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

Climate Change and Dynamics of Insect Pests: Management Options in Tobacco

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Tobacco is a low volume and high value commercial crop in India, substantially contributing to the national economy, promoting rural livelihood security and generating employment to millions of people. India occupies second place in production (750 M kg) and exports (260 M kg) after China (2300 M kg) and Brazil (270 M kg) respectively. India exports 225 M kg of tobacco and its products to about 100 countries earning foreign exchange to the tune of Rs 6,060 crores and an internal revenue generation of about Rs 1,98,900 crores. Tobacco provides livelihood to about 3.6 crores people including 0.6 crores farmers and 3 crores farm and industrial labourers. Among tobacco production constraints identified, increasing incidence of insect pests and diseases are important, particularly in sub-tropical agricultural ecosystem where due to a more conducive environment for pest build–up, losses incurred are substantially high in terms of both quantity and quality. In the recent times, there has been a growing concern about the sustainability of tobacco production due to various reasons. Though the introduction of high yielding varieties, improved production practices, large scale use of chemical fertilizers and pesticides helped in increasing the tobacco production, the pest problems are also undergoing changes. The insect pests and diseases which were minor and manageable are becoming major and causing considerable damage in the recent past, thereby threatening production of quality tobacco.

Insect pest problems in tobacco have shown a shift in the recent past due to climate, ecosystem, and technological changes. The major insect pests that infest tobacco in India are tobacco caterpillar, *Spodoptera litura* (nursery and main field); stem borer, *Scrobipalpa heliopa* (nursery and main field); whitefly, *Bemisia tabaci* (nursery and main field) vector of leaf curl virus disease; tobacco aphid, *Myzus nicotianae*; bud worm and

seed capsule borer, *Helicoverpa armigera* (main field). Whereas, ground beetles, *Mesomorphus villiger* and *Spodoptera exigua* are minor and sporadic in nature. These pests cause substantial damage to yield and quality of tobacco under congenial conditions.

Challenges Due to Climate Change *vis- a- vis* Insect Pests of Crops

Insect pests of crop plants are most affected by global climate change. We have clear evidence about the increase in global average temperatures and change in rainfall rates in the recent times (IPCC 2001; Balling and Cerveny 2003; Fauchereau *et al.* 2003). Over past century, the global temperature has increased by 0.8°C and is expected to reach 1.1 - 5.4°C by the end of next century. Also, the CO_2 concentration in the atmosphere has increased steeply from 280 ppm to 370 ppm and is likely to be doubled by the end of 21st century (Keeling *et al*. 1995; IPCC 2007). These changes are attributed mainly to the over exploitation and misuse of natural resources for various anthropogenic developmental activities resulting in erratic weather events like changes in rainfall patterns, frequent droughts and floods, increased intensity and frequency of heat and cold waves, out breaks of insect pests and diseases, etc., profoundly affecting many biological systems and ultimately human beings (IPCC 2007). The most imminent climatic changes in recent times is the increase in the atmospheric temperatures due to increased levels of greenhouse gases, viz., CO_2, CH_4, O_3, N_2O and CFCs. Due to the increasing concentration of these greenhouse gases, there is a serious concern about further changes in the climate and its impact on plants and herbivores. Agro-ecosystem environment is largely governed by interactions between abiotic components, *viz*., temperature, humidity, rainfall, soil factors, pollutants and biotic factors, *viz*., crop plants, weeds, insect pests and pathogens. The abiotic stress factors regulate the effects of biotic stresses and are most harmful when occur in combination, greatly influencing crop growth and productivity to the extent of 80% (Oerke *et al.* 1994; Theilert 2006). Hence, in the background of climatic change, it is essential to address multiple stresses threatening sustainability of agricultural production systems including tobacco. Pest menace under the influence of climatic factors, at various stages of crop growth is one of the factors limiting agricultural productivity (Oerke *et al*. 1994). In India, pest damage varies considerably in different agro-climatic regions across the country mainly due to differential impacts of several abiotic factors (Reed and Pawar 1982; Sharma *et al*. 2005, 2010). This has major impact for the intensification of yield losses due to potential changes in crop diversity and increased incidence of insect pests in the context of imminent climate change (Fand *et al*. 2012).

Complex physiological effects exerted by the increasing temperature and CO_2 may affect profoundly, the interactions between crop plants and insect pests (Hare 1992; Caulifield and Bunce 1994; Roth and Lindorth 1995). Global climate change may lead to increased abundance of tropical insects pests (Cannon 1998; Patterson *et al*. 1999:

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increases and altered rainfall patterns may result in shrinking of crop growing seasons with intense problems of early insect infestations. Hence, there is a need to change the crop calendars according to the changing crop environment. The growers have to change insect management strategies in accordance with the changes in pest incidence and extent of crop losses in view of the changing climate. Geographic information system (GIS) based risk mapping of crop pests can be utilized in area wide pest management programmes. Screening of pesticides with novel mode of action particularly investigating role of insecticides in enhancing stress tolerance in plants need to be undertaken for use in future crop pest management.

The changes in insect pest scenario due to the impact of climate change, technological and ecosystem changes warrant a paradigm shift in tackling these pests with appropriate management interventions. The ability to include realistic impacts of pests in future climates has a direct connection to considerations of sustainable tobacco production. The corner stone of pest management has to be the adoption of good agricultural practices at every stage of tobacco production. In the changed scenario, it is essential to develop new and innovative mechanisms to better forecast and manage pest incidences in tobacco through the development of an effective pest forecasting system. The forecasting and prediction models have to be modified depending on the changed situations locally in all the major tobacco growing regions. Systematic monitoring, increased research on the biology of the insect pests, breeding for durable resistance to major pests, and improved modelling of the many interacting processes, would be an essential underpinning investment for future pest management in tobacco. Use of reduced risk pesticides, finding effective alternative to pesticides, monitoring and management of pesticide resistance, effective implementation of phytosanitary measures and utilisation of all means that contribute to ecological balance play a great role in management of insect pests of tobacco in the changing scenario.

The extent of insect pest problems due to climate change will depend on specific regions and crops, the location-specific problems have to be addressed for specific situations. Better understanding of the interactive relationships between insect pests, their natural enemies, host plants and climate are essentially required to develop crop-pest models for each specific region and crop. To ensure this, monitoring is essential to provide indications of a response to changes in climate. Use of local biodiversity and ecosystem functions, understanding the local agro-ecological balance will be critical to address the pest problems and enhance productivity. There is a need to restore and enhance resilience in agro-ecosystem.

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