

## Integrated Pest Management with Reference to INM

Archana U Singh\* and Prasad D

Division of Nematology, IARI, New Delhi, India

### Abstract

Modern agriculture is highly input intensive and greatly dependent on chemical pesticides for the control of insect pests, diseases and nematodes. Indiscriminate and excessive use of pesticides in agriculture has played havoc with agro-ecosystem by polluting water and food chains and causing emergence of pesticide resistance both in target and non-target pests. INM techniques recognize the importance of biological control used against noxious nematodes. This approach being knowledge based has great flexibility and contributes admirably to the preservation of ecosystem and sustainable agriculture. In the context of changing cropping pattern and the environmental degradation, strategies are needed to minimize present use of organic inputs hence, INM assumed is a part of ecosystem especially artificial ecosystem. However, now a days INM has evolved more as a holistic approach in crop protection.

**Keywords:** Integrated nematode management; Pests; Diseases; Nematode

### Introduction

Among various pest control methods, Integrated Pest Management (IPM) has gained importance as it is eco-friendly and helps in sustainable production. IPM is defined as the selection, integration and implementation of available pest control methods. The common and major components of IPM are cultural, physical, chemical and biological control. IPM packages have to be developed based on the crop, the environment and it should be region specific. Information technology helps in IPM programs [1]. Success of IPM depends on sharing and transferring the technology to the farmers. IPM deals with economic profitability, human health and environmental risk [2]. The ideal objective of IPM should be to maximize profit while minimizing human health and environmental risks. In late 1950's IPM concept is evolved due to the hazardous effect of the pesticides on the environment and this has led to the re-discovery of the value of biological control and helps in the conservation, preservation and protection of biodiversity. Later, the innovative and traditional methods such as cultural control, physical and mechanical control, need based use of pesticides, host-plant resistance, transgenic plant etc. [3] reduced the hazardous effects of pesticides and supported IPM practices until today [4].

### Integrated Pest Management (IPM) has been defined in many ways

It consists of the development, use and evaluation of pest control strategies that result in favourable socio-economic and environmental consequences [5].

It is a system approach to reduce pest damage to tolerable levels through a variety of techniques, including predators and parasites, genetic resistance hosts, environment modification and when necessary and appropriate, pesticide.

The Food and Agriculture Organisation (FAO) described this concept as a pest population management system that utilizes all suitable techniques in a compatible manner to reduce pest populations and maintain them at levels below those causing economic injury [6].

It refers to an ecological approach in pest-management in which all available necessary techniques are consolidated in a unified programme, so that pest populations can be managed in such a manner that economic damage is avoided and adverse side effects are minimized [7].

### The following basic principles has been suggested for practice of pest management

Determine how the life-system of the pest needs to be modified to reduce the number to tolerable limit. Apply biological knowledge and current technology to achieve the desirable modification i.e., applied ecology. Devise procedures for pest control suited to current technology and compatible with economic and environmental quality aspects i.e., economic and social acceptance.

### The proper utilization of this approach involves the following steps

To develop an integrated programme against any pest, it is essential to have possible effective methods for its control. To establish economic threshold and economic injury at which the control operation should be initiated. To bring about the possible effective control methods in such a way that the integrated components should hold the nematode pests below damaging threshold level and avoid environmental disturbances.

IPM can be divided into seven components [8]. Biological monitoring, environmental monitoring, the decision maker, decision support system, the decision, procedure implementation and the system. Integrated nematode management (INM) is not an isolated approach from IPM, rather a component of it hence should match the convergent objectives of trans-disciplinary mode of implementation [9]. Integrated pest management includes research, development, technology transfer and implementation needed to integrate two or more control measures to manage one or more nematode species. INM must be imposed in conjunction with broader objectives of IPM. Nematode management is important for high yields and quality that are required by the high cost of modern crop production [10]. Therefore, the idea of keeping the nematode population below the economic damage level by adopting

\*Corresponding author: Archana U Singh, Division of Nematology, IARI, New Delhi-12, India, E-mail: [arch\\_212@yahoo.com](mailto:arch_212@yahoo.com)

Received January 22, 2016; Accepted March 11, 2016; Published March 18, 2016

Citation: Singh AU, Prasad D (2016) Integrated Pest Management with Reference to INM. Adv Crop Sci Tech 4: 220. doi:10.4172/2329-8863.1000220

Copyright: © 2016 Singh AU, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

different available tactics is advised to the growers [10]. The young tender seedlings of various crops are very much vulnerable to attack by nematode while the older plants achieve some degree of tolerance.

Chemical control with the application of nematicides is the most effective means of nematode management. However, most of the effective nematicides have been withdrawn from the world market. At present, a fewer insecticides having nematicidal property are so far available to the farmers and many of them are not cost effective and environmentally acceptable [11]. Despite their inherent drawbacks, chemical nematicides could be applied judiciously so that the doses and cost are reduced drastically. The applications of nematicides through seed treatment, bare-root dip treatment and nursery bed treatment have been proved to be effective to protect the young seedlings from nematode attack. In spite of the problems associated with nematicides, they comprise an important tactic for many of the nematode IPM systems especially for high-value crops [12].

The modern concept of pest management is based on ecological principles and involves the integration and synthesis of different components /control tactics into a pest management system. IPM is a component of the agro-ecosystem management technology for sustainable crop production. An increase in the area of cultivation, intensive cropping, use of heavy amounts of chemicals and fertilizers and introduction of high yielding varieties etc. [13] resulted in the increase of pests (including nematodes) and pathogens. Plant-parasitic nematodes, hidden enemies of crops are microscopic, invertebrate animals often called as *threadworms, eelworms or roundworms*. They are distributed all over the world in different kinds of habitats and found in nearly every biological niche that supports life. They damage the crops not only by feeding on plants but also by interacting with various other organisms. They cause severe losses to economically important crops like vegetables, cereals, pulses, oilseeds, fruit crops, etc. Ref. [14] have indicated an annual crop loss due to phytonematodes on worldwide basis to the tune of \$100 billion [15]. In a world-wide survey conducted by Sasser [16] the 10 most important genera of plant parasitic nematodes revealed were *Meloidogyne, Pratylenchus, Heterodera, Ditylenchus, Globodera, Tylenchulus, Xiphinema, Radopholus, Rotylenchulus* and *Helicotylenchus* causing damage to agricultural crops. In India also, there are some reports which indicate heavy crop losses due to nematodes [17].

A committee in 1971 on the estimation of crop losses constituted in USA and estimated 6 per cent loss in field crops, 12 per cent loss in fruit and nut crops, 11 per cent loss in vegetable crops and 10 per cent loss in ornamental crops which gives an annual monetary loss of 1590.7 million dollars due to nematodes. Losses estimated due to nematode attack to different cultivated crops all over the world by FAO is around 400 million dollars. Thus, nematodes either alone or in combination with other pathogens constitute an important constraint to world

agricultural production. However, the nematode control problem is rather very tricky, especially because the majority of nematode pests are soil-borne and thereby necessitate a careful study of the situation and proper selection of strategy [18].

A complete understanding of the behavior of nematode species involved, host plant and the ecological constraints is essential before an appropriate method could be applied. In the current agricultural scenario, INM have been emphasized due to the social, economical and environmental status in the agricultural society. INM programs developed so far have already contributed to a decline in chemical inputs on many crops. Integrated management for nematodes requires: 1) determining whether pathogenic nematodes are present within the field 2) determining whether nematode population densities are high enough to cause economic loss and 3) selecting a profitable management option [19].

Attempts to manage nematodes may be unprofitable unless all of the above Integrated management procedures are considered and carefully followed. Similarly, some management methods pose risk to people and the environment. Individual methods of nematode control have either proved ineffective or uneconomical approach against plant-parasitic nematodes [20]. Therefore, integration of various suitable tactics [21] may be an eco-friendly, economically viable and practically feasible approach for managing nematode problems in different crops.

**The approach of an integrated nematode management should be according to Ref. [22]**

Minimization of environmental and health hazards, Utilization of several compatible measures, Maximization of natural biotic and abiotic environmental resistance, Understanding and counteracting nematode survival strategies, Minimum use of drastic control measures, Increased reliance on location specific and resource compatible management strategy, Minimizing input costs in harmony with potential gains and Maximizing of profit to the grower.

Integrated nematode management strategies can be applied sequentially or simultaneously. The first approach includes season to season or year to year integration of strategies and is particularly relevant to annual cropping cycles [18]. The second major approach to INM involves simultaneous application of two or more strategies. This approach may be utilized for both annual and perennial crop production [23,24]. The integration of different strategies for nematode management is not a new concept. Kuhn [25] used crop rotation and fallowing for the control of nematodes. Tyler [26] proposed combination of two or more control strategies into an overall management programme is the only sound and sustainable approach for the effective control of root-knot nematode (Table 1).

A low input sustainable integrated nematode management strategy

Kind of Control Methods	Methods in the Category
Cultural Methods	Fallowing, Flooding, Summer ploughing, Time of planting /sowing, Manuring and irrigation, Cover crops, Green manuring, Antagonistic crops, Trap crops, Crop rotation.
Genetic Methods	Resistant varieties, Tolerant crops/varieties, Genetic Engineering.
Biological Methods	Nematophagous fungi, Parasitic bacteria, Predatory soil fauna (nematodes, mites, collembola, tardigrades, enchytreids)
Physical Methods	Solar heat, Steam, Hot water, Irradiation, Electricity
Chemical Methods	Fumigation, Systemic nematicides applied to soil as granules, drench etc. all over or on selected spots, Nematicide sprays, Seed treatment, Bare root dip treatment
Botanical Methods	Neem, Mahua, Karanj used as deoiled seed cakes; leaves etc. as soil amendment. May possibly serve as source of nematicidal chemicals, Microbial nematicides, anti-metabolites, steroids, etc.

**Table 1:** Different Methods of Nematode Control used in INM programme.

for low and medium value crops in the tropical and subtropical region, which would be applicable to root-knot and cyst nematodes as well as to many other concomitant nematodes [22] is suggested here:

**Summer:** Two or three deep summer ploughing with a soil turning harrow at fortnightly intervals, preferably with a light irrigation between two ploughing, soil solarization of nursery-beds or pit soil using clear thin polyethylene mulch for 3 -6 weeks before sowing; application of granular systemic nematicides to nursery-beds; growing of non-host or antagonistic commercial crop, and ploughing back non-commercial crop residues before monsoon.

**Monsoon:** Green manuring with non-host or trap crop or application of organic soil amendments/manure.

**Kharif:** Growing non-host and commercial crops; nematicidal treatment of nursery-beds and seed, spot application of systemic nematicides in high value crops; uprooting and burning of roots of host crops and weeds after harvest.

**Rabi:** Delaying sowing/planting to mid-November (when soil temperature falls to 15-18°C) restricting growing of susceptible or tolerant crops to Rabi season with a suitable period of rotation; removal and burning or roots ploughing back non-commercial but disease-free crop residues.

The options given above have to be location specific and additional to the normal sanitation [27] and good crop husbandry practices of tillage, manuring, irrigation, weed control, etc.

### Management packages suggested against major root-knot and cyst nematode pests in India

**Molya disease of wheat and barley caused by *Heterodera avenae*, *H. filipjevi*:** Summer ploughing twice at 2 week interval, Crop rotation with mustard, chickpea, lentil, pea, carrots, fenugreek for two years or application of carbofuran @ 1 kg a.i./ha at the time of sowing wheat and barley or grow barley var. Rajkiran.

**Root-knot disease of vegetables caused by *Meloidogyne incognita*, *M. javanica***

**Transplanted vegetables:** Summer ploughing of main field twice at 2 week interval, Soil solarization of area for nursery-beds, Application of carbofuran or phorate @ 0.1 g a.i. per m<sup>2</sup> or application of neem-cake 1 kg/m<sup>2</sup>, if available, Organic amendment with FYM @ 10 tonnes per ha, Crop rotation with mustard, African marigold, sesamum, onion, garlic, wheat, rice, maize, ragi, etc. for one year or grow resistant variety.

**For direct sown bold-seeded vegetables:** Summer ploughing of main field twice at 2 week interval, Crop rotation with mustard, African marigold, onion, garlic, sesamum, wheat, rice, maize, Ragi etc. for one year, Seed dressing with carbosulfan @ 3% w/w or, neem seed kernel powder @ 5-10% w/w or some other neem based product at recommended dose or application of neem cake @ 1 kg/m<sup>2</sup>, if available, Organic amendment with FYM @ 10 tonnes per ha

**Widely spaced direct seeded vegetables (Cucurbits):** Summer ploughing of main field twice at 2 week interval, Crop rotation with mustard, African marigold, onion, garlic, sesamum, wheat, rice, maize, ragi, etc. for one year, if feasible, Seed dressing with carbosulfan @ 3% w/w or, neem seed kernel powder @ 5-10% w/w or some other neem based product at recommended dose. Spot application of carbofuran @ 0.05 g a.i./ spot or neem cake @ 50-100 g per spot, Organic amendment with FYM @ 10 tonnes per ha.

**Root-knot disease of pulse crop caused by *Meloidogyne incognita*, *M. javanica*:** Summer ploughing of main field twice at 2 week interval, Crop rotation with mustard, onion, garlic, sesamum, wheat, rice, maize, ragi, etc. for one year if feasible, Seed dressing with carbosulfan @ 3% w/w or neem seed kernel powder @ 5-10% or some other neem based product at recommended dose, Grow resistant variety.

**Root-knot disease of ornamentals and fruit crops (*Meloidogyne incognita*, *M. javanica*, *M. hapla*):** Solar heating of pit soil in warm areas, Soil solarization of soil sealed in polythene bags for pot cultures, seedling/cutting propagation, Spot application of carbofuran @ 0.05 g a.i./ spot or neem cake @ 50-100 g/ spot.

**Root-knot disease of groundnut (*Meloidogyne arenaria*):** Summer ploughing twice at 2 week interval, Crop rotation with cereals or millets for 1-2 years, Grow suitable resistant groundnut varieties, if available.

**Root-knot disease of rice and wheat (*Meloidogyne graminicola*, *M. triticoryzae*)**

**Nursery-bed:** Selection of root-knot nematode free area for nursery or soil solarization of area for nursery-beds, for 3-6 weeks in late April-May, Application of carbofuran or phorate @ 0.1 g a.i./ha.

**Main field:** Summer ploughing of main field twice at 2 week interval, Pudding of main field before transplanting, Avoiding direct sowing of rice in main field, Crop rotation with mustard or other non-host crops, Late sowing of wheat in late Nov. to mid December using suitable variety, Green manuring with *Sesbania* spp. or *Crotalaria* spp. in time permits.

**Pigeonpea cyst nematode (*Heterodera cajani*) in pulse crop:** Summer ploughing of main field twice at 2 week interval, Crop rotation with non-legume crops, Seed treatment of pulse crops with carbosulfan @ 3% w/w or neem seed kernel powder @ 5% w/w.

**Rice cyst nematodes (*Heterodera oryzaicola*):** Crop rotation to avoid rice or banana for 1-2 yrs, Application of carbofuran @ 1 kg a.i./ha

**Potato cyst nematodes (*Globodera rostochiensis*, *G. pallida*):** Crop rotation with non-solanaceous crops such as cabbage, cauliflower, radish, carrots, pulses, cereals etc limiting potato to once in 3-4 years, Grow resistant potato variety like Kufri-Swarna, Thus, it is not necessary to apply each of the practices suggested and depending upon the infestation the selection of management practice and dose would have to be decided.

## Discussion

### Validation and demonstration of INM technologies

**On soybean:** A field trial was laid out at the Farm of IARI, New Delhi during Kharif season in 2 m × 2 m plot with the following treatments as: *Lantana camara* chopped leaves @ 400 g/4 m<sup>2</sup> (T1), seed Treatment with Kalisena @ 2% (T2), Triazophos @ 1.5 l/ha (T3) and combinations T4=T1+T2, T5=T1+T3, T7=T1+T2+T3 and T8=control. Seeds of soybean cv. Pusa-24 were sown in well infected plots in lines. Population of *R. reniformis* was estimated before treatment, at the time of harvest and yield (plot weight) per plot were recorded. Data presented in Table 2 revealed that the combinations of more than one treatment were efficient in managing reniform nematode, *R. reniformis* thus resulted more growth of soybean as compared to control. Significant increase in yield was recorded in all combinations (T4, T5, T6 and T7 treatments) as compared to single application (T1, T2 and T3 treatments) [28].

Treatments	<i>R. reniformis</i> population			Yield (g) Weight of pod
	Initial	Final	% decrease	
T1= <i>Lantana camara</i> Chopped leaves @ 400g	256.6	166.6	35.0	850.0 (29.15)
T2=Kalisena @ 2% S.T	283.3	173.3	38.8	750.0 (27.38)
T3=Triazophos @ 1.5 l/ha	320.0	283.3	11.5	683.3 (26.14)
T4=T1+T5	303.3	210.0	30.5	903.3 (30.05)
T5=T1+T3	293.3	160.0	45.3	766.3 (31.08)
T6=T2+T3	250.0	200.0	20.0	1183.3 (34.39)
T7=T1+T2+T3	320.0	201.0	37.1	833.3 (30.54)
T8=Control	256.6	240.3	6.2	466.6 (21.60)
CD 5%				(3.86)

Table 2: Nematode population and yield of soybean as influenced by various INM treatments.

**On mungbean:** A field trial was undertaken during 2005 crop season in plots of 4 m<sup>2</sup>, replicated thrice with following treatments: T1=Multineem (0.03% Aza) @ 2 l/ha, T2=*T. harzianum*, T3=Phorate @ 1 kg a.i./ha, T4=T1+T2, T5=T1+T3, T6=T2+T3, T7=T1+T2+T3 and T8=Control. All the treatments were applied in rows before sowing mung crop cv. *Pusa ratna*. Soil samples before the treatment at harvest were recorded for *R. reniformis* population (Table 3). Yield was also taken at the end of the experiment. All the treatments either alone or combination were effective in reducing *R. reniformis* population under field condition. However, maximum reduction was recorded in treatment where all three components of INM was used. This in turn enhanced the yield of mung bean crop. Maximum yield was recorded in T7 (Multineem+*T. harzianum*+Phorate) treatment as compared to control [29].

**On pea:** A Field trial was conducted in IARI field, New Delhi having good population of reniform nematode. Plots of 2 m × 2 m were prepared and Pea cv. *bonville* were sown in lines. The treatments were: *Calotropis procera* chopped leaves + twigs @ 2 l/ha (T1); *Trichoderma viride* @ kg/ha and Triazophos 40EC @ 1 l a.i./ha and their combinations in RBD design and replicated thrice. Observations on nematode population before treatment and at harvest were taken with yield of pods/plot (Table 4). Results revealed that higher yield was

observed in T7 treatment where combination of all three was taken in the experiment.

## Conclusion

The success of integrated nematode management will depend on a wide range of appropriate expertise on research/demonstration/training projects. It requires a strong research base, to provide information on nematode pests, crops, agronomic practices related to the crop and their interactions [30]. Once the various integrated control programme are developed, it is necessary that they should be put to practice [12,31]. The implementation of these programmes will require scientists/trained technicians and efficient extension media [32]. In addition to these, they should also possess communication skills which are needed to work with the farmers. Similarly, farmers with their available resources could follow integration of cultural, biological [32,33] chemical methods and resistant varieties in suitable combination for each crop cultivation system [34,35].

## Future Line of Work

Intensive and extensive surveys on the presence of parasitic nematodes infesting agricultural crops should be conducted. Use of cultural practices should be emphasized depending on area/locality. Emphasis should be given on the integration of nematode management practices by adoption of cultural practices, resistant varieties, nematicides, organic amendments, biological control agents, etc. Role of secondary organisms in causing diseases along with nematodes should be studied and nematode management practices be evolved. Need to develop varieties, which are resistant or tolerant to nematodes. Varietal screening and subsequent breeding programmes should be intensified. Attempts should also be directed towards biological control. *Paecilomyces lilacinus*, *Trichoderma harzianum*, *Verticillium chlamydosporium* and VAM fungi have been identified all over the world as potential biocontrol agents against plant parasitic nematodes. The possibility of using these bacteria and fungi as biocontrol agents against nematodes infecting crops should be explored.

Treatments	Initial Nematode	Final Nematode	Total Yield (g)
	Pop.	Pop.	Pop.
T1	280.0	190.0	333
T2	260.3	160.0	313
T3	212.3	173.3	349.3
T4	243.3	180.6	366.6
T5	300.0	176.6	366
T6	312.3	200.0	283.3
T7	273.3	153.3	449
T8	310.3	400.0	216

Table 3: INM on Kharif mungbean.

Treatments	<i>R. reniformis</i> population		Yield (g)/plot
	Initial	Final	
T= <i>Calotropis</i>	360.6	230.0	250.0
T2= <i>T. viride</i>	400.0	310.0	214.3
T3=Triazophos	393.3	246.6	253.3
T3=Triazophos	376.6	244.3	300.3
T5=T1+T3	370.0	231.3	233.3
T6=T2+T3	390.0	250.0	316.6
T7=T1+T2+T3	393.3	200.0	366.6
T8=Control	408.3	433.3	200.0

Table 4: INM on Pea.

## References

- Singh UA, Prasad D (2009) Integrated Nematode Management on Lentil. Ann PI Protec Sci 18: 276-277.
- Singh UA, Prasad D (2014) Nematicidal efficacy of bioagents, botanicals and phorate on mungbean. Ann PI Protec Sci 22: 459-460.
- Mittal A, Kumar V, Ahmad I (2000) Status and prospects of Nematode resistance in crop plants—a review. Agricultural Reviews 21: 16-25.
- Goswami BK, Mittal A (2002) Effect of some fungal bioagents on root-knot nematode, *Meloidogyne incognita* infecting brinjal. Pak J Nematol 20: 55-59.
- Bird GW (1980) Nematology-status and perspectives. The role of nematology in integrated pest management. J of Nematology 12: 170-176.



6. Smith RF, Reynolds HT (1966) Principles, definitions and scope of integrated pest control. *Proced FAO symposium on Integrated Pest Control*. Rome FAO 1: 11-17.
7. NAS (National Academy of Sciences) (1969) Principles of plant and Animal Pest control. Vol. 3, Washington DC, USA: Insect Management and control.
8. Bird GW (1987) Role of Nematology in integrated pest management programs. In: Veech JA, Dickson DW (eds) *Vistas on Nematology*, Society of Nematologist, Inc., Maryland, USA, pp: 114-121.
9. Mittal A, Goswami BK (2004) Hatching inhibition of black egg-masses of *Meloidogyne incognita* caused by *Hyphomycetous* fungi. *J Mycol PI Pathol* 34: 283.
10. Singh AU, Prasad D (2015) Role of soil fungi on wilt incidence and *Meloidogyne incognita* on tomato. *Ann PI Protec Sci* 23: 365-368.
11. Thomason IJ (1987) Challenges facing nematology: environmental risks with nematicides and the need for new approaches. In: *Vistas on nematology*, Veech JA, Dickson DW (eds.). Society of Nematologists, USA, pp: 469-476.
12. Singh UA, Prasad D (2014) Efficacy of fungal bioagents against *Rotylenchulus reniformis* on summer mung crop. *Ann PI Protec Sci* 22: 234-235.
13. Tripathi PK, Singh CS, Prasad D, Singh OP (2006) Use of fungal bioagents for the management of *Meloidogyne incognita* infecting tomato. *Ann PI Protec Sci* 14: 194-196.
14. Bhatti DS, Jain RK (1977) Estimation of loss in okra, tomato and brinjal yield due to *Meloidogyne incognita*. *Indian J Nematol* 7: 37-47.
15. Sasser JN, Freckman DW (1987) A world perspective on Nematology: The role of society. *Vistas of Nematology*, pp: 7-14.
16. Sasser JN (1989) Plant parasitic nematodes: the farmers hidden enemy. Department of plant pathology, North Carolina State Univeristy, Raleigh, USA, p: 115.
17. Dhaliwal GS, Arora R, Dhawan AK (2004) Crop losses due to insect pests in Indian agriculture. *Indian J Ecol* 31: 1-7.
18. Singh UA, Singh V, Prasad D (2010) Botanicals for the management of Phytonematodes. In: "Pests and Pathogens: Management Strategies" by Reddy Vudem D, Poduri NR, Khareedu VR, pp: 251-274.
19. Mojumder V, Mittal A (2003) Effect of neem products as seed coating against *Heterodera cajani* in cowpea. *Legume Res* 26: 231-232.
20. Narayana R, Goswami BK, Mittal A (2000) in National Nematology Symposium on "Integrated nematode management for Sustainable agriculture in the changing agro-ecological and economic scenario in the new millennium", NSI, Division of Nematology, IARI, New Delhi-12 at Orissa Univ of Agri & Technology, Bhubaneswar, India, p: 33.
21. Prasad D, Dubey KN, Mittal A (1997) An integrated approach for management of plant-parasitic nematodes in groundnut (*Arachis hypogea*). *Ann PI Protec Sci* 5: 217-219.
22. Gaur HS (1995) Some ecological considerations is integrated nematode management. In: *Nematode Pest Management – An Appraisal to eco-friendly Approach*. Swarup G, Das Gupta DR, Gill JS (eds.). New Delhi, NSI Publication.
23. Mittal A (2006) Fungi for the ecofriendly management of phytonematodes on Agricultural crops and its future perspectives. In book entitled "Eco-friendly management of phytonematodes" by Indra Rajuvanshi and Girdhari Lal Sharma, pp: 220-240.
24. Sharma HK, Prasad D, Pankaj L, Sharma P (2006) Bio-management of *Meloidogyne incognita* infesting okra. *Ann PI Protec Sci* 14: 191-193.
25. Kuhn J (1981) Neuere versuche Zur Bekämpfung der Rubennematoden. *Z Pflkrankh* 1: 85-86.
26. Tyler J (1933) The root-knot nematode. *Circular* 330.
27. Devi G, Yadav RK, Thakur NSA (2007) Screening of tomato varieties/lines for resistance against root-knot nematode (*Meloidogyne incognita*). *Indian J Nematol* 37: 83-84.
28. Prasad D, Mittal A (2004) Effect of *Calotropis*, oilcakes and phorate on growth of soybean and *Meloidogyne incognita* population. *Ann PI Protec Sci* 12: 234-235.
29. Singh UA, Prasad D (2011) Integrated nematode management by the use of multilineem, *Trichoderma harzianum* and Phorate against *R. reniformis* on Kharif mung cv. Pusa ratna. *Annals of PI Protec Sci* 18: 278-279.
30. Mittal A, Prasad D, Dala R (2005) Effect of imidacloprid, neem seed cake and carbofuran singly and in combination on Lentil infected with *Rotylenchulus reniformis*. *Annals of PI Protec Sci* 14: 24-28.
31. Rizvi R, Irshad M, Sartaj Ali T, Zehra K (2012) Effect of some botanicals for the management of plant-parasitic nematodes and soil-inhabiting fungi infesting chickpea. *Turkish Journal of Agriculture & Forestry* 36: 710-719.
32. Fazal M, Bhat YM, Ashaq M (2011) Combined application of *Paecilomyces lilacinus* and carbosulfan for management of *Meloidogyne incognita* and *Rotylenchulus reniformis*. *Annals of PI Protec Sci* 19: 168-173.
33. Simon SL, Bhandari G (2010) Antagonistic efficacy of *Paecilomyces lilacinus* and *Verticillium chlamydosporium* against *Meloidogyne incognita* infecting okra. *Indian J Nematol* 37: 113.
34. Jatala P (1986) Biological control of plant parasitic nematodes. *Annual Review of Phytopathology* 25: 453-489.
35. Prasad D, Mittal A (2004) Fungal Biocontrol of Plant-parasitic nematodes in book entitled by *Advances in Plant Protection Sciences*. In: Prasad D, Amerika S (eds.), Akansha Publishing House, New Delhi, India, pp: 219-230.

Citation: Singh AU, Prasad D (2016) Integrated Pest Management with Reference to INM. Adv Crop Sci Tech 4: 220. doi:10.4172/2329-8863.1000220

### Submit your next manuscript and get advantages of OMICS Group submissions

#### Unique features:

- Increased global visibility of articles through worldwide distribution and indexing
- Showcasing recent research output in a timely and updated manner
- Special issues on the current trends of scientific research

#### Special features:

- 700+ Open Access Journals
- 50,000+ Editorial team
- Rapid review process
- Quality and quick editorial, review and publication processing
- Indexing at major indexing services
- Sharing Option: Social Networking Enabled
- Authors, Reviewers and Editors rewarded with online Scientific Credits
- Better discount for your subsequent articles

Submit your manuscript at: <http://www.omicsonline.org/submition/>