et al.,* 2006). Neem extracts can be used for the management of root knot nematodes (Muller and Gooch, 1982). The effectiveness of neem against nematode has also been reported by other scientists (Alam, 1986; Alam and Shabir, 1986; Sheikh 1989). Different scientists reported on the mechanisms associated with effectiveness of neem products against nematodes. Nematicidal bioactive compounds in neem are soluble in water, which can be absorbed by the plants and make the plant tissue toxic for nematodes development and reproduction (Egunjobi and Aflomi, 1967; Alam *et al.,* 1978; Khan *et al.,* 1974). Phenolic compounds are absorbed systemically by the roots of potato plant exposed to neem formulations which might have induced tolerance against nematodes (Alam *et al.,* 1980). This study reveals that all soil

amendments were effective in reducing the root knot nematode (*Meloidogyne incognita*) infestation. However the neem was the most effective amendment in preventing the fecundity of adult female and consequently the egg mass production. The reduction in egg mass formation will ultimately reduce residual population in the soil.

CONCLUSION: It is concluded from the results that all soil amendments were effective in reducing the infestation of *Meloidogyne incognita*, however neem was the most effective amendment followed by caster cake and kanair leaves than saw dust in preventing the fecundity of adult female and consequently the egg mass production. Sugarcane bagasse remained less effective against *Meloidogyne incognita.*

REFERENCES

Alam, M.M and A. Shabir. 1986. Soil population of plant parasitic nematodes infecting triticale hexapodies as influenced by soil amendments and nematicides Int. Nematol. Network Newsl. 3(1): 19-20.

Alam, M.M. 1986. Possible use of weeds as soil amendments for the management of root-knot and stunt nematodes attacking eggplant. Agricultural Wastes, 16: 97-102.

Alam, M.M., A.M. Khan and S.K. Sexena. 1978. Mechanism of control of plant parasitic nematodes as a result of the application of organic amendments to the soil. IV-Role of formaldehyde and acetone.Indian. J. Nematol., 8: 172-174.

Alam, M.M., M. Ahmad and A.M. Khan. 1980. Effect of organic amendment on the growth and chemical composition of tomato, egg plants and chillies and their susceptibility to attack by *Meloidogyne incognita.* Plant Soil, 57: 231-236.

Anwar, S.A., A. Zia., M. Hussain and M. Kamran. 2007. Host suitability of selected plants to *Meloidogyne incognita* in the Punjab, Pakistan. Int. J. Nematol., 17:144-150.

Anwar, S.A., N. Javed, A. Zia, M. Kamran and M. Hussain. 2009. Root knot nematode reproduction and galling severity on thirteen vegetable crops. Pp. 310-314. International Symposium on prospects of Horticultural Industry in Pakistan. Held at University of Agriculture, Faisalabad on March 28-30, 2007.

Barker, K.R. and S.R. Koenning. 1998. Developing sustainable system for nematode management. Annu. Rev. Phytopathol., 36:165-205.

Berkeley, M.J. 1855. Vibrio forming excrescences on the roots of cucumber plants. Gard.Chron., 14: 220 (Throne's Principles of Nematology. McGeaw Hill Book Co. New York, 1961. p. 312).

Bourne, J.M., P.K Karanja, H. Kalisz, D.K. Karanja, T.H. Mauchline and B.R. Kerry. 2004. Incidence and severity of damage caused by *Meloidogyne* spp. and isolation and screening of the nematophagous fungus *Pochonia chlamydosporia* from some of the main vegetable growing areas in Kenya. Int. J. Nematol., 14(1): 111-120.

Egunjobi, O.B. and S.O. Aflomi. 1967. Effect of neem leaf extract on population of *Pratylencus branchyrus* on growth and yield of maize. Nematologica, 22: 125-132.

Galper, S., F. Choen, Y. Spiegel and I.Chet. 1991. Nematicidal effect of collagen amended soil and collagenase. Rev. de. Nematologie, 1(1): 67-71.

Hassan, S.M.E., M.S. Rahman, M.R. Amin, A.T.M.R. Hoque and S.M.S. Islam. 2001. Effect of some organic substances on the root knot disease of brinjal. On line J. Biol. Sci., 1(8): 791-792.

Javed, N., S.R. Gowen, M.I. Haq and, S.A. Anwar. 2006. Protective and curative effect of neem (*Azadirachtaindica*) formulations on the development of root knot nematode (*Meloidogyne javanica*) in roots of tomato plants. Crop Protection, 26(4): 530-534.

Kelman, A.H.E. 1984. Post-harvest pathology of fruits and vegetables. Univ. Calif. Agri. Exp. Stn. Bull., 1914: 1-3.

Khan, A. M., M.M. Alam and S.K. Saxena. 1974. Mechanism of the control of plant parasitic nematodes as a result of the application of oil-cakes to the soil. Indian J. Nematol., 4: 93-96.

Linford, M.B. 1937. Stimulated activity of natural enemies of nematodes. Soil Science, 85: 123-124.

Linford, M.B., F. Yap and J.M. Olivelra. 1938. Reduction of soil populations of root knot nematodes during decomposition of organic matter. Soil Science, 45: 127-141.

Muller, R. and P.S. Gooch. 1982. Organic amendments in nematode control. 1983. An examination of literature (Helminth Abst. 872, Sr. B. 52(2): 93). North Carolina State. University.http://www.cals.ncsu.edu/sustainable/ peet/ IPM/nematodes/c06nemat.html

Peet, M. 2001. Sustainable practices for vegetable production in the south. North Carolina State University.

http://www.cals.ncsu.edu/sustainable/peet/IPM/nematodes/c06nemat.html

Perombelon, M.C.M., 2002. Potato diseases caused by soft rot *erwinias*: An overview of pathogeneses. Plant Pathology 51: 1-12.

Rivera, L. and E. Aballay. 2008. Nematicide effect of various organic soil amendments on *Meloidogyne ethiopica*, on potted vine plants. Chilean Journal of Agricultural Research. 68 (3), 290-296.

Rodriguez-Kabana, R., G. Godoy, G. Morgan-Jones and R.A. Shelby. 1983. The determination of soil chitinase activity: Conditions for assay and ecological studies. Plant and Soil, 75: 95-106.

Rowe, T., W. Carlson, and W. Bottorff, 1993. *Thrinaxodon*: Digital Atlas of the Skull. CD-ROM (First edition, for MS-DOS platform), University of Texas Press, 623 megabytes.

Sheikh, K.M. 1989.Control of root-knot nematode (*Meloidogyne* spp.) by soil amendments. M.Sc. Theses, p. 84. Dept. Pl. Path. Univ. of Agric., Faisalabad.

Stirling, G.R. 1991. Mode of action of organic amendments against nematodes. *In:* Biological Control of plant parasitic nematodes. Progress, Problems and Prospects. C. A. B. International, pp. 170-185.

Tabassum, K.A. and F. Shahina. 2004. In vitro mass rearing of different species on Entomopathogenic namatodes in monoxenic solid culture. Pak. J. Nematol., 22(2): 167-175.

Taylor, A.L., and J.N. Sasser. 1978. Biology, identification and control of root knot nematodes (*Meloidogyne* spp.). North Carolina State Univ. Raleigh Graphics, USA P. 111.

Taylor, P. and C. Netscher, 1974. An improved technique for preparing perineal patterns of *Meloidogyne* spp. Nematologica, 20: 268-269.