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Dynamics of Crop Protection and Climate Change

Impact of Climate Change on Nematode Population 18

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Nematodes, the marvel of evolution, possess incredible ability to survive extreme weather events and hostile environments with a simple body organization. Genome sequences of model nematodes have revealed that many genes and physiological processes in these worms are common to humans, higher animals, and plants. Understanding the molecular mechanisms underlying their survival under adverse environments may provide new opportunities in developing novel strategies to minimize or mitigate the impact of global warming. Nematode communities in soil are composed of a variety of trophic and ecological groups, which can be directly linked to key ecosystem functions like primary production, primary consumption, secondary consumption, decomposition, etc. Because of these attributes, soil nematode communities serve as an excellent model system for studying impacts of climate change on the belowground productivity. Nematodes are currently being extensively investigated in most studies, analyzing response of terrestrial ecosystems to climate change.

They are ubiquitous, diverse, and the most abundant group of multicellular organisms on the Earth. They are represented at more than one trophic level in soil foodwebs as they act as primary consumers (herbivores), secondary consumers (bacterivores and fungivores), and tertiary consumers (omnivores, carnivores and predaceous nematodes). They play multiple and contrasting roles in regulating productivity of plant and animal based production systems. It is estimated that nematodes cause crop losses worth US $ 125 billion annually in agriculture (Chitwood 2003). Bacterial and fungal feeding nematodes are beneficial to crop growth because they help in enhancing the nutrient availability to crop plants. Predatory nematodes predate on plant parasitic nematodes; thus, have potential for biocontrol.

Entomopathogenic nematodes are beneficial to crop production as they help in biological control of the insect pests of crop plants and reducing the consumption of chemical pesticides. Therefore, they constitute a fundamental group of biological indicators that needs to be investigated from the perspective of climate change impacts. Since entomopathogenic nematodes are very sensitive to temperature and UV radiation, global warming may have adverse affect on these nematodes. Interactions between herbivorous nematodes and plants are also likely to change as a result of climate influence. Climate change may also influence the plant nematode interactions by interfering with host defense mechanisms. Increased water stress due to climate change diminishes plant vigor and alters C:N ratios, lowering plant resistance to nematodes. Neilson and Boag (1996) assessed the possible effect of climatic change on the distributions of some common virus-transmitting *Xiphinema* and *Longidorus* species within Great Britain. They observed that theoretically an increase of 1°C in mean temperature would result in the northward extension of these nematode species by about 160-200 km.

We cannot continue to rely on currently available nematode management strategies as global environment is changing. Climate change will cause alterations in the spatial and temporal distributions of nematodes, and consequently, the control methods will have to be altered to suit these new situations. Assessment of the impacts of climate change on nematode infestations and in crops provide a basis for revising management practices to minimize crop losses as climatic conditions change (Ghini *et al*. 2008). Nematicides are primarily used for the management of nematodes. Changes in temperature and precipitation can alter persistence and availability of chemical nematicides in soil which may influence their efficacy. Information on impact of climate change on fate of nematicides in soil is almost negligible.

Recent observations suggest that nematode pressure on plants may increase with climate change. As a consequence of this, there may be a substantial rise in the use of nematicides in both temperature and tropical regions to control them. In general, organophosphorus and carbamates require moderate temperature (25-30°C) and moisture for effective control of plant parasitic nematodes, however, higher temperature and moisture comparatively reduce the toxicity of the chemicals. Non-chemical nematode management methods, such as green manuring, crop rotation, mulching, application of organic manures, etc., assume great significance under changing climate scenario. One of the direct consequences of climate change for the nematode management is the host plant resistance to nematodes. Climate change mediated changes in physiology can alter the expression of resistance genes or mechanisms of cultivars obtained through both traditional or genetic engineering methods. However, the most serious threat to genetic resistance to nematodes may be posed by the increased selection pressure resulting from acceleration of nematode developmental rate and increase in number of generations per season due to global warming.

Similarly, very little is known about impact of climate change on botanicals and biological control agents. In general, nematode, bacterial, and fungal based biopesticides are highly vulnerable to environmental stresses. Increase in temperature understanding the emerging scenario of host pathogen interactions. Innovative methods may have to be adopted to develop adaptation strategies to overcome the impacts due to climate change and climate variability, so that the food and livelihood security of rainfed farmers can be ensured. There is a need for a greater understanding of the effect of climate change on the efficacy of synthetic fungicides, their persistence in the environment, and development of resistance in pathogens populations to the fungicides.

Research on impacts of climate change on soil nematodes has been limited, with most work concentrating on the effects of a single atmospheric constituent under controlled conditions. More long term studies in varied ecosystems under different cropping systems of particularly tropical regions are needed to critically assess the impact of climate change on soil nematodes. This knowledge is vital for developing appropriate mitigation and adaptation strategies to minimize the impact of climate change on agriculture. Recently, national (Network Project on Climate Change of the Indian Council of Agricultural Research to understand the variability among major soil borne pathogens) and international network are also actively anticipating and responding to biological complexity in the effects of climate change on agriculture and crop diseases. (Karen *et al.* 2009).

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