The Hidden Cost of Climate Change: More Pests in Vegetable Crops

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ABSTRACT

Climate change has emerged as a significant driver of increased pest attacks on vegetable crops, threatening food security and agricultural sustainability worldwide. Rising temperatures, altered monsoon and erratic weather events create favourable conditions for the proliferation of insect pests, pathogens and invasive species. Warmer climate accelerates pest life cycle, expand their geographic ranges and disrupt the natural balance between pests and their predators. Moreover, climate changes due to rainfall pattern and warmer temperature can lead to the emergence and migration of invasive pest species into new areas. Effective mitigation strategies include the adoption of resistant varieties, IPM strategies, use of biocontrol agents, regular monitoring and promotion of sustainable farming practices.

INTRODUCTION

Vegetables play an important role of a healthy diet as they are rich sources of micro nutrients, vitamins, minerals and dietary fibre. World Health Organisation (WHO) recently made recommendations that include consumptions of 400 grams of fruits and vegetables each day. The optimum amount of intake depends on several factors such as age, sex and level of physical activities. Consumption of vegetables that are rich sources of calcium, zinc, vitamin A, B C, E etc can help to combat hidden hunger, alleviate

poverty and can enhance food security in rural households.

Vegetable production is heavily influenced by climatic factors such as temperature, rainfall, photoperiod etc. along with soil properties such as pH, soil type, soil fertility etc. In today's world, increased temperatures and elevated atmospheric carbon dioxide are the most prominent factors of climate change posing threat to crop production. Extreme weather events such as heat waves, altered monsoon, heavy rainfalls leading to floods and severe droughts are increasing since the past decades (Phophi *et al*.,2017). Climate change is most likely to alter insect pest population and their relationship with the host, thus resulting in negative impact on crop productivity.

How does climate change impact insect pest population?

***Effect of high temperature on pest dynamics*:**

As poikilothermic creatures, insects' body temperatures are influenced by the ambient temperature. When it comes to insect behaviour, development, and reproduction, temperature is likely the most significant environmental component (Skendžic *et al*., 2021). The metabolism, metamorphosis, movement, and host availability of pests are all influenced by temperature, which also affects the likelihood of changes in pest population dynamics. Increased temperature tends to speed up insect movement, development, and consumption, which can impact fecundity, survival, generation time, population size, and geographic range, among other aspects of population dynamics, according to research. Whiteflies, stem borers, and aphids are a few examples of insect pests that are resistant to high temperatures.

***Effect of variable rainfall on insect pest behaviour*:**

Changes in rainfall frequency and intensity are crucial markers of climate change. It has been observed that precipitation intensity has increased while frequency has reduced. Droughts and floods have been more likely to occur under this kind of rainfall pattern. Overlapping rainfall has a direct impact on insect species that hibernate in the soil. Flooding and extended water stagnation can result from severe rains. This event threatens insect survival and affects their diapause. Furthermore, flooding and severe rains can wash away bug eggs and larvae. Aphids, mites, jassids, whiteflies, and other small-bodied pests can be washed away by intense rain. Variability in rainfall can significantly affect the number of insects.

***Response of insect pests to increased CO_2 concentration*:**

The effects of increasing CO_2 levels on insect pests are highly dependent on their host plants. Increased CO_2 levels would have a greater impact on C_3 crops (cucurbits, tomato, okra etc.) than on C_4 crops (baby corn, amaranthus etc.). Higher CO_2 is anticipated to have a favourable effect on C_3 plants and a negative effect on C_4 plants, whereas the latter are less sensitive to changes in insect feeding habits.

***Rising risk of invasive alien insect species*:**

Insect invasion pathway involves a chain of events that include the transport, introduction, establishment, and dispersal of invasive alien insects. Climate change can directly affect the transport and introduction of invasive insects. Extreme climate events (e.g., storms, high winds, currents, and swells) could shift pests to new areas where they may find environmental conditions favourable for establishment (Divekar *et al*. 2024).

Strategies for sustainable control of pest population in changing climate:

IPM strategies are primarily introduced by growers and researchers to maximize crop yields and financial returns while minimizing adverse environmental effects (FAO 2021).

- **Crop diversification:** Crop diversification refers to growing a variety of crops in a given area, instead of focusing on monocropping. An increased plant diversity can regulate pest population by favouring the efficacy and abundance of natural enemies and also by reducing the density of specialised pest species.

- **Use of resistant varieties:** Resistant varieties offer a cost-effective, eco-friendly, and durable foundation for managing pests in a warming world. Sustained investment in breeding, regional adaptation, and knowledge dissemination is essential to scale their impact.

- **Use of Biological agents:** Biological agents ranging from predatory insects and parasitoids to microbial pathogens and sterile males offer selective, sustainable, and long-term pest control.

Examples: Green lacewings (*Chrysoperla carnea*) prey on aphids, whiteflies, thrips, spider mites, and moth eggs, particularly effective in organic and enclosed systems. Ladybugs (*Coccinellidae)* consume aphids and other soft-bodied insects is an example of predators.

- **Use of companion crops:** The companion crops can be grown either a trap crop or intercrops. The main purpose of growing companion crops is to protect main crops from insect pests that will cause damage. Companion crops grown as intercrops can be used as repellents for insect pests (Cook *et al*., 2007).

CONCLUSION:

With changing of climate, insect biology may alter due to rising of temperatures and carbon dioxide levels. This can raise insect growth and development, fertility rates and insect dispersion and adaption to new environments. Due to growing generations and populations, it is reported that these pests will cause severe agricultural damage in warmer regions if they are not controlled. If temperatures stay high, it is also reasonable to assume that these pests may have high rates of overwintering. The impact of climate change on crop yield has been the subject of additional research. The management of ectothermic pests and other new pests in the context of climate change should be the subject of further study.

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