Chapter-6

Summary
SUMMARY

The present investigation was carried out to envisage the results of various experiments performed under field and glasshouse conditions to evaluate the efficacy of different organic amendments applied either alone or in combinations with either of the two nematicides (Carbofuran/Furadan- 3G and Phorate/Thimet 10-G) against plant-parasitic nematodes attacking tomato cv. ‘K-25’, chilli cv. ‘Pusa Jawala’ and okra cv. ‘Saimla’. The organic additives which included various plant parts and plant products like ‘Nimin’ (a neem based triterpene rich product of Godrej Soaps Ltd.), neem-gold (a neem based formulation of Khadeshwar Oil Mills Ltd.) and oils of neem, castor, groundnut and mustard were used as urea coating agents for controlling some potential and important plant-parasitic nematodes. Water extracts of leaves of some selected plant species and oil cakes were tested for their antinemic properties in vitro. These extracts were also tested as bare-root dip treatment for determining their systemic activity against these plant-parasitic nematodes.

The nematode controlling efficacy of some antagonistic crops was also evaluated under field conditions by growing them intermixed with nematode-susceptible crops. The interculture of antagonistic crops was further aided with the application of various organic amendments in order to achieve an integrated approach of nematode management. The water soluble fractions of various plant leaves and oil cakes were tested against the larval hatching, penetration and nematode mortality in vitro. Summary of the various results of above experiments is as follows:

Egyptian clover/Berseem (Trifolium alexandrinum) and Lucerne/Rizka, alfalfa (Medicago sativa) are two most important fodder crops cultivated for
dairy animals throughout the Northern India. However, most often another fodder crop, Chicory/Kasni (*Cichorium intybus*) is also grown intermixed with these crops. It was observed from the preliminary studies that fields having kasni singly or intermixed with the other two fodder crops harboured low populations of plant-parasitic nematodes. Hence a thorough study was undertaken to evaluate the practice of mixed-cropping of these fodder crops against the population of various plant-parasitic nematodes under normal as well as deep ploughed fields. It was observed that the populations of *Meloidogyne incognita*, *Tylenchorhynchus brassicae*, *Rotylenchulus reniformis* and *Hoplolaimus indicus* multiplied freely in both normal as well as deep ploughed fields, indicating berseem to be a good-host for these nematodes, however, *Tylenchus filiformis* did not support the crop. Similarly *rizka* appeared to be a good-host for *M. incognita*, *T. brassicae* and *Hoplolaimus indicus* in both normal and deep ploughed fields whereas it can be regarded as a poor-host for *Helicotylenchus indicus* and a non-host for *T. filiformis* on the basis of their multiplication. However, in case of kasni, in both normal and deep ploughed fields, the population of all the nematodes except *M. incognita*, declined significantly. The nematode suppressant efficacy of kasni was observed even when it was grown intermixed with either berseem or rizka, thereby indicating the antagonistic nature of this crop towards the population of various plant-parasitic nematodes.

The nematode controlling efficacy of growing kasni with either berseem or rizka greatly enhanced when different beds were also treated with various organic amendments/nematicides. Carbofuran in combination with inorganic fertilizer was found to be most efficacious followed by phorate and inorganic fertilizer against the nematodes. It was followed in order of efficiency by neem
cake, castor cake, groundnut cake, neem leaves and castor leaves respectively. This integrated approach was found to be more effective in deep ploughed fields (30 cm deep).

The results indicated that the reduction in the nematode population had a positive correlation with the improvement in the fodder yields of various antagonistic crops. The beneficial effects of all the treatments particularly the oil cakes and combined action of nematicides and inorganic fertilizer persisted in the next growing season i.e., after a lapse of 5-8 months when a susceptible tomato cv. ‘K-25’ (Lycopersicon esculentum) crop was grown in the same fields without giving any further treatments. The residual effect of neem cake was most pronounced both with respect to control in the nematode population as well as in the improvement of plant growth.

Through a series of various glasshouse experiments it was observed that several organic additives when applied in the form of fresh chopped leaves of some selected plant species including Azadirachta indica, Eucalyptus citriodora, Ricinus communis, Melia azedarach, Callistemon lanceolatus, Tagetes patula, Clerodendrum inerme and Thuja orientalis, at two different doses (50g and 100g/pot) were highly effective in reducing the population densities of naturally occurring plant-parasitic nematodes (T. brassicae, Hoplolaimus indicus, R. reniformis, T. filiformis and Helicotylenchus indicus) and the root-knot incidence caused by M. incognita in tomato cv. ‘K-25’, chilli cv. ‘Pusa Jawala’ and okra cv. ‘Saimla’. However, the efficacy of these chopped plant leaves varied from nematode to nematode. The reduction in the nematode population and root-knot development brought about simultaneous enhancement in the plant growth characters of all the test crops. Among
various treatments, chopped leaves of *Azadirachta indica* were most and that of *Thuja orientalis* least effective.

Similar results were obtained with the soil amendment of various neem parts/products (chopped leaves, seed powder and oil cake) alone and in combination with carbofuran and phorate. The combined influence of all the treatments significantly reduced the population densities of different plant-parasitic nematodes and root-knot development of *M. incognita* on tomato cv. ‘K-25’, chilli cv. ‘Pusa Jawala’ and okra cv. ‘Saimla’. This reduction brought about significant improvement in various plant growth characters. However, among different treatments the combined application of neem cake and carbofuran was found to be most promising and effective.

The various results obtained were worthwhile when the naturally infested field soil was treated with various oil cakes applied alone as well as in combination with a chemical nematicide, carbofuran. The population density of the nematodes was suppressed when plants were treated with different organic additives, however, oil cakes when combined with carbofuran were more effective in reducing nematode populations and enhancing the plant growth of all the test plants (tomato cv. ‘K-25’, chilli cv. ‘Pusa Jawala’ and okra cv. ‘Saimla’). These treatments were also found to be effective in improving various plant growth characters (plant length, plant weight, number of fruits and fruit weight) and reducing various nematode developing characters of root-knot nematode (number of galls, number of eggmasses/g of root and soil population/200 cc of soil) in tomato cv. ‘K-25’, chilli cv. ‘Pusa Jawala’ and okra cv. ‘Saimla’.
Recently Godrej Soaps Ltd. has marketed a neem-based product with the trade name of ‘Nimin’ and has recommended it for urea coatings to prevent leaching of nitrogen. During various glasshouse experiments it was observed that urea coated with ‘Nimin’, neem-gold and oils of neem, castor and mustard were found highly satisfactory in reducing the population density of naturally occurring nematodes viz., *M. incognita*, *T. brassicae*, *Hoploliamus indicus*, *R. reniformis*, *T. filiformis* and *Helicotylenchus indicus* on tomato cv. ‘K-25’, chilli cv. ‘Pusa Jawala’ and okra cv. ‘Saimla’. Similar results were also observed in a separate study against the root-knot infestation caused by *M. incognita* on tomato cv. ‘K-25’, chilli cv. ‘Pusa Jawala’ and okra cv. ‘Saimla’ and thus bringing up a corresponding improvement in various plant growth parameters.

In a related study carried out under field conditions to assess the nematotoxicity of chopped leaves, seed powder and oil cake of neem in combination with two nematicides against the soil population and root-knot infestation caused by *Meloidogyne incognita* on tomato cv. ‘K-25’, chilli cv. ‘Pusa Jawala’ and okra cv. ‘Saimla’, it was observed that all the treatments either alone or in various combinations were effective in reducing the nematode development (as observed by counting the number of galls and number of eggmasses/plant) and soil population (after 45 DAP and 90 DAP) and thereby enhancing various plant growth characters (plant length, plant weight, number of leaves, number of fruits/plant and yield/kg/plot). However, the combined application of oil cake of neem and carbofuran was most efficacious in minimizing the nematode assault and thus favouring the plant growth.
Bare-root dip treatment of tomato cv. ‘K-25’ and chilli cv. ‘Pusa Jawala’ seedlings with extracts of leaves and oil cakes of neem and castor alone and in combination with a chemical nematicide, carbofuran, provided protection against the root-knot infestation of *Meloidogyne incognita*. A curative effect was also noted when roots of pre-infected seedlings were given a similar treatment. The suppression of root-knot development was greater in pre-infected seedlings as compared to those inoculated after the dip treatment. Here again, the combined influence of both the oil cakes with carbofuran was more effective in comparison to the individual treatments and the neem extracts were more promising than that of castor extracts.

During *in vitro* studies, the extracts of both undecomposed and decomposed oil cakes of neem, castor, groundnut and mustard were found to be highly deleterious to the root-knot nematode. However, the toxicity being more pronounced in decomposed extracts than the undecomposed ones. The toxicity of different extracts increased with an increase in the concentration and the exposure period. A similar trend was also observed when the water extracts of leaves of various plant species were tested against the mortality of different plant-parasitic nematodes. These extracts also inhibited the larval hatching of *M. incognita* and here again the efficiency of the inhibition in hatching was increased with increasing concentration of the extracts.