C. Chattopadhyay and D. Prasad (eds),
Dynamics of Crop Protection and Climate Change

Multitropic Interaction with Nematodes and Climate Change 19

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In the last 25 years, agricultural scientists have become more interested in complex food web interactions between plants, herbivores and soil microbes. Such multitrophic interactions in the soil ecosystem and the factors that govern them are important to understand, for better management of pests and diseases. Nematodes are an important component of soil food webs and interact as members of various trophic groups as parasites of plants, saprophytes on dead decaying matter, or as microbivorous forms that feed on soil bacteria and fungi that are an important component of detrital food web, or as entomopathogenic species that form a mutualistic relationships with certain bacteria to cause septicemia in insects. Plant-parasitic nematodes also predispose crops to pathogenic fungi and bacteria resulting in disease complexes. Conversely, several soil bacteria and fungi parasitise nematodes and their toxic metabolites reduce nematode invasion, development and multiplication. Such interactions vary with the microbe, nematode host, cropping pattern, crop cultivar, presence of other microbes and abiotic factors especially temperature and moisture.

The global rise in temperature and change in precipitation pattern due to increased emission of CO_2 and other green house gases are established facts. The suggested increase in mean annual surface temperature of 2-7°C by 2100 is not only the largest change globally, it is also the greatest change relative to the existing climate regime (Heal 1997). Such temperature changes are expected to influence the pest scenario and influence disease epidemiology. Changes are expected to occur in the type, density, and economic importance of pests and pathogens. This will particularly influence pathogens or pests with alternate hosts. As host species occupy new areas, new disease complexes may arise. While some diseases/pests may cease to be economically important, others may proliferate, more due to changes in precipitation patterns. The significant changes expected to occur with respect to nematodes due to climate change include:

- Altered host physiology with consequences on nematode biology;
- Altered life cycle of the nematode;
- Altered host defense response;
- Altered production of metabolites (exudates) from the plant roots and microbes in the rhizosphere;
- Altered survival strategies of nematodes; and
- Altered densities of microbivorous nematodes;

Effect on Distribution of Nematodes

All the plant-parasitic nematodes have a basal temperature below which they do not infect and develop, an optimum temperature at which they infect and complete their life cycle and an upper threshold above which the development does not take place (Table 19.1).

Table 19.1 Optimum, Basal and Upper Temperature Thresholds of Important Parasitic Nematodes of India

Nematode Species	Temperature (°C)		
	Basal	Optimum	Upper threshold
Heterodera cajani	11.0	25-29	35
Meloidogyne incognita	9.8	25-30	---
M. javanica	----	24-30	---
Radopholus similis	21.0	23-25	26
Rotylenchulus reniformis	11.1	25-30	36.0
Ditylenchus destructor	5 .0	25-30	34
Heterodera avenae	2 .0	17	23
Aphelenchoides fragariae	2 .0	18	--
Ditylenchus dipsaci	11.0	19	30

Changes in the mean annual temperature are expected to change the distribution pattern of these nematodes (Kamra and Sharma 2000). There have been studies to map the expected change in the distribution of plant feeding nematodes with predicted changes in the temperature (Boag *et al.* 1997, Yeates *et al.* 1998). Microbivorous nematodes have not been included in such distributional studies as their present distributions are insufficiently well known. However, investigation of Ruess *et al.* (1999) have reported a changes in composition of nematode fauna, in favour of fungal and plant feeding species with an increase in temperature and NPK fertilization, on two soils of subarctic Sweden. Nematodes especially, the r-strategies (*Rhabditis*) are expected to survive the frequency of extreme events particularly, the variations in precipitation. The effects of global warming are expected to be most marked at high

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The optimum temperature for *X. americanum* to transmit Tobacco Ringspot virus (TRSV) is 27-34°C. However, the effect of temperature is more on the host or virus than on the vector. A longer duration of conducive temperatures may result in a greater spread of the disease. Virus transmitting nematodes like *L. macrosoma* and *X. index* which were earlier found only in North Europe have now spread to South Europe due to an average increase in temperatures (Boag *et al.* 1996).

Conclusion

Thus, based on the limited studies that have been carried out to study the effects of climate change on nematodes in different trophic groups, certain predictions have been made. More long-term investigations need to be carried out with nematodes and its associates to critically assess the impact of climate change.

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