

Impact of Heat Stress on Growth and Yield of Vegetable Crops in Ranchi Region

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Abstract

High temperatures, particularly during the reproductive stages, are a major abiotic stress that negatively impacts the growth and yield of vegetable crops. In the Ranchi region, the increasing frequency of heat waves, coupled with the effects of climate change, has heightened concerns about the sustainability of vegetable production. This article investigates the specific impact of high temperatures on the growth and productivity of vegetable crops in Ranchi, with a focus on common crops like tomatoes, potatoes, and cauliflower. The findings suggest that elevated temperatures significantly reduce the rate of photosynthesis, impede flowering, and increase the incidence of diseases, ultimately leading to decreased yields. The review also explores strategies to mitigate the impact of heat stress, such as using heat-tolerant varieties, modifying planting schedules, and employing agronomic practices like mulching and shading. Understanding these dynamics is crucial for enhancing vegetable crop productivity in this region under changing climatic conditions.

Introduction

The Ranchi region, located in Jharkhand, India, experiences a moderate tropical climate with distinct seasonal variations. While the region benefits from a relatively cool and temperate climate, recent shifts in weather patterns have resulted in higher-than-usual temperatures during key cropping seasons. This article discusses the impact of high temperature on the growth and yield of vegetable crops in the Ranchi region, highlighting the challenges posed by heat stress, particularly during the reproductive and fruit-setting phases. The vulnerability of vegetable crops to heat stress in this region poses significant challenges for local farmers who depend on crops such as tomatoes, potatoes, cauliflower, and peas for their livelihood.

1. Effect on Germination & Seedling Establishment

High temperatures have been shown to adversely affect seed germination and the establishment of seedlings. In vegetable crops like tomatoes and peppers, excessive heat (above 35°C) can cause poor germination rates. Seeds may fail to

sprout, or seedlings may become weak and exhibit stunted growth, making them more susceptible to pests and diseases. Ranchi's climatic variability, with occasional heatwaves, can be a limiting factor for establishing a healthy vegetable crop.

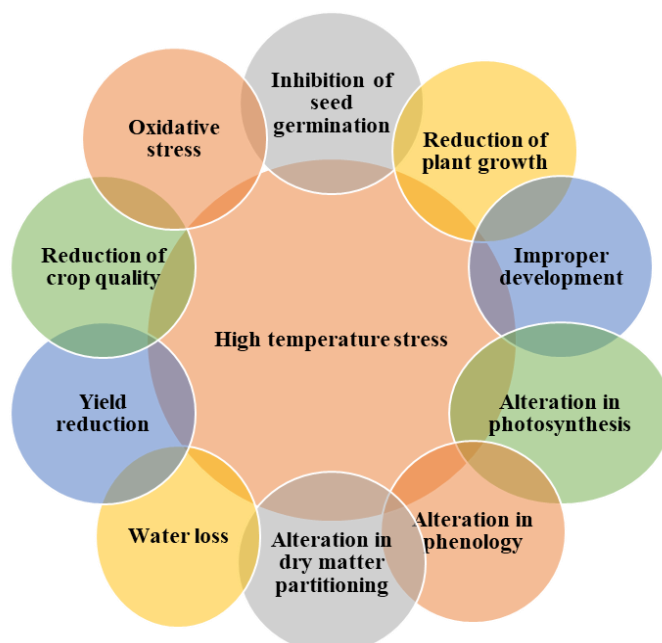


Fig. 1. Impact of High Temperature on Vegetable Crops

2. Photosynthesis and Growth Reduction

Temperature is one of the most crucial factors affecting photosynthesis—the process by which plants convert sunlight into food. When the temperature exceeds the optimal range for a specific crop, photosynthesis efficiency decreases. High temperatures lead to stomatal closure, reducing the intake of carbon dioxide, which is essential for photosynthesis. For instance, tomatoes and cauliflower, which are commonly grown in Ranchi, have an optimal temperature range of 20°C–30°C. Exposure to temperatures above this range results in reduced chlorophyll content and impaired metabolic functions, leading to poor vegetative growth.

3. Flowering and Pollination Issues

High temperatures also affect reproductive processes such as flowering and pollination. In crops like tomatoes and cucumbers, high daytime temperatures (above 35°C) can cause flower abortion,

resulting in reduced fruit set. During hot periods, pollination is often ineffective, as the activity of pollinators like bees is reduced in extreme heat. This results in fewer fruits and a significant decrease in yield.

4. Impact on Yield and Fruit Quality

For many vegetable crops, heat stress directly translates into reduced yield. In the case of tomatoes, prolonged exposure to high temperatures can lead to poor fruit set, cracking, or even premature ripening. Similarly, crops like cauliflower and cabbage are prone to bolting when exposed to high temperatures, causing the plant to flower prematurely rather than form edible heads. Furthermore, heat stress increases the likelihood of pest outbreaks, which further reduces yield quality.



a. Fruit cracking in tomato



b. Blossom end rot in chilli



c. Richyness in Cauliflower

Climate Change and Its Role in Temperature Increase

Global climate change is contributing to an increase in temperatures worldwide, and Ranchi is no exception. The region has witnessed a rise in average temperatures in recent years, which has directly impacted crop productivity. Prolonged periods of high temperatures not only affect vegetable crops in the short term but may also lead to changes in the cropping calendar, making it challenging to predict the optimal sowing and harvesting periods.

In Ranchi, a delay in the monsoon season or irregular rainfall patterns can lead to extended hot spells during the vegetable growing season, exacerbating the negative impact of high temperatures. This makes vegetable farming more

unpredictable, which may result in increased financial risks for local farmers.

Adaptation and Mitigation Strategies

1. Heat-Tolerant Varieties

The development and use of heat-tolerant vegetable varieties is one of the most promising strategies for mitigating the impact of high temperatures. Breeding programs focused on selecting crops that can withstand higher temperatures without significant reductions in yield are essential. For instance, certain varieties of tomatoes, such as heat-tolerant hybrids, have been shown to perform better under elevated temperatures.

2. Shading and Mulching Techniques

Agronomic practices like mulching and shading are effective in reducing the temperature around the root zone. Shading nets, for example, can be employed to protect crops from direct exposure to the sun, while mulching helps conserve soil moisture and maintain a cooler soil environment. These practices have been shown to reduce heat stress and improve crop productivity.

3. Adjusted Planting Schedules

To avoid the peak heat periods, adjusting the planting and harvesting schedules can be an effective strategy. For example, crops can be planted early in the season to ensure that they mature before the hottest months. Alternatively, using staggered planting schedules can ensure that not all crops are exposed to high temperatures at the same time.

4. Irrigation Management

Proper irrigation is critical during high-temperature periods to ensure that crops receive sufficient water. Drip irrigation systems, which deliver water directly to the roots, are particularly beneficial in maintaining soil moisture levels while preventing water wastage. Timely irrigation also reduces the risk of heat stress on vegetable crops.

Conclusion

High temperatures pose a significant threat to vegetable crop productivity in the Ranchi region, affecting key processes such as germination, growth, flowering, and fruit setting. The combined effect of climate change and increasing temperatures necessitates the adoption of adaptive strategies to maintain sustainable vegetable production. Heat-tolerant varieties, effective crop management

practices, and timely irrigation can mitigate the impact of heat stress and enhance yield stability. It is essential for farmers, agricultural researchers, and policymakers to work together to develop strategies that will help the Ranchi region's vegetable crops thrive under the changing climatic conditions.

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