



Climate Change Impacts on Crop Microclimates and Adaptation Strategies

*Sanghamitra Sahoo

M.Sc. Research Scholar, Department of Agricultural Meteorology,
College of Agriculture, OUAT, Bhubaneswar, Odisha, India

*Corresponding Author's email: sanghamitra342@gmail.com

We all check the weather forecast, but does a plant experience the same weather we do? The answer to this question is no. What makes the difference is the crop microclimate. Every crop field has its own secret, hidden weather called microclimate, which can be much different than the official forecast. When we talk about climate change and agriculture, the usually jumps straight to big numbers like rising global temperatures, shifting rainfall patterns, extreme weather events. But climate condition just centimeters above the soil and within the leaf canopy itself play a major role in the crop yield and production that's the crop microclimate. Climate change is now making this microclimate extreme and unpredictable. This article explains how Changes in crop microclimate directly affect plant growth, flowering, pollination, water use, and yield. How to minimize these impacts, different adaptation strategies such as climate resilient varieties, efficient irrigation, mulching, crop diversification, agroforestry, and weather-based farm management. These practices help to create a favorable microclimate around crops and improve agricultural resilience under changing climatic conditions.

Impacts of Climate Change on Crop Microclimate

Climate change alters the local temperature, humidity and airflow at different layers of the crop canopy and surroundings of plant, which disrupts their growth and increase stress.

- Increase in Air and Canopy Temperature

Global warming has resulted in higher average temperatures and more frequent heat waves. Increased temperature raises canopy temperature, accelerates crop development and shortens the growing period. Crops may reach maturity earlier, reducing biomass accumulation and grain filling duration. High temperatures during flowering can reduce pollen viability, leading to poor fertilization and lower yields in crops such as rice, wheat, maize, and pulses.

- Changes in Soil Moisture

Irregular rainfall and prolonged dry spells reduce soil moisture availability. Dry soils increase soil temperature and reduce water uptake by roots. As a result, crops experience moisture stress, reduced photosynthesis, and poor growth. On the other hand, excessive rainfall may cause waterlogging, affecting root respiration and nutrient absorption.

- Increased Evapotranspiration

Higher temperatures increase evaporation from the soil surface and transpiration from plants. This leads to greater water demand by crops. Farmers may need additional irrigation to maintain optimum growth conditions, particularly in arid and semi-arid regions.

- Alteration of Relative Humidity

Climate change affects atmospheric humidity levels. Lower humidity combined with high temperature increases canopy temperature and plant water loss. Conversely, excessive humidity can promote fungal diseases such as rust, blight, mildew, and leaf spot.

- Increased Frequency of Extreme Weather Events

Heat waves, droughts, floods, cyclones, and unseasonal rainfall are becoming more common. These events disrupt the crop microclimate and damage crops at critical growth stages. Strong winds can cause lodging, while heavy rainfall can lead to soil erosion and nutrient losses.

- Changes in Pest and Disease Incidence

Temperature and humidity strongly influence pest and disease development. Warmer conditions may increase insect reproduction and survival rates. Changes in crop microclimate can also create favorable conditions for new pests and diseases, posing additional challenges to crop production.

Adaptation Strategies

To reduce the adverse impacts of climate change on crop microclimate, farmers can adopt several practical adaptation measures.

- Use of Climate Resilient Varieties

Cultivation of heat tolerant, drought tolerant, flood tolerant, and salinity tolerant varieties which can withstand adverse climatic conditions, improved varieties that maintain their yield levels even under stress environments.

- Adjustment of Sowing Time

Alteration of planting dates so that crops are not subjected to temperature or moisture stress at the critical growth stages. Proper timing improves crop performance and reduces climate related risks.

- Efficient Water Management

Efficient irrigation practices such as drip irrigation, sprinkler irrigation, and rainwater harvesting help maintain adequate soil moisture. Farm ponds and other water storage structures for supplemental irrigation during dry periods.

- Mulching

Mulching is a practice used in agriculture that includes various methods of mulching the soil's surface with residues from crops, straw, leaves, or plastic films. Mulching aims to reduce the loss of moisture from the soil, conserve soil moisture, and lower temperatures, and smother weed growth while improving the crop growth environment.

- Conservation Agriculture

Conservation agriculture is a system that consists of minimum tillage, maintaining surface residues and crop rotation. These practices improve soil structure, maintains soil fertility, increase water infiltration and enhance soil moisture conservation.

- Crop Diversification

Crop diversification is a farming technique that involves growing different varieties of crops to avoid the risks associated with growing a single crop. It provides an additional source of family income and it ensure food security in the farm.

- Agroforestry

Agroforestry is the practice of integrating trees with crops and animals in the same field. Trees in agroforestry systems provide shade, shelter and act as windbreak for crops. It lowers the temperature in the crop field and increase the crop yield.

- Protected Cultivation

Protected structures such as greenhouses, polyhouses, and shade nets help regulate temperature, humidity, and radiation. These systems protect crops from extreme weather conditions and improve productivity.

- Weather-Based Agro Advisories

Modern weather forecasting and agro advisory services give farmers timely information on rainfall, temperature, pest outbreaks, and irrigation requirements that help them to manage their crops and increase yield.

- Precision Agriculture

The use of technologies such as remote sensing, sensors, drones, and decision support systems can help monitor crop condition and microclimate variability. Precision management is efficient and reduces the risk exposure from climate variability.

- Windbreaks and polytunnels

These are the physical barriers that reduce the wind speed and prevent the rapid drying out of canopy air and protect the crops from mechanical stress and heat stress.

Conclusion

Climate change is significantly impacting the crop microclimate by altering temperature, rainfall patterns, humidity, soil moisture, and the frequency of extreme weather events. These changes directly influence crop growth, development, yield, and quality. Effective adaptation strategies are necessary to maintain agricultural productivity and food security. Adoption of climate-resilient varieties, improved water management, mulching, conservation agriculture, crop diversification, agroforestry, protected cultivation, and weather-based advisories can help farmers cope with changing climatic conditions. Sustainable management of crop microclimate will play a crucial role in building climate-resilient agriculture in the future.

References

1. IPCC. 2022. Climate Change 2022: Impacts, Adaptation and Vulnerability. Cambridge University Press.
2. FAO. 2023. Climate-Smart Agriculture Sourcebook. Food and Agriculture Organization of the United Nations, Rome.
3. Lal, R. 2020. Climate change and agriculture: impacts and adaptation. Journal of Soil and Water Conservation, 75(5): 123A–129A.
4. Boomiraj, K., Wani, S.P., Garg, K.K., Aggarwal, P.K. and Palanisami, K. 2010. Climate change adaptation strategies for agro-ecosystem. Journal of Agrometeorology, 12(2): 145–160.
5. Hatfield, J.L. and Prueger, J.H. 2015. Temperature extremes: Effect on plant growth and development. Weather and Climate Extremes, 10: 4–10.
6. Gruda, N., Bisbis, M. and Tanny, J. 2019. Influence of climate change on protected cultivation. Journal of Cleaner Production, 225: 481–495.
7. Singh, S.D., Rao, G.G.S.N., Patil, N.G. and Muralikrishna, I.V. 2018. Agricultural adaptation strategies to climate change. Indian Journal of Agricultural Sciences, 88(5): 673–682.
8. Pathak, H., Aggarwal, P.K. and Singh, S.D. 2012. Climate Change Impact, Adaptation and Mitigation in Agriculture. Indian Agricultural Research Institute, New Delhi.