International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(3): 684-686
www.biochemjournal.com
Received: 25-12-2023
Accepted: 30-01-2024

Lipsa Dash
Assistant Professor, Department of Entomology, College of Horticulture, Odisha University Of Agriculture and Technology, Chiplima, Odisha, India

Corresponding Author:
Lipsa Dash
Assistant Professor, Department of Entomology, College of Horticulture, Odisha University Of Agriculture and Technology, Chiplima, Odisha, India

Effects of global warming on pest status in agriculture

Lipsa Dash

DOI: https://doi.org/10.33545/26174693.2024.v8.i3Si.858

Abstract
Global warming has been a great concern now a days. The harmful effects of global warming has both positive and negative effect on the pest population and it hampers the pest management strategies in agricultural field. For this reason, global warming has been an important criterion in Entomology. Having tolerance of narrow range of temperature, insects are greatly affected by the change in temperature. It affects the distribution and migration of pests across the field. Insects may experience additional or reduced life cycle due to change in weather conditions. Hence the basic biology, lifecycle and life span of insects are hampered by the change in climatic conditions.

Keywords: Global warming, migration, distribution

Introduction
Climate change has been an important criterion in abundance and distribution of species. Global warming is the increase in temperature which is now a major issue for mankind. It possess threat to both survival and distribution of insect pests. For food security, increasing crop yield would be a rather sustainable approach than clearing crop field. Modern approaches are focused on impact of climate change which includes rising global temperature, carbon dioxide concentrations, heat waves, flooding, intense storms, droughts etc. Hence more attention has been given to above abiotic factors. However, along with these abiotic factors some biotic factors also play a major role in impacting crop yield. Among all the biotic factors, the major factor is the pest population which are also affected by weather disturbances. Increase in temperature affects reproduction, survival, and population dynamics of pest.

Impact of increase in temperature
Effect of temperature on insects largely suppresses the effects of other environmental factors (Bale *et al.* 2002) [1]. Temperature is the most important factor which governs the survival, reproduction, distribution and lifecycle of pests. Out of different temperature range, low temperature is having more detrimental effect than high temperature in determing the geographical distribution of pests. Rising temperature on insect can be direct, through the influence of climatic factors on the insects' physiology and behavior or indirect, as mediated by host plants, competitors or natural enemies (Thomson *et al.*, 2010) [2]. *Helicoverpa zea* in North America (EPA, 1989) and *H. armigera* in North India has shown the impact of temperature on pest status successfully (Sharma *et al.* 2010) [3]. Rise in temperature has a great influence on the habitat shifting of pests. Viability and incubation period of *H. armigera* eggs is strongly influenced by the fluctuation in temperature. Today, many butterfly species are depleting due to decrease of the natural vegetation for developmental activities (Sidhu and Mehta, 2008) [4]. Around 99.9% of all species have become extinct. Due to climate change the current extinction rates are 100 to 1,000 times greater than what has happened earlier, and nearly 45 to 275 species are becoming extinct everyday (Sharma, 2010) [3]. Rise in temperature influences the distribution of insects. Around 1ºC rise in temperature increases the speed 200 km northwards (in northern hemisphere) or 40 m upward (in altitude). Due to fluctuation in temperature unfavourable areas may become favourable for pests. Early adult emergence and an presence of migratory species of aphid have been reported in UK (Harrington *et al.*, 2007) [5].

Diapause is a period of suspended developmental activities, which is controlled by temperature, humidity and photoperiod. Insects that experience winter diapause are likely to experience the most significant changes in their thermal environment. Increased temperatures will speed up the development cycle of insects which results in more cycles of generations per year. Hence insects can complete more generations per year (Petzoldt and Seaman, 2010) [6]. Climate change has increased the frequency and intensity of of insect-pests populations. Occurrence of of sugarcane woolly aphid *Ceratovacuna lanigera* Zehntner in sugarcane growing areas of Karnataka and Maharashtra during 2002-03 resulted in 30% yield losses (Joshi and Virakamath, 2004) [7]. Climate change can cause incidence of insect transmitted plant diseases through multiplication of insect vectors (Sharma *et al.*, 2005) [8].

Increased CO_2 levels

Increased CO_2 level can have a significant effect on pest population status. Increased CO_2 level can increase the carbon nitrogen ratio which ultimately dilutes the nitrogen feeding by protein limited insects (Coviella *et al.*, 1999) [9]. Showed in soybean a low level of deterrent phytochemicals under high ambient CO_2 allows Japanese beetle to feed heavily on the plants. High levels of this gas increases the carbohydrate content of which affects the growth of aphids (Chen *et al.*, 2004) [10]. Phytophagous insects may also develop adaptations to overcome higher carbon to nitrogen ratios. Lindroth *et al.* (1993) [11] reported that performance of saturniid caterpillars is only marginally affected when the carbon to nitrogen ratio increased by 13-28%. Biochemical analysis of the foliage showed that plants grown under the elevated CO_2 levels had lower N-content, and higher C-content, C/N ratio and polyphenols. Larvae grown under higher concentration of CO_2 had shown higher digestibility to leaves than larvae grown under standard condition. Rao *et al.* (2009) [19] have demonstrated feeding behaviour with two foliage feeding insect species, *A. janata* and *S. litura* using castor plants as sample under three concentrations viz., 700 ppm, 550 ppm, 350 ppm (ambient) of CO_2. Insects grown under 700 ppm and 550 ppm concentrations had shown higher digestibility over insects under ambient CO_2 concentration. Even though relative consumption rate increased, the efficiency of digestibility decreased. Soyabean grown under elevated CO_2 condition have shown 57% more damage to Japanese beetle, Potato leaf hopper and Mexican beetle.

Effects of rainfall

Change in frequency of rainfall may affect the distribution and abundance of pests. Under change in climatic conditions frequency of rainfall will decrease while intensity will increase. Under such circumstances sucking pests like aphids, jassids, whiteflies will reduce as they get washed away with heavy rainfall (Pathak *et al.*, 2012) [12]. Due to climate change, average rainfall will decrease in several regions which leads to occurrence of summer droughts in many areas. Aphid population on wheat and other crops was adversely affected by rainfall and sprinkler irrigation (Daebeler and Hinz, 1977) [13]. Masters *et al.*, (1998) [14] have carried out novel manipulations of local climate to investigate how warmer winters with either wetter or drier summers would affect the homopteran insects a major component of the insect fauna of grasslands.

Impact of climate change on Pests

Breakdown of Host Plant Resistance

Host Plant Resistance is one of the most important criteria for managing the pest population. Efficiency of HPR largely depends on climatic factors like temperature, rainfall and carbon dioxide concentration. Changes in these climatic factors may alter the interactions between insect pests and their host plants (Sharma *et al.*, 2010) [3]. Under stressful environment plants become more susceptible to attack by the pest due to failure in its own defensive mechanism. Due to rise in temperature and water stress conditions sorghum plant may show susceptibility to sorghum midge and spotted stem borer (Sharma *et al.*, 2005) [8]. High CO_2 causes changes in nutritional quality and secondary metabolites of the host plants. Severe drought benefits Bark beetles, wood borers, and sap sucking insects, while *Spodoptera exigua* (Hub.) exhibited a reduced ability to feed on drought-stressed tomato leaf tissue. CO_2 enriched atmosphere reduces nutritional quality of leaves due to dilution in nitrogen content by 10-30% (Coley and Markham, 1998) [15].

Transgenic crops

High temperature, elevated CO_2 levels, or drought, leading to decreased resistance to insect pests due to reduction in formation of toxic protein. Cotton bollworm, *Heliothis virescens* destroyed Bt cottons due to high temperatures in USA (Kaiser, 1996) [16]. Reasons for the failure of insect control may be due to inadequate production of the toxin protein, environment stress, locally resistant insect populations, and development of resistance due to inadequate management (Sharma and Ortiz, 2000) [17].

Natural Enemies

Global warming changes the relationship between pest and natural enemies. Changes in temperature will also alter the timing of diurnal activity patterns of different groups of insects. Temperature affects not only rate of development in insects but also the fecundity and sex ratio. Oriental armyworm, populations increased during extended periods of drought followed by heavy rainfall. High concentration of CO_2 and temperature increases aphid population, however, the parasitism rates remain unchanged in elevated CO_2 (Triltsch, 1996) [18].

Conclusion

Climate change is now a reason of great concern. It has a great impact on diversity, distribution, incidence, reproduction, growth, development, voltisim and phenology of insect pests. Climate change affects the host plant resistance and natural enemy efficiency. Dealing with the climate change bears uncertainty, unpredictability over time and place. Effects of climate change on pest population should be given proper attention to have successful pest management strategies. Hence, It is a need to have a proper look at the likely effects of climate change on crop protection, and devise appropriate measures to mitigate the effects of climate change on food security.

References

1. Bale DK, Singh J, Vennila S. Emerging Crop Pest Scenario under the Impact of Climate Change. J Agril. Phy. 2002;11:13-20.

2. Thomson MB, Blanford S. Thermal biology in insect parasite interactions. Trends Ecol. Evol. 2010;18:344-350.
3. Sharma HC. Global Warming and Climate Change: Impact on Arthropod Biodiversity, Pest Management, and Food Security Global Warming and Climate Change: Impact on Arthropod Biodiversity, Pest Management, and Food Security. In: National Symposium on Perspectives and Challenges of Integrated Pest Management for Sustainable Agriculture, 19-21 Nov 2010, Solan, 2010.
4. Sidhu AK, Mehta HS. Role of butterflies in the natural ecosystem with special reference to high altitude (Pangi Valley, Himachal Pradesh). In: Proceedings of International Conference on Climate Change, Biodiversity and Food Security in the South Asian Region, 3 - 4 November, 2008. Punjab State Council for Science and Technology, Chandigarh and United Nations Educational, Scientific and Cultural Organization, New Delhi, 2008, p.36.
5. Harrington R, Clark SJ, Weltham SJ, Virrier PJ, Denhol CH, Hullé M, *et al*. Environmental change and the phenology of European aphids. Global Change Biology. 2007;13:1556-1565.
6. Petzoldt C, Seamann A. Climate Change Effects on Insects and Pathogens. Climate change and Agriculture: Promoting Practical and Profitable responses. 2010, 6-16, Accessed online at http://www.climateandfarming.org/pdfs/ FactSheets/III.2Insects.Pathogens.pdf.
7. Joshi S, Viraktamath CA. The sugarcane woolly aphid, *Ceratovacuna lanigera* Zehntner (Hemiptera: Aphididae): its biology, pest status and control. Curr. Sci. 2004;87:307-316.
8. Sharma HC, Dhillon MK, Kibuka J, Mukuru SZ. Plant defense responses to sorghum spotted stem borer, Chilo partellus under irrigated and drought conditions. Int. Sorghum Millets News. 2005;46:49-52.
9. Coviella CE, Trumble JT. Effects of elevated atmospheric carbon dioxide on insect-plant interactions Conserv. Biol. 1999;13:700-712.
10. Chen FJ, Wu G, Ge F. Impacts of elevated CO_2 on the population abundance and reproductive activity of aphid, Sitobion acenae Fabricius feeding on spring wheat. J Appl. Entomol. 2004;128:723-730.
11. Lindroth RL, Kinney KK, Platz CL. Responses of deciduous trees to elevated atmospheric CO_2: productivity, phytochemistry and insect performance. Ecol. 1993;74:763-777.
12. Pathak H, Aggarwal PK, Singh SD. Climate Change Impact, Adaptation and Mitigation in griculture: Methodology for Assessment and Application Division of Environmental Sciences, Indian Agricultural Research Institute New Delhi, 2012, p. 111-130.
13. Daebeler F, Hinz B. Compensation of aphid injury to sugarbeet by means of supplementary rain. Arch Phytopathol. Pflanzenschutz. 1977;13(3):199-205.
14. Masters GJ, Brown VK, Clarke IP, Whittaker JB, Hollier JA. Direct and indirect effects of climate change on insect herbivores: Auchenorrhyncha (Homoptera). Ecol. Entomol. 1998;23(1):45-52.
15. Coley PD, Markham A. Possible effects of climate change on plant/ herbivore interactions in moist tropical forests. Climatic Change. 1998;39:455-472.
16. Kaiser J. Pests overwhelm Bt cotton crop. Nature. 1996;273:423.
17. Sharma HC, Ortiz R. Transgenics, pest management, and the environment. Curr. Sci. 2000;79:421-437.
18. Triltsch CD, Cameron A, Green RE, Bakkenes M, Beaumont LJ, Collingham YC, *et al*. Extinction risk from climate change. Nature. 1996;427:145-148.
19. Prasad KE, Das B, Maitra U, Ramamurty U, Rao CN. Extraordinary synergy in the mechanical properties of polymer matrix composites reinforced with 2 nanocarbons. Proceedings of the National Academy of Sciences. 2009 Aug 11;106(32):13186-13189.