



Effect of Climate Change on Arthropod Diversity in Agricultural Ecosystems

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Climate change and global warming are of great concern to agriculture worldwide and are among the most discussed issues in today's society. Climate parameters such as increased temperatures, rising atmospheric CO₂ levels, and changing precipitation patterns have significant impacts on agricultural production and on agricultural insect pests. Anthropogenically induced climatic change arising from increasing levels of atmospheric greenhouse gases would have a significant effect on agricultural pests. Changes in climate may trigger changes in geographical distribution, increased overwintering, changes in population growth rates, increases in the number of generations, extension of the development season, changes in crop-pest synchrony, changes in inter specific interactions, pest biotypes, activity and abundance of natural enemies, species extinction, increased risk of invasion by migrant pests and efficacy of crop protection technologies. Global warming will also reduce the effectiveness of host plant resistance, transgenic plants, natural enemies, biopesticides, and synthetic chemicals for pest management. Under elevated temperature and CO₂, the pest species exhibit increased herbivory, longevity, voltinism, reproduction cycles, fecundity, population size and pesticide resistance. The plant phytochemical defense mechanism against insect attack also may decrease under raised greenhouse effect. This induces additional damage to plants by enhancing the longevity and fecundity and population of the pest species. Plants also shift their other chemical defense mechanisms from nitrogen-based chemicals to carbon-based chemicals under high CO₂ environment leading to enhanced herbivory by the insects to satisfy their nitrogen requirement. As a result, there is a serious risk of crop economic losses, as well as a challenge to human food security.

Impact of climate change

There are a number of factors associated with climate change that may impact the relationship among climate, arthropod pests, natural enemies and host plants. These include:

- Distribution, abundance, and quality of host plant;
- Pest physiological and behavioral processes;
- Natural enemy effectiveness;
- Plant growth rates and plant health;
- Distribution and abundance of pest population; and
- The presence of competing species.

However, the greatest effects on arthropod pests as it relates to climate change are carbon dioxide (CO₂) and temperature.

Impact of carbon dioxide

The number of potential relationships or factors associated with climate change and arthropod pests. For example, increased carbon dioxide levels may:

- Result in higher consumption rates by insects;
- Allow invasive insect species to outcompete native insect species.
- Encourage the increase in migration of invasive insect species and noninvasive species into new regions/areas;
- Increase the duration and intensity of arthropod pest outbreaks due to extended frost-free periods; and
- Create a higher potential for the occurrence of insect-borne human diseases such as malaria and dengue fever.

It is possible that climate change may increase the range of expansion of certain insects. Migration of new insect pests, both in terms of latitude and altitude, may result in a change in the ecosystem thus allowing populations of new species to increase. This may force other species to extinction because these new species may be better competitors at higher temperatures, although this may not always be the case. Population dynamics are not predictable as insect pests could be constrained by natural enemies, host-plant availability, and competition with other insect species. Furthermore, the rate at which insect species can establish populations permanently into new areas that are suitable will be limited by the rate of spread of host plants into new areas, which would impact specialist and generalist herbivores differently.

Effect of higher temperatures

- The impact on life history parameters (for example, reduced offspring production) of natural enemies such as parasitoids and predators
- Possibility of insect outbreaks
- Insect development, survival, distribution and abundance are directly affected by temperature because insects are cold-blooded animals.
- Lead to temporal and/or geographical separation leading to arthropod pest outbreaks.
- Impact on multiple generations of insect.

Impact on pest management

- In general, this could lead to increased pesticide use (insecticides and acaricide) throughout the growing season with more frequent applications, resulting in higher incidences of resistance occurring in arthropod pest populations because of the increased selection pressure placed on these populations. In addition, this may directly and indirectly impact natural enemies thus influencing any natural mortality.
- Additional factors to consider in regard to pest management include long-term harmful effects to plants (phytotoxicity) due to the amount of pesticide applications, and associated infestations of arthropod pests for extended periods of time. This may lead to natural infestations of multiple arthropod pest guilds such as chewers (caterpillars and beetles), suckers (aphids, scales and leafhoppers) and/or wood-boring insects occurring simultaneously on the same plant.
- Finally, potential effects of climate change on pesticides, may include decreased residues or persistence, reduced toxic action on arthropod pests, increased treatment rates or dosages required, increased number of pesticide applications, and fewer times suitable for pesticide application (influenced by temperature and wind, which may prevent or delay application)..

References

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