Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(6): 716-720

Received: 19-09-2017
Accepted: 22-10-2017

Silpi Patel
Ph.D Schloar, Department of Nematology, Odisha University Of Agriculture and Technology (OUAT), Bhubaneswar, Odisha, India

Narpinderjeet Kaur Dhillon
Department of Plant Pathology, Punjab Agricultural University, Ludhiana, Punjab, India

Correspondence
Silpi Patel
Ph.D Schloar, Department of Nematology, Odisha University Of Agriculture and Technology (OUAT), Bhubaneswar, Odisha, India

Evaluation of sunnhemp (*Crotalaria juncea)* as green manure /amendment and its biomass content on root knot nematode (*Meloidogyne incognita*) in successive crop brinjal

Silpi Patel and Narpinderjeet Kaur Dhillon

Abstract
In the present study an attempt was made to evaluate the effect of sunnhemp (*Crotalaria juncea)* as green manure and amendment along with the quantity of biomass incorporated upon root knot nematode in successive crop brinjal (2013-14 and 2014-15). Application of sunnhemp as green manure or as amendment decreased nematode infestation in soil as well as in successive crop brinjal after the evaluation of results of the experiment. Sunnhemp as green manure was found to be more effective than its use as amendment for reducing infestation in soil and roots. When sunnhemp was green manured/amended in soil shoot height and shoot weight were also increased. For reduction of nematode infestation in soil and roots of successive crop brinjal incorporation of biomass @ 75gm/kg was found to be effective.

Keywords: amendment, green manure, management, root-knot nematode, sunnhemp (*Crotalaria juncea*)

Introduction
Recent years have shown a shift to pest control strategies from chemical to ecologically safe methods due to increase in public awareness on environmental pollution and hazards caused by pesticide residues. Addition of organic cover crops, green manure, amendments not only increases the nutrient content of soil but also play role in change of micro flora and micro fauna community structure in the soil. Certain amendments also play role in disease suppression of some important soil borne pathogens. Of the different soil borne pathogens associated with crops, root knot nematode is becoming an important limiting factor especially in vegetable crops in open as well as protected cultivation. Growing of susceptible plants, builds up the nematode population to a maximum as crop reaches maturity (Shurtleff *et al.*, 2000) [28] and in some cases the plants die even before reaching maturity (Singh and Khurma, 2007) [29]. Management of *Meloidogyne* spp. and other plant-parasitic nematodes has been challenging worldwide, particularly due to reduced availability or complete ban of effective chemical nematicides such as methyl bromide. Major limitations to wide use of synthetic nematicides include their hazards to environment, toxicity to important non-target organisms including humans, high cost, and limited availability in developing countries. This has prompted the search for environmentally safe alternative control methods. Scientists looking for alternative strategies are exploring the use of natural products with nematicidal activity such as organic amendments, root exudates, plant volatile compounds, entophytic bacteria, crop rotation, plant extracts and use of cover or antagonistic crops and resistant varieties.
Green manures has the potential to increase soil organic matter (Allison, 1973) [2], increase microbial activity (Harris *et al*., 1994) [9] and suppress plant diseases (Viaene and Abawi, 1998) [31], reduce erosion (Creamer *et al*., 1997) [6], improve the physical characteristics of the soil (Reid and Goss, 1981) [23] and reduce plant diseases (Sumner and Boosalis, 1981) [30]. Phytochemicals could offer sustainable management option due to the presence of nematicidal properties in many higher plants (Chitwood, 2002) [5]. Antihelminthic compounds are produced by antagonistic plants with different modes of action (Pandey *et al.*, 2003) [19]. Antagonist crops such as marigold, sorghum, sudangrass, brassica and sunnhemp being non-hosts of root-knot nematode are also recently being considered for management of nematodes.

Marigolds, *Tagetes* species which exude polythienyls have been proven to be nematicidal in nature and are being widely studied. Sunnhemp (*Crotalaria juncea* L.) is a fast-growing legume that is used as a cover crop in many tropical and subtropical areas and has been recommended by PAU (Punjab Agricultural University, Ludhiana). It has been reported to possess nematicidal properties (Ritzinger and McSorley, 1998) [26]. In addition to its antagonistic nature to nematodes when incorporated into the soil, sunnhemp adds organic manure thus increasing its twofold utility in sustaining productions in organic systems (Wang *et al.*, 2004) [33]. The present study intends to explore the allelopathic properties of *Crotalaria juncea* for management of root knot nematode in infested soils.

Materials and Methods

Studies were conducted in pot house of Department of Plant Pathology, Punjab Agricultural University (PAU) Ludhiana for two years in 2013-14 and 2014-15 to evaluate the efficacy of two application methods viz. a viz, Sunnhemp (*Crotalaria juncea)* as green manure and as amendment along with the effect of quantity of biomass incorporated to manage root knot nematode in successive brinjal crop. The experiment was conducted in two parts as follows-

1. Evaluation of Sunnhemp as green manure and its biomass content on root knot nematode in succeeding crop brinjal.
2. Evaluation of Sunnhemp as amendment and its biomass content on growth parameters and root knot nematode in succeeding crop brinjal

1. Evaluation of Sunnhemp as green manure and its biomass content to manage root knot nematode in succeeding crop brinjal. The trial was conducted for two consecutive years 2014 and 2015. In first year; pots were filled with infested soil with initial population of 264.6 juveniles/ 250cc soil. Fifteen seeds of sunnhemp were sown in each 8 inch pot. After germination, thinning was done to maintain 10 plants/pot. Irrigation frequency and duration was adjusted according to plant growth stages. Fifty day old sunnhemp was uprooted and weighed. Plant parts were cut into 2 cm long pieces and calculated amount of biomass of green manure i.e 0g/kg (no green manuring), 25g/kg, 50g/kg, 100g/kg and 200g/kg green manure was incorporated into the soil of the same pot used. Wetting period of 10 days was given and watering at alternate day was done so that it was fully decomposed in soil. Soil nematode population/250cc was assessed after green manuring. After that successive susceptible brinjal was transplanted to each pot. Each treatment was replicated thrice in both years. Observations on nematode population in soil were recorded two times, i) fifteen days after green manuring ii) after sixty days of transplanting of brinjal crop. RGI (Root Galling Index) was taken on 0-5 scale at the end of the crop brinjal. The data was subjected to analysis of variance (ANOVA) and CRD for significant differences using CPCS1.
2. Evaluation of Sunnhemp as amendment and its biomass content on growth parameters and root knot nematode in succeeding crop brinjal

Experiment was conducted in pots to study the effect of use of sunnhemp as a amendment. For amendment; sunnhemp was grown in the field and after 50 days it was uprooted and weighed. Chopped sunnhemp shoot parts with the above said weight were added to soil and pots were watered and soil was upturned thrice in a week for proper mixing and decomposition of sunnhemp before sowing of susceptible brinjal crop. Observations were taken on soil nematode populations after 50 days of transplanting of successive crop brinjal. RGI (Root Galling Index) was also taken on 0-5 scale at the end of the crop brinjal.

Results

Results in trials conducted in 2013-14 revealed that soil nematode population taken after fifteen days of green manuring and amendment with sunnhemp decreased significantly (< 60% reduction) as compared to initial population of soil (Table 1 and 2). In trials on green manuring with sunnhemp, brinjal was taken as successive susceptible crop after fifteen days of green manuring. Observations on nematode population in brinjal crop taken after 60 days revealed that the buildup of root-knot nematode population was higher in control where sunnhemp was not incorporated (Reproduction factor (Rf) = 2.16) as compared to treated pots. Maximum decrease in nematode population was observed in pots green manured with sunnhemp@200g/kg of soil (62% reduction) followed by 100g/kg soil. Buildup of root knot nematode in these dosages was observed to be less than the initial population (Rf<1) and both these dosages were significantly at par with each other. Biomass content of 25g and 50g of sunnhemp when used as green manure reduced soil nematode population/250 cc soil; however it was significantly less as compared to higher application rates of 100 and 200g/kg soil. Buildup of root knot nematode population in successive crop brinjal was more at these dosages (Rf>1) respectively in brinjal (Table 1). Root galling index in brinjal was observed to be significantly less in sunnhemp green manured pots (2.1-2.3 at 100 and 200g/kg soil) as compared to control (4.8).

Experiments on effect of sunnhemp as amendment revealed that the reduction in nematode population was comparatively less than the pots where sunnhemp was grown and green manured. Reduction in nematode population in soil at sixty day old brinjal crop was observed to be 37-55% in pots amended with sunnhemp@100 and 200g/kg soil as compared to 62-63% in pots green manured with sunnhemp. RGI was maximum in brinjal plants grown in non-green manured / non amended pots. (4.7). It was observed to be significantly less in pots when sunnhemp was added as as amendment(2.3-2.5) at application rates of 100 and 200g/kg soil.

Application of sunnhemp as green manure or as amendment increased growth parameters of following crop brinjal.(Fig.1-2) Maximum increase in shoot length was observed in 200 g/kg of incorporation of green manure followed by 100g/kg (16.3 cm), 50 (15.8 cm) and 25g(10.1 cm) of incorporation. Increase in shoot weight was also observed to be maximum at 200g (20.9g) and minimum at 25g (13.7g). Root length increased significantly by more than 70% at application of biomass content of 100g (6.7 cm) and 200g (7.0 cm). Root weight also increased by more than 35 % in greater than 100g incorporation as compared to control. Addition of sunnhemp as amendment significantly increased growth parameters though it was found to be comparatively less as compared to incorporation of sunnhemp as green manure.(Fig1 and 2)

The experiment was repeated in 2015. Since the application rates of 100 and 200g/kg were observed to be at par in 2014; the repeated experiment was with treatments of 0,25,50,75 and 100g/kg soil. Root-knot nematode population soil and roots decreased significantly on application of sunnhemp as green manure or as amendment. Decrease in soil population and RGI was higher in pots green manured with 75g/kg and 100g/kg of sunnhemp and these two applications were

statistically at par with each other. Incorporation @ 25 and 50g/kg soil of sunnhemp was observed to be significantly less as compared to higher dosage of 75 and 100g/kg soil. Growth parameters were also observed to be higher at these dosages.

Discussion

The present findings revealed that incorporation of sunnhemp reduced root-knot nematode infestation in soil as observed fifteen days after green manuring. On growing of successive susceptible crop brinjal buildup of nematode population was less in 100g and 200g/kg incorporation (Rf<1) as compared to 25g and 50g/kg soil (Rf>1) indicative of the persistent effect of sunnhemp application at these dosages even after growing of susceptible crop and inferring that the amount of biomass content incorporated into soil had significant effect on the buildup of nematode population. The two year studies revealed that use of sunnhemp as green manure was comparatively more effective in reducing *M. incognita* infestation as compared to its use as amendment. Growth parameters were also observed to be higher in application of sunnhemp as green manure as compared to amendment. Green manure crops have been reported to possess significant potential in the suppression of RKN (*Meloidogyne* spp.) under both greenhouse and field conditions as observed by Morris and Walker (2002), Wang *et al.* (2003) [32] and Kimenju *et al.* (2008). By direct or indirect ways, organic matter has been reported to play an important role in management of nematodes. Directly by releasing toxic products (after decomposition) that kill or inactivate nematodes or indirectly by increasing soil fertility (Boehm *et al.,* 1993) along with altering soil physical and chemical properties affecting soil micro flora (Huang and Huang, 1993). As organic matter decomposes, the initial microbial population eventually decreases as the metabolism of simple sugars, pectins and amino acids is completed (Ferris and Matute, 2003). Incorporation of sundangrass increased populations of total bacteria, fungi, and nematodes as reported by Widmer and Abawi (2000) [1, 35]. Many of these organisms or their metabolites are beneficial for plant growth or antagonistic toward plant pathogens, including nematodes (Viaene and Abawi, 2000) [1].

Conclusion

Results from this study indicate that green manuring with sunnhemp reduced root-knot nematode population in soil as well as in successive susceptible crop brinjal. Sunnhemp which is a legume has property of rapid production of biomass and has been documented to increase nematode antagonistic fungi and suppress many plant-parasitic and bacteriovorous nematodes involved in sol nutrient cycling (Wang *et al.,* 2002) besides improving soil nutrient levels (Reeves *et al.,* 1996) [22]. The reduction in nematode population may be due to production of pyrroloizidine alkaloids and monocrotaline by sunnhemp which possess high vertebrate toxicity and are toxic to nematodes (Rich and Rahi, 1995) [24]. Nematode body began to jerk upon exposure of nematode juveniles to monocrotalline solution (Fassuliotis and Skucas 1969) [7]. Marban-Mendoza *et al.* (1992) [14] had also observed that in large scale cropping system; it may be more practical to grow the legumes and incorporate them as green manures. Incorporating cover crop biomass helps to add nutrients into the soil and can positively impact soil quality by increasing organic matter and improving soil structure (Magdoff and van Es, 2000) [13].

Conclusively, green manuring with sunnhemp have the ability to decrease root knot nematode populations in soil and in successive crops grown when used with optimum biomass contents. Therefore, there is need to explore use of sunnhemp as a green manure crop not only to improve soil fertility but also for management of root knot nematodes in an Eco compatible way for sustaining productions in organic ecosystems.

Table 1: Evaluation of Sunnhemp as green manure and its biomass content on root knot nematode in succeeding crop brinjal (2014-15)

Treatments (g/kg)	Soil nematode popn (after 15 days of GM **)	Per cent reduction over initial population(Pi)*	Soil nematode popn/250cc (at 60 day old brinjal crop)	Rf=Pf/Pi*	RGI (Root Galling Index)	Per cent reduction over control
25	256 (16.0)***	19.1	486 (22.0)***	1.5	3.8	20.8
50	202 (14.2)***	36.1	400 (20.0)***	1.2	3.5	27.0
100	106 (11.6)***	66.5	256.6 (16.0)***	0.8	2.3	52.0
200	99 (9.9)***	68.7	253.3 (15.9)***	0.8	2.1	56.2
Control	226 (15.6)***	28.6	686.6 (26.2)***	2.1	4.8	
C D	1.11		1.6		0.5	

*Initial Population (Pi) - 316.6 nem/250cc soil,
**GM= Green Manuring,
***(Root mean square transformed values)

Table 2: Evaluation of Sunnhemp as amendment and its biomass content on root knot nematode in succeeding crop brinjal (2014-15)

Treatments (g/kg)	Soil nematode popn. (after 15 days of GM**)	Per cent reduction over initial population(Pi)*	Soil nematode popn./250cc (at 60 day old brinjal crop)	Rf=Pf/Pi*	RGI (Root Galling Index)	Per cent reduction over control
25	252 (15.8)***	4.76	423 (20.5)***	1.5	3.8	19.1
50	216 (14.7)	18.3	336.6 (18.3)	1.4	3.6	23.4
100	142 (12.7)	46.3	286.6 (16.9)	1.0	2.5	46.8
200	138 (11.7)	47.8	216.6 (14.7)	0.8	2.3	51.0
control	203 (14.5)	23.2	483.3 (21.9)	1.8	4.7	
C D	1.1		1.5		0.5	

*Initial Population (Pi) - 264.6nem/250cc soil
**GM= Green Manuring
***(Root mean square transformed values)

Table 3: Evaluation of Sunnhemp as green manure and its biomass content on root-knot nematode in succeeding crop brinjal (2014-15)

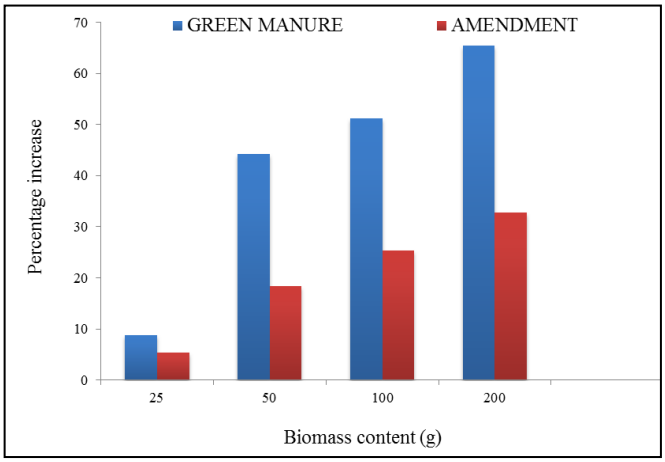
Treatments (g/kg)	Soil nematode popn. (after 15 days of GM**)	Per cent reduction over initial population(Pi)*	Soil nematode popn./250cc (at 60 day old brinjal crop)	Rf=Pf/Pi*	RGI (Root Galling Index)	Per cent reduction over control
25	225 (15.0)***	39.7	385.5 (19.6)***	1.0	3.5	27
50	215 (14.6)	42.4	371.0 (19.2)	0.9	3.4	29.1
75	145 (12.0)	61.1	220.0 (14.8)	0.4	2.3	52
100	138 (11.7)	63.0	206.6 (14.3)	0.4	2.3	52
control	213 (14.6)	42.9	499.1 (22.3)	1.3	4.8	
C D	1.14		1.5		0.55	

*Initial Population (Pi)- 373.3nem/250cc soil
**GM= Green Manuring
***(Root mean square transformed values)

Table 4: Evaluation of Sunnhemp as amendment and its biomass content on root knot nematode in succeding crop brinjal (2014-15)

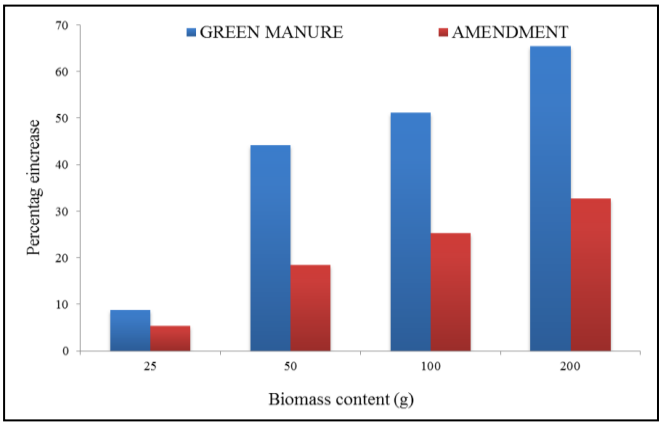
Treatments (g/kg)	Soil nematode popn. (after 15 days of GM)**	Per cent reduction over initial population(Pi)*	Soil nematode popn./250cc (at 60 day old brinjal crop)	Rf=Pf/Pi*	RGI (Root Galling Index)	Per cent reduction over control
25	262 (16.2)***	22.1	390 (19.7)***	1.1	3.7	22.9
50	247 (15.7)	26.6	360 (18.9)	1.1	3.5	27.0
75	183 (13.5)	45.6	257 (16.0)	0.8	2.8	41.6
100	163 (12.7)	51.5	244.0 (15.6)	0.7	2.6	45.8
Control	236 (15.3)	29.8	391 (19.7)	1.1	4.8	
C D	1.2		1.4		0.57	

*Initial Population (Pi) - 336.6nem/250cc soil
**GM= Green Manuring
***(Root mean square transformed values)



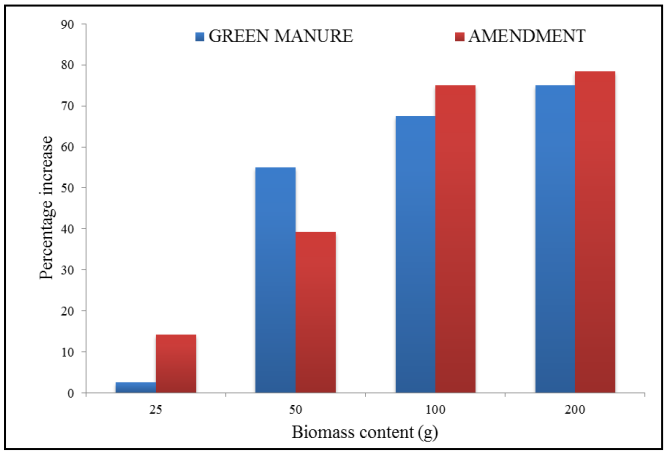
Shoot length (Percentage increase)

Fig 1: Efficacy of sunnhemp as green manure and amendment upon brinjal shoot length



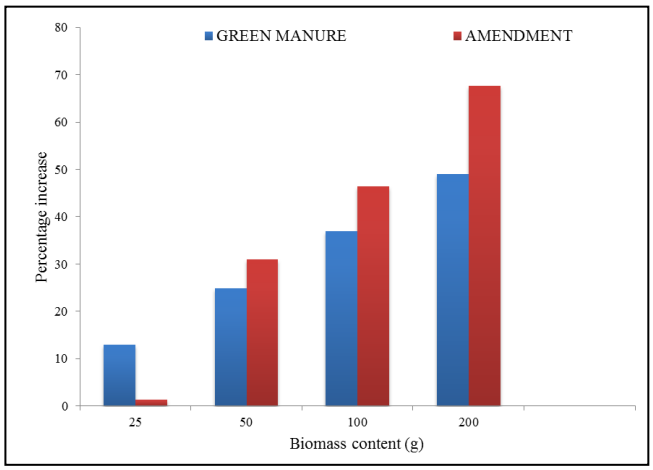
Shoot weight (Percentage increase)

Fig 2: Efficacy of sunnhemp as green manure and amendment upon brinjal shoot weight



Root length (Percentage increase)

Fig 3: Efficacy of sunnhemp as green manure and amendment upon brinjal root length



Root weight (Percentage increase)

Fig 4: Efficacy of sunnhemp as green manure and amendment upon brinjal root weight

References

1. Abawi GS, Widmer TL. Impact of soil health management practices on soil borne pathogens, nematodes and root diseases of vegetable crops. Applied Soil Ecology. 2000; 15:3747.
2. Allison FE. Soil Organic Matter and its Role in Crop Production. Elsevier, New York, 1973, 639.
3. Bello LY, Abogunde MO. Effect of *Delonix regia* leaf extract on egg hatch and larva mortality of root-knot nematode *Meloidogyne incognita*. Archives of Phytopathology and Plant Protection. 2010; 39:253-257.
4. Boehm MJ, Madden LV, Hoiting. Effect of organic matter decomposition level on bacterial species diversity and composition in relationship to *Phytium* damping off severity. Applied Environmental Microbiology. 1993; 59:4171-4179.
5. Chitwood DJ. Phytochemical based strategies for nematode control. Annual Review of Phytopathology. 2002; 40:221-249.
6. Creamer NG, Bennett MA, Stinner BR. Evaluation of cover crop mixtures for use in vegetable production systems. Horticultural Science. 1997; 32:866-870.
7. Fassuliotis G, Skucas GP. The effect of pyrrolizidine alkaloid ester and plants containing pyrrolizidine on *Meloidogyne arcita*. Journal of Nematology. 1969; 1:287-288
8. Gallardo-Lara F, Nogales R. Effect of the application of town refuse compost on the soil-plant system: A review. Biological Wastes. 1987; 19:35-62.
9. Harris GH, Hesterman OB, Paul EA, Peters SE, Janke RR. Fate of legume and fertilizer nitrogen in a long-term cropping systems experiment. Journal of Agronomy. 1994; 86:910-915.
10. Huang HC, Huang JW. Prospects for control of soil-borne plant pathogens by soil amendments. Current Topics in Botanical Research. 1993; 1:223-225.
11. Jing GN, Halbrendt JM. Nematicidal compounds from rapeseed (*Brassica napus* and *B. campestris*). Journal of the Pennsylvania Academy of Science. 1994; 68:29-33.
12. Kimenju JW, Kagundu AM, Nderitu JH, Mambala F, Mutua GK, Kariuki GM. Incorporating green manure into bean cropping systems. Asian Journal of Plant Science. 2008; 5:1682-3974.
13. Magdoff F, van Es H. Building soils for better crops, 2nd ed. Burlington, VT: Sustainable Agricultural Publications, University of Vermont, 2000.
14. Marban-Mendoza N, Dicklow MB, Zuckerman B. Control of *Meloidogyne incognita* on tomato by leguminous plants. Fundamentals of applied Nematology. 1992; 15:97-100.
15. Miller PM, Sands DC, Rich S. Effects of industrial residues, wood fiber wastes and chitin on plant parasitic nematodes and some soil borne disease. Plant Disease Reporter. 1973; 57:438-442.
16. Mohammed A, Alan M. Utilization of waste materials in nematode control. Aligarh Muslim University, India. Phytopathology. 2003; 156:264-267.
17. Mojtahedi H, Santo GS, Wilson JH, Thorpe HJ. Managing *Meloidogyne chitwoodi* on potato with rapeseed as green manure. Plant Disease. 1993; 77:42-46.
18. Morris JB. Special purpose legume genetic resources conserved for agricultural, industrial and pharmaceutical use. Economic Botany. 1997; 51:251-63.
19. Pandey R, Sikora RA, Kalra A, Singh HB, Pandey S. Plants and their products act as major inhibitory agents. In: Nematode Management in Plants. Trivedi PC (ed), Scientific Publishers, Jodhpur, India, 2003, 103-131.
20. Patrick ZA, Sayre RM, Thorpe HJ. Nematicidal substances for plant-parasitic nematodes in extracts of decomposing rye. Phytopathology. 1965; 55:702-704.
21. Pederson GA, Fair brother TE, Greene SL. Cyanogenesis and climatic relationships in U.S. white clover germplasm collection and subset. Crop Science. 1996; 36:427-433.
22. Reeves DW, Mansoer Z, Wood CW. Suitability of sunnhemp an alternative legume crop. in Proceedings of the new technology and conservation tillage, Jackson, TN: University of Tennessee Agricultural Experiment Station, 1996; 96-07:125-130
23. Reid JB, Goss MJ. Effect of living roots of different plant species on aggregate stability of two arable soils. Journal of Soil Science. 1981; 32:521-541.
24. Rich JR, Rahi GS. Suppression of *Meloidogyne javanica* and *M. incognita* on tomato with ground seed of castor, *Crotalaria*, hairy indigo and wheat. Nematropica. 1995; 25:159-164
25. Riegel C, Noe JP. Chicken litter soil amendment effects on soil borne microbes and *Meloidogyne incognita* on cotton. Plant Disease. 2000; 84:1275-1281.
26. Ritzinger CH, McSorley SPR. Effect of castor and velvetbean organic amendments on Meloidogyne arenaria in Greenhouse Experiments 1. Journal of Nematology. 1998; 30:624-31.
27. Schippers B, Bakker AW, Bakker PAHM. Interactions of deleterious and beneficial rhizosphere microorganisms and the effect of cropping practices. Annual Review of Phytopathology. 1987; 25:339-358.
28. Shurtleff MC, Averre CW. Diagnosing plant disease caused by plant parasitic nematodes. The American Phytopathological Society. Saint Paul, 2000, 187.
29. Singh RK, Khurma RK. Susceptibility of six tomato cultivars to the root-knot nematode, *Meloidogyne incognita*. The South Pacific Journal of Natural Science, 2007, 73-77.
30. Sumner DR, Boosalis MG. Effects of reduced tillage and multiple cropping on plant diseases. Annual Review of Phytopathology. 1981; 19:167-187.
31. Viaene NM, Abawi GS. Management of *Meloidogyne hapla* on lettuce in organic soil with Sudan grass as a cover crop. Plant Disease 1998; 82:945-952.
32. Wang KH, McSorley R, Gallaher RN. Effects of Sunnhemp (*Crotalaria juncea*) amendment on nematode communities in soil with different agricultural histories. Journal of Nematology. 2003; 35:294-300.
33. Wang KH, McSorley R, Gallaher RN. Effect of winter cover crops on nematode population levels in north Florida. Journal of Nematology. 2004; 36:517-523.
34. Wang KH, Hooks CR, Ploeg A. Protecting crops from nematode pests: Using marigold as an alternative to chemical nematicides. Plant Disease. 2007; 35:1-6.
35. Widmer TL, Abawi GS. Mechanism of suppression of *Meloidogyne hapla* and its damage by a green manure of sudangrass. Plant Disease. 2000; 84:562-568.