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Impact of Climate Change on Abiotic Stress in Dolichos Bean (*Lablab Purpureus* L. Sweet)

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INTRODUCTION

Climate change has emerged as a major global challenge affecting agricultural productivity and food security. Rising temperatures, erratic rainfall patterns, and increased frequency of extreme weather events such as droughts, floods, and heat waves are intensifying abiotic stresses in crops. These stresses disrupt plant physiological and biochemical processes, ultimately reducing growth and yield. Leguminous crops are particularly sensitive to environmental fluctuations, making them highly vulnerable under changing climatic conditions (IPCC, 2023).

Dolichos bean (*Lablab purpureus* L. Sweet) is an important leguminous vegetable crop widely cultivated in tropical and subtropical regions. It is valued for its high nutritional content and its role in improving soil fertility through biological nitrogen fixation. The crop serves as a rich source of protein, vitamins, and minerals. Fresh green pods contain approximately 6.7 g carbohydrates, 3.8 g protein, 210 mg calcium, 1.7 mg iron, 312 IU vitamin A, and 0.1 mg thiamine per 100 g (Gopal *et al*., 2004). Due to its adaptability and nutritional significance, dolichos bean plays a crucial role in rainfed and subsistence farming systems.

Botanically, dolichos bean is a diploid species (2n = 2x = 22) belonging to the family Leguminosae. However, its growth and productivity are significantly affected by climate change-induced abiotic stresses such as drought, salinity, and temperature extremes. Understanding the impact of these stresses is essential for developing resilient varieties and sustainable management practices (Raza *et al*., 2019)

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2. Climate Change and Abiotic Stress

Abiotic stress refers to the negative impact of non-living environmental factors such as water deficit, salinity, temperature extremes, and nutrient imbalance on plant growth and development. These stresses induce complex physiological, biochemical, and molecular changes, including altered gene expression, enzyme activity, and cellular metabolism (Zhang *et al*., 2023).

Climate change intensifies abiotic stress through multiple pathways:

- Increased temperature → heat stress
- Irregular rainfall → drought stress
- Excessive rainfall → waterlogging
- High evaporation and poor irrigation → salinity
- Soil degradation → nutrient deficiency

These combined stresses significantly reduce crop productivity and threaten agricultural sustainability.

"The major abiotic stresses affecting dolichos bean under changing climate conditions are discussed below."

3. Major Abiotic Stresses Affecting Dolichos Bean

3.1 Soil Salinity Stress

Soil salinity is a major constraint limiting crop productivity worldwide. In dolichos bean, salinity stress affects seed germination, plant growth, and yield. It leads to osmotic stress, ion toxicity (Na^+ and Cl^- accumulation), and nutrient imbalance. Salinity also reduces stomatal conductance and transpiration, thereby limiting photosynthesis. Additionally, it induces oxidative stress through the generation of reactive oxygen species (ROS), causing cellular damage and premature leaf senescence (Kaymakanova *et al*., 2009).

3.2 Drought Stress

Drought is one of the most critical abiotic stresses exacerbated by climate change. Water deficit reduces cell turgor pressure, leading to decreased cell division and elongation. In dolichos bean, drought stress results in reduced plant height, leaf area, root growth, and biomass accumulation. It also causes stomatal closure, limiting CO_2 uptake and photosynthesis. Severe drought conditions accelerate leaf senescence, reduce flowering, and impair pod development (Dhanuja *et al*., 2024).

3.3 Moisture Stress

Moisture stress arises when plants are unable to absorb sufficient water from the soil, often due to salinity or low soil moisture. This leads to stomatal closure, reduced carbon assimilation, and impaired physiological processes. Consequently, overall plant growth and productivity are significantly affected (Wahab et al., 2022).

3.4 Waterlogging Stress

Waterlogging results from excessive rainfall and poor drainage conditions. It creates hypoxic or

anaerobic conditions in the root zone, inhibiting root respiration and nutrient uptake. In dolichos bean, waterlogging reduces chlorophyll content, disrupts photosynthesis, and causes stomatal closure. These effects ultimately lead to reduced growth, flowering, and yield (Setter and Waters, 2003; Ashraf, 2012).

3.5 Cold Stress

Cold stress, including chilling (0–15°C) and freezing (<0°C), adversely affects plant growth and development. It disrupts membrane stability, enzyme activity, and metabolic processes. Cold stress also enhances the production of ROS, leading to oxidative damage. In dolichos bean, it results in poor germination, stunted growth, and reduced yield (Orvar *et al*., 2000; Suzuki *et al*., 2006).

3.6 High Temperature Stress

High temperature stress, intensified by global warming, negatively affects plant growth and metabolism. In dolichos bean, it reduces seedling survival, plant height, root and shoot development, and biomass accumulation. Heat stress also causes protein denaturation and membrane instability. Although plants exhibit adaptive responses such as increased antioxidant enzyme activity and proline accumulation, prolonged exposure significantly reduces productivity (Barik, 2020).

3.7 Nutrient Deficiency

Climate change contributes to soil degradation and nutrient depletion. Nutrient deficiency in dolichos bean leads to poor root development, chlorosis, reduced nodulation, and decreased photosynthetic efficiency. These effects ultimately impair flowering, pod formation, and seed quality.

3.8 Elevated CO_2 Stress

Elevated atmospheric CO_2 initially enhances photosynthesis in C_3 plants like dolichos bean. However, long-term exposure results in nutrient imbalance, particularly reduced nitrogen content, and decreased mineral concentration (e.g., iron and zinc). It may also increase oxidative stress, thereby affecting crop quality and sustainability (Myers *et al*., 2014; Parvin *et al*., 2019).

Table 1: Effect of Different Abiotic Stresses on Growth and Physiology of Dolichos Bean

Abiotic Stress	Effect on Plant Growth	Physiological/Biochemical Mechanism
Drought	Reduced plant height, biomass, yield	Stomatal closure, reduced photosynthesis, ROS production
Salinity	Poor germination, leaf senescence	Ion toxicity (Na^+, Cl^-), osmotic stress
High Temperature	Reduced flowering, pod set	Protein denaturation, enzyme inactivation
Waterlogging	Root damage, reduced growth	Oxygen deficiency, impaired respiration
Cold Stress	Poor germination, stunted growth	Membrane damage, ROS accumulation
Nutrient Deficiency	Chlorosis, poor nodulation	Reduced nutrient uptake, low photosynthesis

"ROS = Reactive Oxygen Species"

4. Physiological and Biochemical Responses to Abiotic Stress

Dolichos bean responds to abiotic stress through various physiological and biochemical mechanisms:

- Stomatal closure reduces transpiration and water loss but limits CO_2 uptake
- Reduction in chlorophyll content decreases photosynthetic efficiency

- Accumulation of osmolytes (e.g., proline, soluble sugars) helps maintain cell turgor
- Generation of reactive oxygen species (ROS) causes oxidative damage
- Activation of antioxidant enzymes (SOD, CAT, POD) protects against ROS
- Alteration in enzyme activity and gene expression regulates stress tolerance

These responses help plants survive under stress conditions but often at the cost of reduced growth and yield.

5. Impact on Growth and Yield

Abiotic stresses significantly affect the growth, development, and productivity of dolichos bean. They reduce germination rate, vegetative growth, flowering, and pod formation. Stress conditions also impair photosynthesis, nutrient uptake, and assimilate partitioning, resulting in lower yield and poor-quality produce.

6. Adaptation and Mitigation Strategies

To minimize the adverse effects of climate change on dolichos bean production, the following strategies can be adopted:

- Development of stress-tolerant varieties through plant breeding
- Efficient irrigation and water management practices
- Improvement of soil health through organic amendments
- Use of biostimulants and plant growth regulators
- Adoption of climate-smart practices such as mulching, crop diversification, and conservation agriculture.

These approaches can enhance resilience and ensure sustainable crop production under changing environmental conditions.

CONCLUSION

Climate change significantly intensifies abiotic stresses such as drought, salinity, temperature extremes, and waterlogging, which adversely affect the growth, physiology, and yield of dolichos bean. Understanding plant responses at physiological and biochemical levels is essential for developing stress-resilient varieties. Integration of improved breeding strategies with climate-smart agricultural practices can help sustain dolichos bean production and ensure food and nutritional security under future climate scenarios.

REFERENCES

Ashraf, M. (2012). Waterlogging stress in plants: A review. *African Journal of Agricultural Research, 7*(13), 1976–1981.

Barik, M. (2020). *Studies on physiological responses of hyacinth bean (Dolichos lablab L.) genotypes against high temperature stress* (Unpublished thesis).

Dhanuja, G. S., et al. (2024). Studies on drought tolerance in dolichos bean (*Lablab purpureus* L.). *International Journal of Advanced Biochemistry Research, 8*(2), 635–639.

Dörr de Quadros, P., Martin, A. R., Zhalnina, K., Dias, R., Giongo, A., Fulthorpe, R., Bayer, C., Triplett, E. W., & Camargo, F. A. O. (2019). *Lablab purpureus* influences soil fertility and microbial diversity in a tropical maize-based no-tillage system. *Soil Systems, 3*(3), 50. https://doi.org/10.3390/soilsystems3030050

Intergovernmental Panel on Climate Change (IPCC). (2023). *Climate change 2023: Synthesis report*. Geneva, Switzerland.

Kaymakanova, M., Stoeva, N., & Mincheva, T. (2009). Salinity and its effects on the physiological response of bean (*Phaseolus vulgaris* L.). *Journal of Central European Agriculture, 9*(4), 749–755.

Maass, B. L., Knox, M. R., Venkatesha, S. C., Angessa, T. T., Ramme, S., & Pengelly, B. C. (2010). Lablab purpureus-A Crop Lost for Africa? Tropical Plant Biology, 3 (3), 123–135.

Myers, S. S., Zanobetti, A., Kloog, I., Huybers, P., Leakey, A. D. B., Bloom, A. J., Carlisle, E., Dietterich, L. H., Fitzgerald, G., Hasegawa, T., Holbrook, N. M., Nelson, R. L., Ottman, M. J., Raboy, V., Sakai, H., Sartor, K. A., Schwartz, J., Seneweera, S., Tausz, M., & Usui, Y.

(2014). Increasing CO_2 threatens human nutrition. *Nature*, *510*, 139–142.

Orvar, B. L., Sangwan, V., Omann, F., & Dhindsa, R. S. (2000). Early steps in cold sensing by plant cells: The role of actin cytoskeleton and membrane fluidity. *The Plant Journal*, *23*, 785–794.

Raza, A., Razzaq, A., Mehmood, S. S., Zou, X., Zhang, X., Lv, Y., & Xu, J. (2019). Impact of climate change on crops adaptation and strategies to tackle its outcome: A review. Plants, 8(2), 34.

Setter, T. L., & Waters, I. (2003). Review of prospects for germplasm improvement for waterlogging tolerance in wheat, barley, and oats. *Plant and Soil*, *253*, 1–34.

Suzuki, N., & Mittler, R. (2006). Reactive oxygen species and temperature stresses: A delicate balance between signaling and destruction. *Physiologia Plantarum*, *126*, 45–51.

Wahab, A., Abdi, G., Saleem, M. H., Ali, B., Ullah, S., Shah, W., Mumtaz, S., Yasin, G., Muresan, C. C., & Marc, R. A. (2022). Plants' physio-biochemical and phyto-hormonal responses to alleviate the adverse effects of drought stress: A comprehensive review. *Plants*, *11*(13), 1620.

Zhang, H., Liu, S., Ren, T., Niu, M., Liu, X., Liu, C., Wang, H., Yin, W., & Xia, X. (2023). Crucial abiotic stress regulatory network of NF-Y transcription factor in plants. *International Journal of Molecular Sciences*, *24*, 4426.

Zhang, H., Zhao, Y., & Zhu, J. K. (2020). Thriving under stress: How plants balance growth and the stress response. *Developmental Cell*, *55*, 529–543.

