ACTA SCIENTIFIC AGRICULTURE (ISSN: 2581-365X)

Volume 3 Issue 7 July 2019

Research article

Sustainable Practices for the Management of Nematodes

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Received: April 29, 2019; **Published:** June 06, 2019

DOI: 10.31080/ASAG.2019.03.0512

Abstract

Various workers developed and identified several sustainable concepts and practices for the management of crop nematodes. In which multiple cropping systems and integrated pest management are age old practices. In the recent time, emphasis has been paid on host resistance, cultural practices like crop rotation, sanitation, avoidance and limited controlled use of nematicides. Traditional practices for root-knot disease management include host resistance, cultural practices like crop rotation, sanitation, eradication of diseased roots and residues. Application of animal wastes, reutilization of industrial effluents and wastes, use of nematode resistant varieties and certain rhizobacteria may induce resistance in hosts.

Keywords: Cropping Practices; Cultural Practices; Non-Chemical Practices and Disease Resistance

Introduction

Nematodes are a part of complex organisms and are quite variable in forms, and causing disease in many crops worldwide [1]. Efforts has been made to sustainably manage nematodes by multiple cropping systems, continuous cropping, non- crop periods and also by crop rotation etc. [2,3]. Various workers do research on the management of plant parasitic nematodes through sustainable and subsistence agriculture and integrated pest management practices [4]. They mainly focus on developing strategies and tactics for sustainable nematode management by conventional agriculture systems. Sustainable agriculture system avoids loss to nature and on the other hand maintains reproduction capacity of the soil. Similarly, sustainable agriculture practices must fulfill all the human needs without causing irreversible damage to the natural resources [5].

In order to meet out expanding demand of world population, it is very important to cope up with increased agriculture production. There is a shifting of subsistence agriculture to intensive through the use of new and modern technology and proper application of natural resources.

The relationship between plant parasitic nematodes, their host crops and environment vary clearly with nematode- host combination and related geographical characteristics. Beside other environmental factors, temperature also plays a very important role in the spread of root-knot nematode population world over. It was observed in tomato and other vegetable crops, that the increase in temperature beyond 28^0 C may promote nematode infestation in these crops [6,7]. Plant parasitic nematode hampers the growth of plants and decreases the yield of that crop. Plant parasitic nematodes limits the productivity of crops as yearly losses estimated to 5% to 12% annually [1]. Yield losses incurred in *Globodera rostochiensis* susceptible potato averaged 38% as compared to 18.3% in resistant variety. *Meloidogyne* and *Heterodera* very often result in devastating losses in certain crops. Nematode reproduction and survival are directly depending upon type of soil, soil moisture, temperature and presence of host plant [8].

Methods of nematode management

For the successful management of plant parasitic nematodes, nematologists developed integrated pest management systems (IPM) for the successful control of them. IPM strategies were found

to be very effective in the sustainable management of most of nematodes. As indicated by Tyler [9]; Bridge [10]; Roberts [11] these IPM practices in the combination are found very effective in the control and spread of root-knot nematodes. Integrating complementary strategy such as host resistance, tolerance, and usage of certain nematicides should minimize the basic problem of loss of efficacy of specific nematicides. Roberts [11] indicated that multiple management practices may be applied for the successful management of nematodes. Bridge [10] point out four strategies for the sustainable management of specific nematodes as

1. Use of nematode free planting materials;
2. Use of non-chemical practices like crop rotation and soil cultivation;
3. Use of different organic soil amendments;
4. Use of multiple cropping systems to increase tolerance to nematodes.

Results and Discussion

After the implementation of above mentioned sustainable nematode control tactics, following results have been obtained.

Integrated pest management

In order to keep away the use of nematicides in the control of nematodes, greater attention is being paid to integrating available resources and cropping systems. Most of IPM practices have focused on nematode biology, host and damage etc. Roberts [11] indicated that multiple control measures may be applied at once for better results.

Soil Life and nematode management

Role of soil biology, nematode type, host- pathogen relationship, cropping systems, growth promoting bacteria have enough potential for the development of new strategies for the sustainable management of nematodes as well as increased crop yields.

Nutrition cycle and nematode control

This is considered as a new approach in nematode management in which nutrient cycling and cropping systems plays very important role in sustainable nematode management. Availability of nutrients, like that of total Carbohydrates, Amino Acids, Proteins and Phenols in different plants is the key factor for the initial spread of nematode infestation in healthy crops. As per an estimation, nematodes constituted only 0.24 and 26% of the total biomass. Bacterial biomass constituted 94% and 75% while Protozoan's constituted 4.9% and 5.9% of the biomass in the conventional and integrated systems respectively. In the integrated system, earthworms constituted 17.6% of the total biomass. Nematodes constituted very small portion of total soil biomass.

Nematodes play very important role in the increase of soil fertility through organic matter decomposition and by the addition of minerals. Several nematodes consume bacteria and helps in the addition of more nitrogen to the soil. In this way nematodes play a very important role in the complex nutrient cycling process and also affect growth and productivity of various crops. Soil amendments like oil cakes, animal wastes increase the population of microbivorous nematodes. These nematodes affect N and C mineralization process in the soil and regulate the availability of nutrients for plants.

Biocontrol of nematode

It is believed that nematodes are very good bioindicator of soil ecology as abundance of nematodes in the soil indicates positive correlation with crop productivity but negative impact on the plant growth due to excessive root- knot galling. Several weeds of agriculture crops are directly or indirectly associated as host to certain plant parasitic nematodes like *Meliodogyne*. Weed eradication program is found very effective in the sustainable management of nematodes. Use of cover crops also restricts different nematodes from agriculture fields. Similarly sustainable agro ecological systems and integrated farming systems like sowing techniques, fertilization, use of organic manure, soil tillage and controlled use of chemical pesticides resulted in the diminish of various soil borne nematodes significantly. Cropping sequences and systems also play vital role in nematode management. In potato fields, fallows and crop rotations have been used frequently to control plant parasitic nematodes. Many antagonistic plants like mustard, rapeseed, crotalaria etc serve as effective trap crops for sustainable management of nematodes. Certain plant growth promoting rhizobacteria may induce resistance against different pathogens as fungi, bacteria, nematodes and insects etc. These rhizobacteria suppressed nematode infection of potato roots [12]. Uses of nematode resistant varieties are one of the

most economical and preferred means of sustainable nematode management. Delayed planting, double cropping system, shifts in the planting and harvest dates have produced promising results in the management of nematodes.

Soil tillage practice can reduce surviving *Meloidogyne* populations by more than 92% and also affects useful organisms as well as suppressing useless plants like weeds etc. In this way tillage practices has been found very effective in plant parasitic nematodes management along with several other benefits like increased soil organic matter, improved soil structure and infiltration of surface water.

Modern technologies and nematode management

For the sustainable management of namatodes many more environments friendly technologies have been developed for the more practical and effective control of various types of plant parasitic and soil borne nematodes. These improved and new techniques will found to be more effective and accurate with very promising results in the sustainable management of nematodes. It will lead to the lesser use of synthetic nematicides and less environmental hazards with more crop productivity.

Modern agricultural practices include computerized productivity management and data analysis in certain crops for the better management of various nematodes. In this technique it has been established a better control over watering pattern, use of chemical fertilizers, and use of nematicides as per the data gathered from different sources. These modern practices resulted in better plant growth and improved yield of different crops. Also on the other hand, this technology has the potential as an effective tool over the control of nematodes.

Genetic engineering and nematode control

Genetic engineering will be very useful tool in the management of nematodes and increasing disease resistance in plants. Gene mapping and diagnostics has been found to be very effective in the development of disease resistant cultivars in several crops but still needs improvement. Transformation of plants with the help of transgenes for the target nematode also involves modern techniques. These genes linking resulted in root-knot resistant plants and showed about 70% less root-gall development in comparison to susceptible plants. Similarly, plant breeding programs with molecular techniques also developed host resistance to nematodes.

Ferti-irrigation from Fertilizer factory effluents

Fertilizer factory liquid wastes will be proved to be very effective in the development of various crops and on the other hand helpful in the sustainable control of root-knot nematodes, *Meliodogyne incognita*. In the present study, an attempt has been made to find out suitable concentration of fertilizer factory effluent (FFE) as ferti-irrigation for better plant growth, disease resistance and productivity. For this purpose different dilutions of FFE have been prepared as 1%, 2%, 5%, 25%, 50% and 100% and control. In these experiments, these concentrations were applied to measure the efficacy of FFE in three cultivars of tomato plant viz. Padamshri, Malintika and Pusa Early Dwarf. 15 days old plantlets were transplanted from field to pots containing autoclaved sterilized soil and each plant was inoculated by ± 1000 freshly hatched larvae of *Meliodogyne incognita* and results were recorded.

From the above experiments, it has been observed that 5% concentration of FFE was found to be very effective to promote better plant growth on one hand and simultaneously develop resistance over root-knot galling process in the experimental plants of tomato. Similarly, tomato cultivar Pusa Early Dwarf showed better results over other experimental varieties with fair crop development and resistance for root-knot disease.

In this way, low concentrations of fertilizer factory liquid wastes were found equally very effective to develop root-knot disease resistance in certain crops as it contain enough amount of phosphate, sulphate, chloride, nitrate, free ammonia, Ammonical nitrogen, Kjeldahl nitrogen etc. which on one hand promotes better plant growth and on the other hand they provide a possible resistance to suppress root-knot galling process [13,14]. Hence reutilization of fertilizer factory effluents has been recommended as ferti-irrigation for the development of crops.

Conclusion

Sustainable management of plant nematodes involves certain control measures like intensive cropping systems, cover crops, animal wastes, tillage systems that result in favorable growth of fungi, protozoa, earthworms, rhizobacteria etc. and on the other hand decreases nematode and other harmful pathogens population.

In this way, traditional and genetic engineered practices should reduce the population of root-knot nematodes and simultaneously decreases the dependency on synthetic pesticides and nematicides and significantly increases the yield of crops [15].

At last, the development of sustainable nematode management systems is not only the potion. It is required to develop very convenient and effective control measures of various nematodes to reduce the every possible loss to food crops in order to fulfill increasing demand of rapid increase in population world over. Use of chemicals to control nematode population is limited up to an extent due to environmental hazards. In this respect, modern technologies from molecular and soil biology and integrated cropping systems are found to be very effective in the sustainable control of many nematodes and resulting in to improved plant growth and productivity.

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Volume 3 Issue 7 July 2019