STUDIES ON THE MANAGEMENT OF PHYTONEMATODES

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ABSTRACT

The present thesis is based on the research work carried out by the author since February 1984. All the work has been done in India, mainly at Aligarh. The contents of the thesis fall under five categories:

Seasonal fluctuations :

There was high population build-up of plant parasitic nematodes on lemon grass and pomegranate from February to May and again in September. There was a definite correlation between nematode population and soil moisture. The nematode populations were more at higher soil moisture levels whereas it declined during dry periods. High as well as low temperature also had adverse effect on nematode population.

Some other important plants, viz. *Citrus*, mango, guava, *Zizyphus*, jambolan, grapes and Indian gooseberry were also selected for the observation of nematode population changes for one year. The soil samples were taken at 10, 20 and 30cm depths. The soil moisture, soil temperature and pH value were taken. By and large, the nematode population was higher in the upper 10 cm soil layer. Based on the high rate of nematode multiplication, jujube and orange can be rated as good hosts, jambolan as moderate host for *Hoplolaimus indicus*, jujube and orange as poor hosts for *Helicotylenchus indicus*, orange as good host for *Tylenchorhynchus brassicae*, jambolan and orange as poor hosts for *Tylenchus filiformis*.

Plant reaction, cropping sequences and interculture of crops :

Nine species of *Amaranthus* were screened against *M. incognita* and *R. reniformis*. Only one species showed highly resistant and one resistant reaction to *M. incognita*.

Results of the experiments with 25 different cropping sequences of vegetables, cereals, fodder crops and oil crops etc. indicate that growing susceptible crops consequently increase the population of plant parasitic nematodes to noxious levels. Fallowing and growing mustard and some other plants caused substantial reduction in the population density of nematodes in most of the situations. However, no individual crop sequence was found to be equally effective against all nematodes present in the soil. Nematode population was less in deep ploughed (40 cm deep) plots than the normal ploughed (20 cm deep) plots both in host and non-host crops. In another experiment, different cropping sequences in four fields, the population of *Heterodera zeae* increased during maize cultivation. Besides fallow, highest decrease in the number of cysts was observed in wheat, Egyptian clover, mustard, barley, pigeon pea and maize. Reaction of crops varies from nematode to nematode.

Interculture of *Zinnia* with tomato; neem, *Azadirachta indica* with tomato, eggplant, cabbage and cauliflower; and marigold/Tagetes spp. viz., *Tagetes minuta*, *T. lucida*, *T. tenuifolia* with tomato, eggplant, cabbage and cauliflower reduced soil populations of commonly occurring nematodes like *M. incognita*, *R. reniformis* and *T. brassicae*. The control of nematodes was found to be due to the toxic nature of root-exudates of these plants.

Nematicides and organic soil amendments :

Significant control of *M. incognita* was obtained on tomato and eggplant by bare-root treatment in dimethoate, carbofuran, fenamiphos, ethoprophos and phorate. In another experiment, the control of *M. incognita* and *R. reniformis*

was observed by bare-root dip treatment in triazophos/hostathion, carbosulfan/posse and rugby on tomato and eggplant. As a consequence in nematode control plant growth improved. Soil application of nematicides also caused significant reduction in nematode population alongwith improvement in plant growth of tomato. The plants raised from carbofuran, fenamiphos and phorate treated seeds of bottle gourd, bitter gourd reduced the root-knot development caused by *M. incognita* and consequently yield improved. Similar results were also obtained while seed soaking of cowpea and okra/lady finger in methyl demeton, dimethoate, UC-54229, acephate, monocrotophos and phosphamidon.

In a field trial oil seed cakes of castor, margosa/neem, mustard, rocket salad, ground nut and two nematicides viz., carbofuran and aldicarb were used for nematode management. All additives were found highly satisfactory for nematode management and improved plant growth of tomato, okra, eggplant and yield of carrot. Efficacy of these organic additives improved in deep ploughed fields as compared to normal fields. There beneficial effects with respect to suppression of nematode population persisted even after a lapse of six months. In another field trial, it was observed that the effectiveness for reducing the nematode population was enhanced when oil cakes and nematicides were combined with soil solarization and consequently improved plant growth of tomato and eggplant. Watered soil covered with polyethylene sheets had better effects. Oil cakes of castor, neem and chopped green tops of water hyacinth, *Eichhornia crassipes* significantly controlled the nematode population and improved plant growth of Egyptian clover in field.

In pot experiments, soil amendments with chopped parts of *Cymbopogon flexuosus*, *Aloe barbadensis*, *Ammi majus*, *Madhuca indica*, *Papaver rhoeas*, *Ruella tuberosa* and *Zinnia elegans* significantly controlled *M. incognita* and increased plant growth of tomato. Water extract of lemon grass, *Cymbopogon flexuosus* was highly toxic to nematodes.

Sawdusts of mango and neem, *Azadirachta indica* reduced root-knot development caused by *M. incognita* and multiplication of *R. reniformis* on tomato and eggplant, and *T. brassicae* on cabbage and cauliflower. Neem sawdust was found to be more efficacious than mango sawdust.

Soil amendments with plant wastes of several weeds and cultivated plants significantly suppressed nematode populations and improved plant growth. Soil amendment with chopped plant parts of water hyacinth, *Eichhornia crassipes* as well as bare root dip treatment in its extracts have significantly controlled *M. incognita* and *R. reniformis* on tomato and eggplant, and *T. brassicae* on cabbage and cauliflower with consequent improvement in plant growth. Extracts of water hyacinth were also found to be highly toxic to these nematodes. Similar results were also obtained with chopped floral parts, leaf and stem of marigold/Tagetes spp. viz., *Tagetes lucida*, *T. minuta* and *T. tenuifolia* with the reduction of root-knot development caused by *M. incognita* and population of *R. reniformis*; general nematode population on tomato and eggplant; and *T. brassicae* on cabbage and cauliflower. As a consequence in the reduction of root-knot development and/or nematode population plant growth improved. Soil application of *Paecilomyces lilacinus* before inoculation of *Luffa aegyptica* plants was found to be more effective for the control of *M. incognita*.

Soil amendments with chopped shoot parts of latex bearing plants, viz. *Artocarpus heterophyllus*, *Carica papaya*, *Ficus carica*, *F. elastica*, *F. glomerata*, *Ipomoea fistulosa*, *Nerium odorum* and *Tabernaemontana coronaria* significantly controlled *M. incognita* and *R. reniformis* on tomato and eggplant, *T. brassicae* on cabbage and cauliflower: and general nematode population on tomato and eggplant with consequent improvement in plant growth. In a similar study chopped shoots of *Euphorbia neriifolia*, *E. tirucalli*, *Pedilanthus tithymaloides*, *Calotropis procera* and *Thevetia peruviana* significantly reduced the nematode population on tomato and eggplant. Water

extracts of these latex bearing plants were highly deleterious to *Hop. indicus*, *Hel. indicus*, *R. reniformis*, *T. brassicae*, *M. incognita* and inhibitory to larval hatching of *M. incognita*.

Seed dressing with plant latices of *Calotropis gigantea*, *C. procera*, *Euphorbia milli*, *E. neriifolia* and *E. tirucalli* significantly inhibited root-knot development caused by *M. incognita* and multiplication of *R. reniformis* on tomato, eggplant and okra, and *T. brassicae* on cabbage and cauliflower. The literature on the potential of plant latices in nematode control has also been reviewed.

Bare-root dip of cabbage and cauliflower in leaf extracts of neem and a related species Persian lilac, *Melia azedarach* were found highly satisfactory for controlling *T. brassicae*. This treatment also improved plant growth and water absorption efficiency of roots. Seed dressings with the extracts of neem and Persian lilac significantly controlled *M. incognita* and *R. reniformis* on tomato, eggplant and okra. Similar results were obtained by seed dressings with azadirachtin and nimbin, two triterpenoids from neem.

Bare-root dip or seed dressings of tomato, eggplant in water extracts of neem, Persian lilac, water hyacinth, latex bearing plants and some other plants tested induced some resistance and allowed fewer larvae of *M. incognita* to penetrate into their roots, this followed reduced galling. Similar results were also obtained in cabbage and cauliflower against *T. brassicae*.

Pathogenicity and interrelationships:

Plant growth, pollen fertility as well as water absorption capacity was significantly retarded due to the infection of root-knot, reniform and cyst nematodes infecting pigeon-pea.

Root-rot fungus, *Rhizoctonia solani* and the nematodes, *M. incognita*, *R. reniformis* and *T. brassicae* significantly reduced plant growth of tomato, eggplant, chilli and papaya when inoculated separately, however, a synergistic

effect was observed in plants inoculated with the fungus and either of the nematodes. Similar trend was noted in case of reduction in water absorption capacity of roots. The presence of the fungus on the other hand, had an antagonistic effect on the multiplication of nematodes. Similar results were also obtained in okra inoculated with *R. solani* and/or *M. incognita* and *R. reniformis*.

Higher number of fungal species and nematode population was observed in the roots of okra/lady finger, *Abelmoschus esculentus* plants infected with Yellow Vein Mosaic Virus (YVMV) in comparison to the healthy plants. Deep ploughing (40 cm deep soil) had an adverse effect on fungal species and nematode population. Deep ploughing also brought about significant improvement in plant growth. *M. incognita* and brinjal Mosaic Virus together caused more damage to brinjal plants than alone.

Book Chapters/Reviews:

There are ten Book chapters/reviews which have been written by me as a single or joint author. Out of 10, 9 chapters have been published (83-91) in various books and one chapter is unpublished (92). In these chapters, some are introductory in nature (82, 85), some have nematode control strategies (84, 85) and some chapters give broad lines of biological control of plant parasitic nematodes (87, 88, 90, 91, 92). Antagonistic plants in general and neem in particular have also been discussed (86). Special feature of the book chapters is that its substantial portion is based on the personal experimentation and experiences of the authors.