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Bright Future with Nematicidal Phytochemicals

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Abstract

The environmental pollution with chemical pesticides became a serious problem in pest control systems around the world. Chemical nematicides are part of the environmental problems, and in the same time, are the basic and the first defense line utilize against phytoparasitic nematodes. Thus it was necessary to search about alternative sources could be used in integrated nematode management programs. Using plant parts in pest management is one of the oldest options for the human such as, *chrysanthemum* spp, *Derris elliptical* and *Ryania speciosa*. Nowadays, various phytochemicals that extracted from different plant parts such as alkaloids, glycosides, limonoids, quassinoids and even phenolics became a new and/or promising tools to use as fungicides, bactericides and nematicides.

Introduction

No one can deny that phytonematodes became one of the most destructive pest around the world. The latest statistics in 2012 showed that plant parasitic nematodes cause damages estimated by $118 billion [1].

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 [2,3]. Phytonematodes are root feeders, which completing their life cycles in or on the root zone or even shoot zone in some cases. The most wide spread plant nematodes that parasitize crops are the root-knot nematodes which consist of more than 150 species. Among the root-knot nematodes, *Meloidogyne* javanica (Treub) Chitw., *M. incognita* (Kofoid and White) Chitw., *M. arenaria* (Neal) Chitw., and *M. hapla* Chitw., are of major agronomic importance, being responsible for 95% of infestations [4] and responsible for at least 90% of all damage caused by nematodes [5]

Moreover, in a survey it was found that the root-knot nematodes are the most targeted group by 48% of nematicides that use in various crops [6]. At the same time, he found that in terms of global crop production, vegetables attract 38% of the nematicide market, followed by potato (25%), banana (9%), tobacco (8%), sugar beet (6%) and other crops (14%). There are certain and various methods to control the plant parasitic nematode around the world. The most broad-spectrum method which the most farmers depend on is chemical control, next to biological control, resistant varieties, trap crops, crop rotation, cover crops, cultural control and soil solarization have been tested with different levels of successes [7,8]. Accordingly, several groups of researchers are attempting to maximize the role of bio-nematicides in managing phytonematodes because of certain advantages over synthetic products, such as: (i) contain novel compounds that plant-parasitic nematodes are not yet able to resist; (ii) are less concentrated and thus less toxic than synthetic compounds; (iii) biodegrade relatively rapidly; and (iv) are derived from renewable sources [9,10]. The source of these bio-nematicides could be plants, bacteria, fungi, actynomycetes and / or any microorganism from the soil. Also, natural materials like chitin, Chitosan or even mushrooms. The newest bio-nematicides which used in the last years are avermectin group, name products and certain groups of microorganisms. Meanwhile, plants are very imported source for recent materials that could be used as bio-nematicides like phytochemicals. Therefore, it was necessary to throw a light on some of these phytochemicals.

Piperamides

Solanaceae: Piperamides is produced by certain species of piper genus, such as capsaicin which belong to Capsicum genus, (*Capsicum frutescens*, Mill.), has nematicidal properties [11,12]. Piperamids have been considered contact toxicant, repellent and antifeedant, as well as neurotoxins [13]. Very little data are available about the environmental fate of capsaicin, but initial assessment suggests that it will bind to sediments [14].

Polyacetylenes and polythienyls

Asteraceae: Marigold (*Tagetes* spp.) contains polyacetylenes and polythienyls that proved their nematicidal activity [9,15]. The first report about the resistance of marigolds verities to nematodes was by Goff [16], who recorded that French marigolds (*T. Patula*) and African marigolds (*T. Erecta*) were the most types that suppressed the root-knot nematode infection during trials of 80 different ornamental annuals. The nematicidal performance of marigold depends on the usage way e.g., intercrop/cover crop/soil amendment, seeding rate, the marigold cultivar, the species or races of target nematodes, the temperature, or the age of marigold plant [17]. Incorporating marigolds in *M. incognito* infested cowpea or soybean fields has the potential to reduce the nematode populations and yields damages [18]. Marigold suppressed *M. incognito* efficiently when planted immediately following an *M. incognita* susceptible crop but did not enhance beneficial soil organism [19]. Furthermore, African marigold compost effectively reduced *M. incognita* infection in tomato [20] Moreover, the aqueous root extracts of marigold were applied against *Meloidogyne* sp.on tomato seedlings resulted in increased plant indices over the control treatment [21].

Cyanogenic glycosides

Euphorbiaceae: Cyanogenic glycosides are amino acid present in more than 2500 plant species, playing an important role in plant

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defense against herbivores due to their bitter taste and release of toxic hydrogen cyanide. Cassava roots and leaves (*Manihot esculenta*) contain various quantities of cyanogenic glucosides and some little quantities of linamarin and lotoaustralin. When cells are damaged, enzymes hydrolyze these glucosides, releasing cyanide via cyanohydrin intermediates. Meanwhile, a liquid substance was found to release in cassava roots called Manipueira, this substance has been utilized for nematode control in Brazil [22,23].

Poaceae: Sudan grass (*Sorghum sudanense*) used as a green manure that release nematicidal compounds. Sudan grass contains glycoside dhurrin which can be hydrolyzed to yield cyanide. It was found that fractionated Sudan grass extracts effective against *M. hapla* [24].

Terpenes

Terpenes structures are consisting of isoprene units (C5), which may contain oxygen. Terpenoids are classified to hemi-terpenes (C5), monoterpenes (C10), sesquiterpenes (C15), diterpenes (C20), triterpenes (C30), and tetraterpenes (C40) [25]. Some pairs of terpenes have synergistic impact on *M. incognita* which cause paralysis, and those pairs are trans-anethole/geraniol, trans-anethole/eugenol, carvacrol/eugenol, and geraniol/carvacrol [26].

a - Sesquiterpenoids

Malvaceae: The first sesquiterpenoids discovered to be nematotoxic were the aldehydes hemigossypol and 6-methoxyhemigossypol, in addition the dimmers gossypol, and 6-methoxygossypol. These compounds are found to be associated with resistant varieties of cotton (*Gossypium hirsutum*) to *M. incognita* [27]. A crude terpenoid aldehyde extract from cotton inhibited the movement of *M. incognita* at 50 µg/ml, while gossypol did at 125 µg/ml [28].

Solanaceae: Rishitin is a sesquiterpenoid phytoalexin found in potato tuber discs (*Solanum tuberosum*), which infected with the potato rot nematode *Ditylenchus dipsaci* [29].

Pinaceae: Also, α-humulene is a sesquiterpene which extracted from *Pinus massoniana* and found to be repellent to *B. xylophilus* that cause red ring in the heart -wood of pine [30].

B - Diterpenoids

Thymelaeaceae: Odoracin is a plant extract from roots of *Daphne odora*, which found toxic compound against *Aphelenchoides besseyi*, at 5.0 µg/ml [31]. This compound, is consisting of a diterpenoid (C20), benzoic acid as well as a fatty acid. Also, odoratrin is related substance which was isolated and recorded activity [32].

Conclusion

In this mini assay it was aimed to show the importance of some phytochemicals and try to make a small notes to those who work at pesticides industries fields and could extract and formulating phytochemicals alone or / and combined with pesticides.

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