Climate change and pest outbreaks in Palms

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Global climate change, the current burning issue around the globe is the change in climate over time, either due to natural variability or as a result of human activity exerts multitude of threats to human life in various forms. Global average temperature increased by 0.6^oC in 20th century while CO_2 reached to 380 ppm till date. By the end of 21st century the global average temperature is projected to increase by 1.4-7.5^oC and CO_2 by 560 ppm, if the uncontrolled anthropogenic activities continue with the same speed to meet the demanding needs of growing population (IPCC, 2007). Climate change may disrupt not only pest dynamics in agriculture but also the dynamics of herbivores in stable ecosystem.

Changes in climate may trigger changes in geographical distribution, increased overwintering, changes in population growth rates, increases in the number of generations, extension of the development season, changes in crop-pest synchrony, changes in interspecific interactions, pest biotypes, activity and abundance of natural enemies, species extinction, increased risk of invasion by migrant pests and efficacy of crop protection technologies. Global warming will also reduce the effectiveness of host plant resistance, transgenic plants, natural enemies, biopesticides, and synthetic chemicals for pest management.

Many people believe that global warming as predicted would increase pressure from pests and diseases. Higher temperatures and longer growing seasons could result in increased pest population in temperate regions of Asia. In general, however, most pest species are favoured with warm and humid conditions. Pest infestations often coincide with changes in climatic conditions, such as early or late rains, drought, or increases in humidity, which can reduce yields. Climate change might have an influence on increased pesticide use due to presence of diseases and pests.

Effect of physical factors on insect pests

Insects remain active with in temperature range from 15 to 30-32^oC. Within the range of favourable temperature, an increase in temperature increased the rate of development thereby decreasing the developmental period. Distribution and frequency of rainfall may also affects the incidence of pests through changes in humidity levels as well as directly. Small insects such as aphids, jassids and whiteflies are washed away by heavy rains thereby reducing their incidence of crops.

Temperature thresholds for insect flight vary both among and within species with season and also with region. Climate warming would advance the time of year at which the flight thresholds are first reached and increase the possibility of early immigration. Likewise there are optimal and threshold temperatures for insect walking, an important factor in local redistribution. Below the optima, the climate warming would enhance movement but above it will be detrimental.

With rise in temperature, onset of hibernation may be delayed while it may be suspended earlier than usual in spring, thereby increasing period of activity of pests, which would result in more damage. Non-diapausing species of aphids such as *Myzus persicae*, which are able to over winter in their active stages showed increased survival in warm winters.

Rising temperature directly affect the biology and physiology of insect communities by shortening the life cycle and increasing number of generations which aggravate the pest problems. The feeding rate of the insect pests increases by 25% to meet their nutritional requirements in the form of aminoacids under elevated CO_2 (500 ppm). Global climate change also affects the migratory pattern and behaviour of insects like locusts, monarch butterflies and fruitflies.

For analyzing the impact of temperature rise on pest population, each species has to be studied separately in the light of its favourable range with respect to weather factors, current ambient conditions and quantum of temperature increase. If after the increase in temperature, the ambient temperature still remains within favourable range of the pest then more population may be expected because insect species will be able to complete their life cycles faster. However, if ambient temperature goes beyond the favourable range then pest population may be affected adversely.

The elevated CO_2 would produce increased plant size and canopy density with high nutritional quality foliage and microclimate more conducive to pests and diseases. Insect species richness has been shown to be strongly correlated with plant biomass and height as larger plants increased structural complexity and greater range of resources that herbivores can utilize. Under higher CO_2, there was an increase in C: N ratio, which increased feeding of herbivores in order to derive more amino acids.

At elevated $CO_{2,}$ there was an increased partitioning of assimilates to root crops and due to more carbon storage in roots, losses from soil borne pests may be diminished under climate change. Climatic warming would affect temperate annual and multivoltine species in different ways and to different degrees. In case of multivoltine species such as Aphididae and some Lepidoptera, higher temperatures would allow faster development rate probably allowing for additional generations within a year.

Global warming and climate changes will result in:

- Extension of geographical range of pests and pathogens.
- In cooler latitudes, global warming brings new species.
- Increased risk of invasion by migrant pests.
- Reduced effectiveness of crop protection technologies.
- A 2.4 to 2.7-fold increase in pesticide use by 2050.
- Increased probability of pests developing faster resistance to pesticides.
- Warmer winter temperatures would reduce winter kill, favouring the increase of pest populations. Rising temperatures extend the growing season.
- Overall temperature increases may influence crop pest interactions by speeding up pest growth rates which increases reproductive generations per crop cycle.

Assessment of Climate change impacts

Impact of climate change would depend upon on complex interactions of climatic and biological factors with technological and socioeconomic changes that are difficult to predict. Therefore, these interactions are not amenable to qualitative analyses. Hence, quantitative (modeling) approaches, which allow investigating multiple scenarios and interactions simultaneously, will become more important for impact assessment.

Approaches for studying Climate change impact

1. Experimental approach
2. Empirical approach
3. Simulation approach

Adaptation and Mitigation: Adaptation refers to an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects that moderate, harm or exploit beneficial opportunities.

- Biosecurity, quarantine, monitoring, and control measures can be strengthened to control the spread of pests and diseases under a warming climate.
- More resilient/adaptable crop genotypes needed,especially with durable resistance to pests.
- Adoption of environmental conserving pest controlling activities such as organic farming, biocontrol and integrated pest management.
- Application of natural mulches helps in suppression of harmful pests and diseases.
- A diverse fauna of natural enemy species can successfully suppress pests.
- Avoidance of excess use of nitrogen which can increase the severity of certain diseases and make a crop more susceptible to pests.
- The growers of the crops have to change pest management strategies by rescheduling the crop calendars in accordance with the projected changes in pest incidence and extent of crop losses in view of the changing climate.
- Pesticides with novel mode of actions such as neonicotinoid insecticides for controlling sucking pests which induces salicylic acid associated plant defense

responses. Such more compounds needs to be identified for use in future crop pest management.

Conclusion:

Pest outbreaks in Coconut:

Encouraged by favourable climatic factors and low population of the natural enemy fauna often ***epidemic outbreak*** of the pest devastates large areas of coconut plantations. The Eriophyid mite, *A. guerreronis* has become a serious problem in coconut plantations, causing heavy losses in coconut production. It was first recorded in 1965 in Guerrero state of Mexico (Keifer, 1965). The first report on occurrence of this exotic mite was made by Sathiamma et al. (1998) from Ernakulam district of Kerala. Rugose Spiralling Whitefly (RSW) (**Aleurodicus rugioperculatus** Martin) is an invasive pest on coconut reported from Polalchi, Tamil Nadu and Palakkad, Kerala during July-August 2016. Reported first from coconut during 2004 at Belize, the pest had threatened coconut palms in Florida during 2009. The change in weather pattern reflected as deficit monsoon was one of the primary reasons of immediate upsurge of spiraling whitefly. Increase in temperature over 2^{o}C during summer was found as another pre-disposing factor for the increase in pest population. Emergence of sucking pest as a victim of climate change, thus, warrants close scrutiny. Yet another pest, the coconut caterpillar, *Opisina arenosella* often causes locally serious outbreaks with severe defoliation to coconut palms and subsequent loss of yield.

Conclusion: Therefore, there is a need to generate information on the likely effects of climate change on pests to develop robust technologies that will be effective in future under global warming and climate change.