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Nematode Problems Affecting Agriculture in the Philippines[1]

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Abstract: Nematodes are considered major pests on most economic crops in the Philippines, particularly on banana, pineapple, citrus, tomato, ramie, and sugarcane. *Radopholus similis* is the most destructive nematode on banana, while *Meloidogyne* spp. are more serious on various vegetable crops such as tomato, okra, and celery and on fiber crops such as ramie. *Tylenchulus semipenetrans* is a problem on citrus and *Rotylenchulus reniformis* on pineapple and some legume crops. *Hirschmanniella oryzae* and *Aphelenchoides besseyi* are becoming serious on rice, and *Pratylenchus zeae* is affecting corn in some areas. Lately, *Globodera rostochiensis* has been causing serious damage on potato in the highlands. Control measures such as crop rotation, planting resistant varieties, chemical nematicide application, and biological control have been recommended to control these nematodes.
Key words: chemical control, biological control, cultural practice.

The study of nematodes in the Philippines formally began in 1967 when the first course in nematology was offered in the Department of Plant Pathology, College of Agriculture, University of the Philippines at Los Baños. Research during the last 20 years revealed that nematodes are major pests in most crops in the country. Damage may range from 10 to 50%, and in severe cases crops have become unproductive and had to be changed.

GEOGRAPHIC SURVEYS

Results of many nationwide surveys revealed a number of nematode genera and species that could destroy various vegetable, field, fruit, and fiber crops (1–4,7,8,11,23). Citrus decline in Batangas and other provinces in the 1960s was associated with a virus and the citrus nematode *Tylenchulus semipenetrans* Cobb (12,13). Nematode pathogenicity and population control studies showed that *T. semipenetrans* reduced the growth of citrus plants and that controlling the nematodes improved plant growth (13). It was, however, too late to save the citrus industry in these locations, because the citrus growers were already shifting to sugarcane, rice, and other crops.

In 1967, a severe decline of ramie in Mindanao was attributed to root-knot nematodes. Nematicide treatment of soil planted to ramie improved growth and yield of the crop (22). One ramie company, however, shifted to African oil palm because ramie was not economical.

Another important crop that suffers considerable nematode damage is the Cavendish banana. In northern Mindanao, where over 25,000 hectares are grown, this crop is seriously affected by *Radopholus similis* (Cobb) Filipjev, *Meloidogyne incognita* (Kofoid and White) Chitwood, *Helicotylenchus* sp., *Pratylenchus* sp., *Rotylenchulus reniformis* Linford & Oliveira, and others. *R. similis* is the most destructive and widely distributed nematode throughout the banana plantations (1). Banana growers must apply nematicide two or three times a year to control these nematodes.

On pineapple, the most destructive nematode is *R. reniformis.* Several thousand hectares of pineapple plantations in the country are infested with *R. reniformis* and other species. Large pineapple companies in Mindanao are applying nematicides every planting season to control these nematodes.

About 15 nematode genera are associated with sugarcane in the country (24). Pathogenicity tests showed that *M. incognita, T. martini* Fielding, *R. reniformis,* and *Pratylenchus zeae* Graham are capable of damaging sugarcane plants (18,24). Reyes (24) demonstrated that nematicide appli-

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cation to sugarcane fields before planting significantly controlled nematodes and increased growth and yield of the crop.

Cotton and tobacco are also attacked by nematodes. A survey in the tobacco growing areas in the Cagayan Valley and Ilocos regions by Cortado and Davide (8) identified root-knot nematodes *M. incognita* and *M. javanica* (Treub) Chitwood as widely distributed. In some areas, *Pratylenchus* sp. and *Tylenchorhynchus* sp. were also found in high population densities. Survey and inoculation studies on cotton indicated that *R. reniformis* and *M. incognita* were the most common nematode problems and were capable of causing damage to the crop (6,7).

A number of nematode species are associated with rice and corn. On rice, the two most important nematode species are the rice root nematode, *Hirschmanniella oryzae* (van Breda de Haan) Luc & Goodey, and white tip nematode, *Aphelenchoides besseyi* Christie. At high population densities each species can damage rice plants (23,33). On corn, *P. zeae* and *T. martini* have been identified as potentially destructive (32).

Castillo (3) surveyed legume crops in 26 provinces and found 11 nematode genera associated with mungbean; seven with peanut, and eight with soybean. Of these, *Meloidogyne* spp. and *Rotylenchulus* spp. were considered most important in mungbean and soybean, whereas *Pratylenchus* spp. and *Rotylenchulus* spp. were more common on peanut.

Root crops, particularly sweet potato and cassava, are also attacked by nematodes. Castillo and Maranan (4) reported that in 25 provinces surveyed, 11 nematode genera were associated with sweet potato and 12 with cassava. Based on prevalence and frequency of occurrence, *Rotylenchulus* spp. and *Meloidogyne* spp. were considered potentially destructive to the two crops.

Valdez (29) reported that *R. reniformis* caused a stubby root disease of coffee seedlings.

Red ring, the most destructive nematode disease on coconut in the West Indies, has not yet been found in the Philippines. In his nationwide survey, Valdez (30) reported 16 genera of plant-parasitic nematodes associated with coconut, but none of them seriously damaged the crop.

On the other hand, many of our vegetable crops are attacked by nematodes. The most destructive are the root-knot nematodes, *Meloidogyne* spp. particularly *M. incognita*, which easily destroys tomato, celery, eggplant, okra, beans, and others (11). *Rotylenchulus* spp. were found seriously affecting ginger, beans, eggplant, celery, and black pepper (2).

Potato in the highlands of mountain provinces is also attacked by nematodes. A survey by Davide and Quebral (11) showed that the lesion nematode *Pratylenchus* sp., the stubby root nematode *Trichodorus* sp., and the spiral nematode *Helicotylenchus* sp. were more common. Lately, however, the potato-cyst nematode, *Globodera rostochiensis* (Woll.) Behrens, has seriously affected potato, particularly at higher elevations (21).

In general, most of our crops have nematode problems, and the severity of damage depends largely on the ability of the crops to tolerate and resist the attack. Control measures are needed to maintain crop productivity.

Control Strategies

During the past decade, a number of control measures for nematodes have been evaluated. These include the use of nematicides, planting resistant varieties, crop rotation, and the use of toxic plants such as *Tagetes* spp. and micro-organisms such as the nematode-parasitic fungi as biological control agents. Three nematicides are locally available: phenamiphos (Nemacur 10G), carbofuran (Furadan 3G), and ethoprop (Mocap 5G). Because of their high mammalian toxicity, the government has restricted their use to large-scale plantations where company management can provide medical attention to laborers handling them.

Because of the hazards in nematicide use by small farmers, studies were conducted on alternative control measures, particularly in the area of biological control. In

1968, for the first time, we isolated in pure cultures the nematode-trapping fungi *Dactylella* sp., *Arthrobotrys* sp., and *Harposporium* sp. from rice straw compost and cow manure (9). Reyes and Davide (25) isolated a number of genera and species of nematode-parasitic fungi from cultivated soil, animal manure, and rice straw compost. Included were *Arthrobotrys oligospora* Fres., *Catenaria anguillulae* Torok., *Dactylaria brochopaga* Drechs., *Harposporium anguillulae* Londe, and *Stylopaga* sp. Greenhouse tests showed that root-knot nematodes on tomato could be controlled by *Arthrobotrys* and *Dactylaria* species. However, because of slow fungal growth in various media tested—such as nutrient agar, oatmeal agar, and potato dextrose agar—and lack of local materials for mass production, no attempt was made to use them under field conditions.

The absence of a practical substrate for mass production of nematode-trapping fungi has slowed down our research activities on field application for the biocontrol of nematodes. However, the recent discovery of *Paecilomyces lilacinus* (Thom.) Samson as egg parasites of root-knot nematodes of potato in Peru (20) has renewed our interest in continuing biocontrol studies. An effort to isolate *P. lilacinus* from Philippine soils has yielded five isolates from root-knot eggs in galls of tomato, eggplant, and okra, and one from rabbit manure (31). In a comparative study with the Peruvian isolate, all of the local isolates proved effective against root-knot nematodes except the rabbit manure isolate which was less effective. Unlike the other species of nematophagous fungi, *P. lilacinus* can grow rapidly on farm waste products such as coconut water, ipil-ipil leaves, rice hulls, water lily, or corn cobs. It can be easily applied by dipping planting material such as seeds, tubers, bulbs, or seedlings into the fungus suspension for 3–5 minutes; by drenching around the base of the plants; or by mixing substrate containing at least 14-day growth of the fungus with the soil around the plants. It can also be applied together with organic fertilizers such as chicken manure by mixing 500 g of the fungus substrate with 5 kg of organic fertilizer.

Results of greenhouse and field experiments showed that *P. lilacinus* is not only effective against *Meloidogyne* spp. on tomato and *G. rostochiensis* on potato, but also against other nematode species such as *R. similis* on banana, *T. semipenetrans* on citrus, *R. reniformis* on pineapple, and *Pratylenchus* sp. on corn (17,19,28,31).

As a result of nematode biocontrol, yield of potato, tomato, okra, and pineapple treated with *P. lilacinus* increased by 40–80% and in some cases even more (14). Potato farmers in Atok, Benguet province, obtained yield increases as much as 106% as a result of the biocontrol of the potato-cyst nematode (15). Effects of *P. lilacinus* equalled or exceeded those of phenamiphos, isazofos, and carbofuran. More field trials are needed, however, on banana, citrus, and pineapple nematodes to fully evaluate the effectiveness of *P. lilacinus*. Asiatic Technologies, in Las Pinas, Manila, is now mass producing *P. lilacinus* and marketing it under the trademark BIOCON. It is available at a much lower price than nematicides, and the isolates of *P. lilacinus* we have tested are safer to handle than nematicides. In our more than 6 years of handling them, we have no known cases of infection to man, animals, or plants.

The discovery of *P. lilacinus* is just the beginning of our success in the biocontrol of nematodes. There are other promising micro-organisms that are now being extensively tested under field conditions, and hopefully they can be released soon.

Another control method that has been evaluated for several years is the use of marigold (*Tagetes* spp.) which is known to secrete toxic compounds that control nematodes. In the Netherlands, this crop has been used successfully as an intercrop or rotation crop with vegetables and field crops (27). Our study showed that root extracts of marigold could prevent hatching of *M. incognita* eggs and reproduction (16). As an intercrop with tomato, however, *T. erecta* was less effective for nematode control and competed with the crop for sunlight and fertilizer, as it grew luxuriantly covering the tomato plants (10).

The use of crop rotation as a strategy for nematode control has been thoroughly studied by Castillo et al. (5). They observed that 2½ years of cropping with rice and corn was necessary to control root-knot nematodes before planting a susceptible crop in heavily infested farms. They have also shown that *M. incognita* can be controlled effectively by three successive croppings of either corn or marigold (*T. erecta*) before planting tomato.

In an effort to develop more efficient nematode control strategies, experiments were conducted to evaluate integration of chemical, biological, and cultural control measures against root-knot nematodes. Ruelo and Davide (26) reported a high level of control of root-knot nematodes (*M. incognita*) on tomato using integrated control involving the nematicide Hostathion (5% 1-phenyl-3-(O,O-diethyl-thiophosphoryl)-1,2,4-triazole), chicken manure, nematode-trapping fungi, and marigold (*T. patula*). The combination was more effective than was each method alone. More studies are needed, however, to fully evaluate the effectiveness of integrated control under field conditions.

Our 20 years of nematode study in the Philippines have greatly advanced the science of nematology with considerable progress in the area of biological control. Additional studies are needed on varietal resistance, cropping systems, and the integrated approach to nematode control. Substantial research effort in the coming years will focus on these areas.

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