

Future of Plant Parasitic Nematode Control

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Received: March 09, 2019; **Published:** March 28, 2019

Nematodes are aquatic animals which considered the most numerous Metazoa on the earth. They are divided into many classes such as free-living or parasites of plants and animals. The phytonematodes especially root-knot nematode, *Meloidogyne incognita* (Kofoid and White 1919) Chitwood 1949 are considered as worldwide important nematodes that causing considerable yield loss all over the world [1]. Foliar symptoms may include leaves chlorosis, defoliation, stunting, and early wilting contributing to decreased yields and poor fruit quality [2]. The root system infected with *Meloidogyne* spp. is characterized by gall formation. However, the damage to that infected with *R. reniformis* includes reduced feeder roots, dead tissue and significant reduction in root growth. Nematode damage may induce some members of the cucurbit family to produce large amounts of ethylene gas which can contribute to premature ripening of fruit [3].

Controlling such nematodes by chemical methods is quick and effective. However, deleterious effects of nematicides on environment and human as well as disruption biological balance and high cost have created a new eco-friendly strategy for nematode management.

In the nature, plants produce a number of secondary metabolites to protect themselves from various pests and pathogens. Such metabolites include alkaloids, terpenoids, glycosides and flavonoids. The botanical pesticides offer safe alternative strategy for nematode management due to their facile biodegradability and selective toxicity to target organisms [4]. Hence, different plant materials have been used [5] to evaluate their nematicidal properties and have been reported to be toxic to plant parasitic nematodes. Alkaloids are nitrogenous compounds that possess antibacterial and antiviral activities [6]. Certain plant families viz. Papaveraceae, Ranunculaceae, Solanaceae and Amaryllidaceae are particularly rich in alkaloids. Botanical extracts that contain alkaloids were found to have ovicidal property against *Meloidogyne* eggs [7]. Terpenoids, the primary constituents of the essential oils, are a large and diverse class of organic compounds, produced by a variety of plants. Terpenoids contribute to the scent of eucalyptus, the flavors of cinnamon, cloves, and ginger, the yellow color in sunflowers, and the red color in tomatoes. Besides the role of terpenoid plants in traditional herbal remedies, they exhibited antibacterial, antineoplastic, nematicidal and other pharmaceutical functions. Glycosides play numerous important roles in living organisms and are present in plants of Rosaceae, Brassicaceae, Liliaceae and Polygonaceae. Botanical extracts that contain glycosides were shown pharmacological and toxicological activities as well.

Strategies using biological control with microbial agents are considered as alternative methods for the management of nematodes on various crops. Fungi and bacteria as biological control agents of nematodes have been studied more than other organisms [8].

However, integrating biological control with other methods could make an excellent model for nematode control and achieve the desired results since most studies on biological control have demonstrated that organisms have low efficacies, which make them unacceptable as sole agents.

The source of these bio-nematicides could be plants, bacteria, fungi, actinomycetes and/or any microorganism from the soil. Also, natural materials like chitin, Chitosan or even mushrooms. The newest bionematicides which used in the last years are avermectin group,

name products and certain groups of microorganisms. Meanwhile, plants are very important source for recent materials that could be used as bionematicides like phytochemicals. Therefore, it was necessary to throw a light on some of these phytochemicals [9].

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Volume 5 Issue 4 April 2019

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