A PUBLICATION OF MOTHERHOOD UNIVERSITY, ROORKEE

(Recognized by the UGC with the right to award degrees u/s 22(1) of the UGC act 1956 and established under Uttarakhand Government Act No. 05 of 2015)

Motherhood International Journal of Multidisciplinary Research & Development

A Peer Reviewed Refereed International Research Journal

Volume I, Issue II, November 2016, pp. 37-42

ONLINE ISSN-2456-2831

Impact of Climate Change on Insect Pest

Dr. Mange Ram
Assistant Professor, Faculty of Agriculture
Motherhood University, Roorkee
Uttarakhand, India

Abstract

Climate is the prevalent pattern of weather observed over a prolonged period of time. Our earth faces serious crisis at these days due to climate changes. It has been proved that climate is changing and this change is mainly caused by human activities. Climate change also affects the daily life of all people, but it is very difficult to inform the public about this subject. The universal climate changes have greater impacts on agriculture as well as crop pests. Crop plants and their associated pests both are directly and indirectly influenced by climatic change.

Keywords: Climate change, carbon doixide, temperature, insect pest.

Introduction

Today, climate change or global warming has become serious issue of concern worldwide for existence of life on the earth. In the past one hundred years, the worldwide temperature has increased by 0.8 ^{0}C and is expected to reach 1.1-5.4 ^{0}C by the end of next century (IPCC, 2007). Moreover, the gaseous composition of the atmosphere has undergoes a significant change through misuse of natural resources such as widespread deforestation, industrial emission, fossil fuel combustion and burning of biomass as well as change in land use and land management practices. These anthropogenic activities have resulted in an increased emission of naturally occurring radioactively active gases e.g. carbon dioxide, methane and nitrous oxide popularly known as ‘greenhouse gases’. These are adversely affected many biological systems and ultimately the human beings through aberrant weather events like changes in rainfall patterns, frequent droughts and floods, increased intensity and frequency of heat and cold waves, outbreaks of insect-pests and diseases, etc.

The Indian climate has undergone significant changes showing increasing trends in annual temperature with an average of 0.56°C rise over last 100 years (IPCC, 2007). In India, the insect pest damage varies considerably in different agro-climatic zones mainly due to differential impacts of several abiotic factors such as temperature, humidity and rainfall (Sharma *et al.* 2010). It is responsible for yield losses due to changes in crop diversity and increased incidence of insect-pests. Nowadays, several studies are investigating the impact of climatic change on insect populations.Thus, it is expected that the farmers faces new and intense insect pest problems in the years to come. There is an urgent need to modify crop protection measures with changed climate in order to maintain insect pest population and reduce yield loss.

Review of Literature

Joshi and Viraktamath (2004) reported that India is experiencing declining trend of agricultural productivity due to fluctuating temperatures, frequently occurring droughts and floods, problem soils, and increased outbreaks of insect-pests and diseases. These problems are likely to be aggravated further by changing climate which put forth major challenge to attain a goal of food security.

According to the estimates of NATCOM (2004), there will be 15-40 per cent increase in rainfall with high degree of variation in its distribution. This is leading to frequently occurring extreme events like heat and cold waves, heavy tropical cyclones, frosts, droughts and floods.

Chand and Raju (2009) mentioned that the productivity of Indian agriculture is limited by its high dependency on monsoon rainfall which is most often erratic and inadequate in its distribution.

Collins *et al.* (2007) observed that climatic models based on greenhouse gases are predicting an average increase of 1.8°C to 4°C (3.2°F-7.2°F) over the period from 2007 to 2100.

Rao *et al.* (2009) reported that rainfed zone of the country showed significant negative trends in annual rainfall. The semi arid regions of the country had maximum probability of prevalence of droughts of varying magnitudes (20-30%), leading to sharp decline in water tables and crop failures.

Porter *et al.* (2014) reported that impacts of increasing greenhouse gases on agricultural production can be both positive and negative, although negative effects are assessed to dominate. Positive effects include the extension of crop production in regions in which it was limited by temperature, decreasing of freezing impacts and carbon dioxide fertilization effects on crops. Negative effects have been mostly related to increasing drought, hot extremes, as well as increased vapor pressure deficits and heavy precipitation events.

Climate Change and Insect Pest

Climate change resulting increased temperature, elevated carbon dioxide level and erratic rainfall leading to draught, flood, submergence, salinity situations, has direct and indirect effects on the crop and insect pests. Increased temperature and rainfall directly affect the crop pests, whereas elevated CO_2 has indirect affect through quality of the food materials produced by the host plants. Under both the circumstances life activities of the insect pests are affected. Agriculture is based on several biological, agronomic and economic factors. Climate change force primary change the agro-ecosystems through elevated temperatures and carbon dioxide levels leading to changes in pest activity and population levels. Higher temperatures resulting increase rates of development and number of pests surviving in the winter temperatures. In addition to these direct effects on insect pests, climate change will alter the seasonal patterns and chemistry of crop plants in other words indirectly affecting the insects that feed on plants. Furthermore, elevated carbon dioxide levels may change the nutritional content of some plants, increasing the feeding requirements for insect pests and become more destructive. Climate change or global warming will probably lead to increase agricultural, forest and public health insect pests. Climate change will directly affect insects as:

i. The geographic range of insects
ii. The timing of life cycles of insects
iii. The population dynamics of insects
iv. The natural habitats of insects
v. The structure and composition of ecosystems

Impact of temperature

Insects are poikilotherms, the temperature of their body changes approximately with the temperature of their habitats. Therefore, temperature is the predominant abiotic factor that directly influence their behaviour, distribution, development, survival and reproduction. Higher temperatures are likely to stimulate the reproduction and leading to faster population growth and an additional generation in some insect pests. For instance, the insect species that produce one generation in a year by adopting a new climatic condition can produce two or more generation a year.

A number of literatute clearly showed the impact of climatic change on insect pest population. Increased temperature encourage ants, termite pests, clothes moths, flies, mosquitoes, fleas, stored product moths, woodboring beetles and even bed bugs. For instance, a 3°C (5.4°F) increase in temperature will almost double the growth rate of the German cockroach, *Blattella germanica* (Noland *et al.* 1949). A 5°C (9°F) increase in temperature does the same for the Indian meal moth, *Plodia interpunctella* (Cox and Bell 1991).

Mosquitoes are likely to become more troublesome over larger areas. Up to now, ranges have been somewhat limited by temperatures. For instance, *Aedes aegypti*, which carries yellow fever and dengue, is killed at temperatures below 10°C. It prefers water temperatures of 25-29°C for larval development and the adult thrives best at 26°C. Adult development rate of the malaria mosquito, *Anopheles gambiae*, is greatest at 28-32°C. Warmer winters increase mosquito populations and also increase the geographical range of mosquito vectored diseases (Bayoh and Lindsay 2003). As nighttime temperatures increase, growth rates of caterpillars such as imported cabbageworm, *Pieris rapae*, increase (Whitney-Johnson *et al.* 2005). Diamondback moth, *Plutella xylostella*, is expected to complete two additional generations each year in Japan (Morimoto *et al.* 1998). Alternating cold and warm winters due to global warming encouraged an outbreak of the caterpillar *Thaumetopoea pityocampa* on Scots pine, *Pinus sylvestris* (Hodar and Zamora 2004; Buffo *et al.* 2007). Warmer winters have already lead to increased overwintering populations of some crop pests (Matsumara *et al.* 2005).

Impact of carbon dioxide

By disturbing the balance of gases in the atmosphere and increasing the amount of ultraviolet radiation is responsible for rising the global temperature of the earth's surface. This is mostly due to increased concentrations of greenhouse gases, which include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs). Most of the increase is due to human activities, especially the burning of fossil fuels. The atmospheric carbon dioxide concentration is predicted to increase not only global surface temperature but also change of the precipitation pattern. This could make worse the severity to summer drought and affect crop yield. Elevated carbon dioxide levels also changed plant structure as plant organs may increase in size: increased leaf area, increased leaf thickness, higher number of leaves, higher total leaf area per plant, and stems and branches with greater diameter. This condition favor insect pest incidence by distrubing C:N ratios and reduces the nutritive value of plants. As a result of the C:N ratio change in the plant, phloem sap becomes more concentrated at higher temperatures and thus acts as a richer source of amino acids for sap feeders. Increased C:N ratio in plant tissue resulting increased carbon dioxide levels may slow insect development and increase the length of life stages vulnerable to attack by parasitoids (Coviella and Trumble. 1999).

During the early season, soybeans grown in elevated carbon dioxide atmosphere had 57% more damage from insects (primarily Japanese beetle, potato leafhopper, western corn rootworm and Mexican bean beetle) than normal growing crop. This is brought about by increases simple sugars levels in soybean leaves may lead to stimulate additional insect feeding (Hamilton *et al.* 2005).

Impact of precipitation

Precipitation is the primary source of soil moisture and probably the most important factor determining the productivity of crops. A large number of insect pest species favor the warm and humid environment. Both direct and indirect effects of moisture on crops make them more vulnerable to be damaged by insect pests, especially in the early stages of plant growth. There are fewer scientific studies on the effect of precipitation on insects. Some insects are sensitive to precipitation and are killed or removed from crops by heavy rains. A decrease in winter rainfall could result in reduced aphid developmental rates (Pons *et al.* 1993). Other insects such as pea aphids are not tolerant of drought (Macvean and Dixon 2001).

Conclusion

India is more challenged with impacts of frightening climate change. Insect pest damage varies in different agro-climatic regions mainly due to differential impacts of abiotic factors such as temperature, humidity and rainfall resulting yield losses by changes in crop diversity and increased incidence of insect-pests. It will have serious environmental and socio-economic impacts on rural farmers whose livelihoods depend directly on the agriculture and other climate sensitive sectors. There is an urgent need to understand the abiotic stress responses in crop plants, insect-pests and their natural enemies and careful attention for planning new strategies for future pest management programmes.

References

- **Bayoh, M.N. and S.W. Lindsay. 2003.** Effect of temperature on the development of the aquatic stages of *Anopheles gambiae* (Diptera: Culicidae). *Bull. Entomol. Res.* 93(5):375-381.
- **Buffo, E. A. Battisti, M. Stastny and S. Larsson. 2007.** Temperature as a predictor of survival of the pine processionary moth in the Italian Alps. *Agric. For. Entomol.* 9(1):65-72.
- **Chand, R. and Raju, S.S. 2009.** Instability in Indian Agriculture during different phases of technology and policy, *Indian J. Agric. Econ.* 64, 187-207
- **Collins, W., R. Colman, J. Haywood, R.R.Manning and P. Mote. 2007.** The physical science behind climate change. *Sci. Amer.* 297(2): 64-73.
- **Coviella, C. and J. Trumble. 1999.** Effects of elevated atmospheric carbon dioxide on insectplant interactions. *Conserv. Biol.* 13:700-712.
- **Cox, P.D. and C.H. Bell. 1991.** Biology and ecology of moth pests of stored foods. In: Gorham, pp. 181 193.
- **Hamilton, J.G., O. Dermody, M. Aldea, A.R. Zangerl, A. Rogers, M.R. Berenbaum, and E. Delucia. 2005.** Anthropogenic Changes in Tropospheric Composition Increase Susceptibility of Soybean to Insect Herbivory. *Envirn. Entomol.* 34:2 479-485.
- **Hodar, J.A. and R. Zamora. 2004.** Herbivory and climatic warming: a Mediterranean outbreaking caterpillar attacks a relict, boreal pine species. *Biodivers. Conserv.* 13(3):493- 500.

- **IPCC, 2007.** Climate Change- Impacts, Adaptation and Vulnerability. In: (Eds.: Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., Hanson, C.E.) Cambridge University Press, Cambridge, UK, pp. 976
- **Joshi, S. and Viraktamath, C.A., 2004.** The sugarcane woolly aphid, *Ceratovacuna lanigera* Zehntner (Hemiptera: Aphididae): its biology, pest status and control. *Curr. Sci.*, , **87**, 307-316.
- **Matsumura, M., M. Tokuda, N. Endo, S. Ohata and S. Kamitani. 2005.** Distribution and abundance of the maize orange leafhopper *Cicadulina bipunctata* (Homoptera: Cicadellidae) in Kikuchi, Kumamoto, Japan in 2004. *Kyushu Plant Prot. Res.* 51: 36-40.
- **Macvean, R. and A. F. G. Dixon. 2001.** The effect of plant drought-stress on populations of the pea aphid *Acyrthosiphon pisum*. *Ecol. Entomol.* 26: 440-443.
- **Morimoto, N., O. Imura and T. Kiura. 1998.** Potential effects of global warming on the occurrence of Japanese pest insects. *Appl. Entomol. Zool.* 33(1):147-155.
- **NATCOM, 2004.** India's initial national communication to the United Nations framework-convention on climate change. Ministry of Environment and Forests, pp. 268.
- **Noland, J.E., J.H. Lilly and C.A. Bauman. 1949.** A laboratory method for rearing cockroaches and its application for dietary studies on the German roach. *Ann. Entomol. Soc. Amer.* 42(1):63-70.
- **Pons X, J Comas, R Albajes 1993.** Overwintering of cereal aphids (Homoptera: Aphididae) on durum wheat in a Mediterranean climate. *Environ. Entomol.* 22:381-387.
- **Porter, J.R., L. Xie, A.J. Challinor, K. Cochrane, S.M. Howden, M.M. Iqbal, D.B. Lobell, and M.I. Travasso, 2014:** Food security and food production systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 485-533
- **Rao, G.G.S.N., Rao, A.V.M.S., Rao, V.U.M., 2009.** Trends in rainfall and temperature in rainfed India in previous century. In: *Global climate change and Indian Agriculture case studies from ICAR network project*, (Ed.: PK Aggarwal), ICAR Publication, New Delhi. pp.71-73.
- **Sharma H C, Srivastava C P, Durairaj C, Gowda CLL 2010.** Pest management in grain legumes and climate change. In: Yadav SS, McNeil DL, Redden R and Patil SA (eds.) *Climate Change and Management of Cool Season Grain Legume Crops*. Dordrecht, the Netherlands: Springer, pp.115-140.
- **Whitney-Johnson, A., M. Thompson and E. Hon. 2005**. Responses to predict global warming in Pieris rapae: consequences of nocturnal versus diurnal temperture change on fitness. *Environ. Entomol.* 34(3): 535-540.