International Journal of Ecology and Environmental Sciences
www.ecologyjournal.in
Online ISSN: 2664-7133; Print ISSN: 2664-7125; Impact Factor: RJIF 5.28
Received: 09-11-2020; Accepted: 23-11-2020; Published: 09-12-2020
Volume 2; Issue 4; 2020; Page No. 704-706

Effects of climate change on pest and pesticide use

Lipsa Dash, Deepayan Padhy, V Ramalakshmi, Ajit Kumar Sahu
MSSSOA, Centurion University of Technology and Management, Odisha, India

Abstract
Climate change is the term used to describe a gradual increase in the average temperature of the Earth's atmosphere and its oceans, a change that is believed to be changing the Earth's climate forever. Insects are cold-blooded organisms - the temperature of their bodies is approximately the same as that of the environment. Therefore, temperature is probably the single most important environmental factor influencing insect behaviour, distribution, development, survival, and reproduction. Anthropogenic CO_2 is almost twice more important for temperature increase than other long-lived greenhouse gases combined. Although increased CO_2 should not directly deleteriously affect insects, the temperature increases driven by the increase in anthropogenic CO_2 already affect insects in profound ways including their distribution, nutrition, phenology and role as disease vectors.

Keywords: climate change, pesticide, Earth's atmosphere

Introduction

The Environmental Protection Agency (USEPA) defines pesticide as "any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest". A pesticide may be a chemical substance or biological agent (such as a virus or bacteria) used against pests. Pesticides have been the centre of controversy for a long time and are associated with risks to human health and/or to the environment. On the other hand, society accepts these risks within certain limits as there are also benefits linked to the use of pesticides, in particular in agricultural production. Long-term changes of climate have already been detected and there is wide agreement that the climate will continue to warm over the 21st century (IPCC, 2001a; 2001b). Global warming might increase pest activity. Insects and other arthropods are potentially useful taxa for examining the direct and indirect effects of changes in climate over time. Unlike many other taxa, insects exist over a wide range of temporal and spatial scales. Insect populations can respond rapidly, allowing researchers to identify study foci from ongoing monitoring.

In plain words, insects live short lives, are everywhere, and respond quickly to subtle changes in habitat. This quick response makes insects particularly suitable as candidate species for monitoring changing environments. In addition, monitoring insect populations is generally inexpensive, and often requires a minimal investment in equipment and training. For these reasons, insects are potentially an important source of sentinel information for climatic effects on other higher order taxa. Insects are poikilotherms, consequently their life history parameters are directly linked to temperature (Beresford, and Sutcliffe, 2009; Beresford, 2011) [1]. Several entomologists and biologists have investigated the potential effects of climate change on pest populations (Patterson *et al.*, 1999; Porter *et al.*, 1991) [2, 3]. They confirm that projected warming will help some pest species to survive winters and will accelerate the development of summer-active species. In any particular location, climate change may not mean more pest animals and weeds, but it could mean new pest animals and weeds.

Effects of elevated CO_2 on insect pests

In general, host plants grown under elevated CO_2 are less nutritious to insect herbivores, which can affect their behaviour and performance. Phenotypic host-plant changes typically make leaf material eaten by insects less nutritious. As a consequence, insects have a more difficult time converting the food they eat into biomass. In order to mitigate the effects of less nutritious food, insect herbivores often consume more. Insect herbivore performance is positively correlated with leaf nitrogen concentrations. Zvereva and Kozlov (2010) [5] reported that the leaf nitrogen content decreased for mustard and collard grown under elevated CO_2. Leaf chewing insect herbivore performance is positively correlated with leaf water content. Decrease in leaf water contents was observed under elevated CO_2 for both mustard and collard.

Hamilton *et al.*, (2005) [4] reported higher percent leaf damage or consumption due to cabbage white butterfly fed either mustard or collard grown under elevated CO_2. Similar results have been obtained in leaf miners on a variety of woody species. Zvereva and Kozlov (2010) [5] detected a significant negative effect of elevated CO_2 on insect herbivore performance. They observed that overall herbivore communities were lower on plants grown under elevated CO_2 vs. ambient CO_2. This is likely in part due to higher mortality rates due to both parasitoids and other natural enemies. Hamilton *et al.*, (2005) [4] measured levels of herbivory in soybean grown in ambient air and air enriched with CO_2 or O_3 using free air gas concentration enrichment (FACE). Under open-air conditions and exposure to the full insect community, elevated CO_2 increased the susceptibility of soybeans to herbivory early in the season, whereas exposure to elevated O_3 seemed to have no effect. In the region of the canopy exposed to high levels of herbivory, the percentage of leaf area removed increased from 5 to more than 11% at elevated CO_2.

Effects of elevated temperature on insect pests

Many of the effects of increased temperature on insect performance have to do with the direct effects of temperature on insects. Because insects are exothermic, they tend to be more active under warmer conditions. A typical effect of elevated temperature is therefore to increase consumption rates and therefore decrease the time to pupation, making them less apparent to natural enemies and in some cases increasing the potential number of generations per season. It has been estimated that with a 2 ºC temperature increase insects might experience one to five additional life cycles per season (Yamamura and Kiritani, 1998) [7]. Elevated temperatures increase gypsy moth performance, both decreasing its development time and increasing its survival rate (Williams *et al*., 2003) [6].

Temperature may change gender ratios of some pest species such as thrips (Lewis, 1997) [8] potentially affecting reproduction rates. Insects that spend important parts of their life histories in the soil may be more gradually affected by temperature changes than those that are above ground simply because soil provides an insulating medium that will tend to buffer temperature changes more than the air (Bale *et al*., 2002) [11].

Lower winter mortality of insects due to warmer winter temperatures could be important in increasing insect populations (Harrington *et al*., 2001) [9]. Insect species diversity per area tends to decrease with higher latitude and altitude (Andrew and Hughes, 2005) [10], meaning that rising temperatures could result in more insect species attacking more hosts in temperate climates (Bale *et al*., 2002) [11].

Effect of changes in rainfall pattern on insect pests

Early and timely planting become more uncertain under climate change. During the 2009 rainy season, delay in onset of monsoons by 45 days resulted in delayed plantings of pigeonpea that are prone to damage by *Helicoverpa armigera* and caused heavy damage (Sharma, 2010) [12]. As with temperature, precipitation changes can impact insect pest predators, parasites, and diseases resulting in a complex dynamic. Fungal pathogens of insects are favoured by high humidity and their incidence would be increased by climate changes that lengthen periods of high humidity and reduced by those that result in drier conditions. Some insects are sensitive to precipitation and are killed or removed from crops by heavy rains, this consideration is important when choosing management options for onion thrips (Reiners and Petzoldt, 2005) [13].

The toxicology of climate change

Climate change will have a powerful effect on the environmental fate and behavior of chemical toxicants by altering physical, chemical, and biological drivers of partitioning between the atmosphere, water, soil/sediment, and biota, including: air-surface exchange, wet/dry deposition, and reaction rates (e.g., photolysis, biodegradation, oxidation in air). Temperature and precipitation, as altered by climate change, are expected to have the largest influence on the partitioning of chemical toxicants (Henriksen *et al.* 2013) [15]. In addition, an array of important processes, such as snow and ice melt, biota lipid dynamics, and organic carbon cycling, will be altered by climate change potentially producing significant increases in fugacity (thermodynamic measure of substance tendency to prefer one phase over another) and contaminant concentrations. Other potential interactions between climate change and toxicant exposure include increased susceptibility to pathogens (Abadin *et al.* 2007) [14].

Conclusion

Species life history (evolutionary) adaptations may obscure our ability to detect species response to climate change - accordingly, species respond differently to changes in thermal environments. There are many interactions and it is extremely difficult to predict the impact of climate change on insect pests in the future, but we may expect an increase of certain primary pests as well as secondary pests and invasive species. The best economic strategy for farmers to follow is to use integrated pest management practices to closely monitor insect and disease occurrence. Keeping pest and crop management records over time will allow farmers to evaluate the economics and environmental impact of pest control and determine the feasibility of using certain pest management strategies or growing particular crops. Some of the potential adaptation strategies could be developing IPM with more emphasis on biological control and changes in cultural practices, pest forecasting using recent techniques such as simulation modelling and alternate production techniques.

References

1. Beresford DV, Sutcliffe J. Sampling designs of insect time series data: are they all irregularly spaced? Oikos. 2009; 118:115-121.
2. Patterson DT, Russell AE, Mortensen DA, Coffin RD, Flint EP. Effects of temperature and photoperiod on Texas panicum (*Panicum texanum*) and wild proso millet (*Panicum miliaceum*). Weed Science. 1999; 34:876-882.
3. Porter JH, Parry ML, Carter TR. "The Potential Effects of Climatic-Change on Agricultural Insect Pests." Agricultural and Forest Meteorology, 1991, 221-40.
4. Hamilton JG, Orla D, Mihai A, Arthur RZ, Alistair R, May RB, *et al*. Anthropogenic changes in tropospheric composition increase susceptibility of soybean to insect herbivory. Environmental Entomology. 2005; 34(2):479-485.
5. Zvereva EL, Kozlov MV. Responses of terrestrial arthropods to air pollution: a metaanalysis. Environmental Science Pollution Research International. 2010; 17:297-311.
6. Williams RS, Lincoln DE, Norby RJ. Development of gypsy moth larvae feeding on red maple samplings at elevated CO_2 and temperature. *Oecologia*. 2003; 137:114-122.
7. Yamamura K, Kiritani K. A simple method to estimate the potential increase in the number of generations under global warming in temperate zones. Applied Entomology and Zoology. 1998; 33:289-298.
8. Lewis T. Major crops infested by thrips with main symptoms and predominant injurious species (Appendix II). Thrips as Crop Pests (ed. by T Lewis). CAB International, New York, USA, 1997, 675-709
9. Harrington R, Fleming RA, Woiwod IP. Climate change impacts on insect management and conservation in temperate regions: can they be predicted? Agricultural and Forest Entomology. 2001; 3:233-240.

10. Andrew NR, Hughes L. Diversity and assemblage structure of phytophagous Hemiptera along a latitudinal gradient: predicting the potential impacts of climate change. Global Ecology and Biogeography. 2005; 14:249-262.
11. Bale JS, Masters GJ, Hodkinson ID, Awmack C, Bezemer TM, Brown VK, *et al*. Herbivory in global climate change research: direct effects of rising temperature on insect herbivores. Global Change Biology. 2002; 8:1-16.
12. Sharma HC Effect of climate change on IPM in grain legumes. In: 5th International Food Legumes Research Conference (IFLRC V), and the 7th European Conference on Grain Legumes (AEP VII), 26-30th, Anatalaya, Turkey, 2010.
13. Reiners S, Petzoldt C. Integrated Crop and Pest Management Guidelines for Commercial Vegetable Production. Cornell Cooperative Extension Publication #124VG, 2005.
14. Abadin HG, Chou CHSJ, Llados FT. Health effects classification and its role in the derivation of minimal risk levels: immunological effects. Regul Toxicol Pharm. 2007; 47(3):249-56.
15. Henriksen HJ, Rosenbom A, Keur P, van der, Olesen JE, Jørgensen LJ, *et al*. Prediction of climatic impacts on pesticide leaching to the aquatic environments. Pesticide research no. 143, Miljostyrelsen Strandgade Publication. Kobenhavn K, 2013.