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Light spectrum-mediated improved drought-resilient rootstock performance under drought stress in Okra genotypes

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INTRODUCTION & AIM

Okra (*Abelmoschus esculentus L.*) is extremely sensitive to drought stress, which impairs carbon absorption, osmotic control, and redox equilibrium. The spectrum composition of light is an important environmental signal that controls antioxidant defense, photosystem integrity, and gene expression mediated by photoreceptors. Gaining a molecular understanding of spectrum-specific regulation can help improve the physiological and proteomic responses of okra that are resistant to drought.

OBJECTIVE OF THE STUDY

This study examines the effects of various light spectra on grafted okra genotypes' resistance to drought. The study intends to clarify physiological, biochemical, and proteomic pathways that improve drought stress tolerance and overall plant performance under water-limited settings by combining light-mediated signaling with drought-tolerant rootstocks.

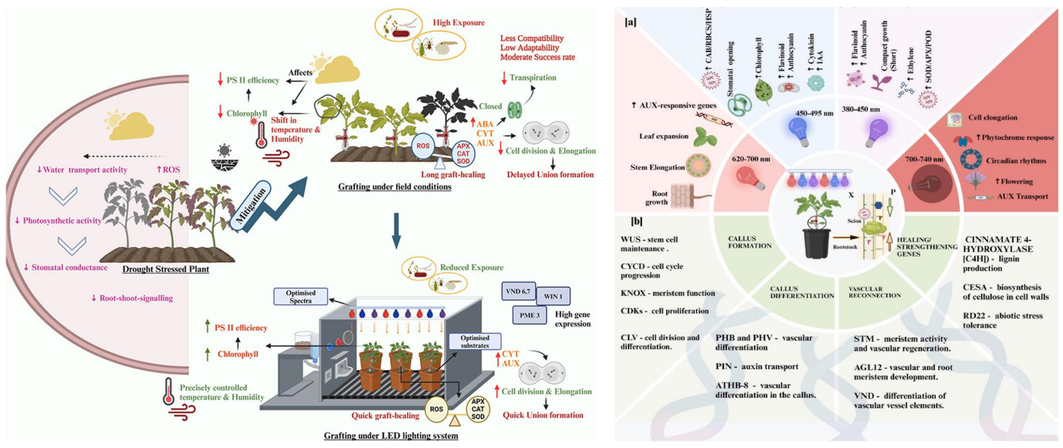
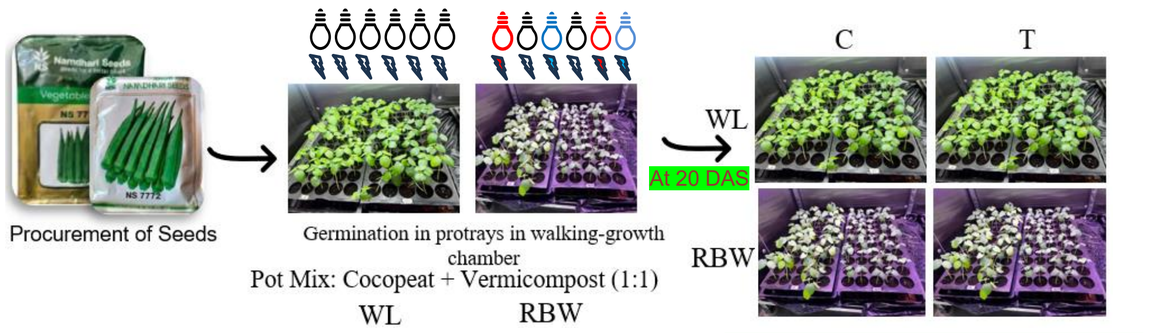


Fig 1. Suresh and Muneer, *Plant Physiology and Biochemistry,* 2025

METHOD

In this study, two okra genotypes, NS 7772 and NS 7774, were assessed in the presence of drought stress grown under two light spectra: red: blue: white (R:B:W) and white light (WL 100%).



Leaf samples were collected after 5 and 10 days of treatment and stored at -80 degrees

Samples were ground in ice-cold LN2 and taken for further analysis

Morpho-Physiological
- Biomass
- LWP (Leaf water Potential)
- Water Transport Activity
- Root Architecture
- Plant/Root ratio

Bio-chemical
- MDA Content
- Proline Content
- H_2O_2 and O_2^- Localization
- Antioxidant enzymes - CAT, APX, SOD isoenzyme pattern

Photosynthetic
- Total Protein Profile – SDS PAGE
- Thylakoid protein – BN-PAGE
- Photosynthetic measurements
- Total Chlorophyll & carotenoid
- Stomatal Index
- Structure of stomata

CONCLUSION

These results demonstrate that grafting, combined with specific spectral light modifications can greatly increase resistance of okra to drought. The superior performance of NS 7774 under red:blue:white (R:B:W) light conditions suggests the potential suitability of NS 7774 for cultivation in drought-prone zones of India. LED-enhanced grafting produces climate-resilient okra transplants in a single growing season, reducing the healing period by half and increasing yield, viral resistance, and drought tolerance.

RESULTS & DISCUSSION

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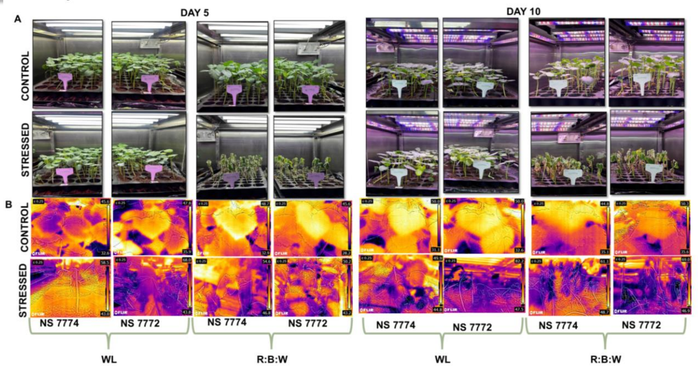
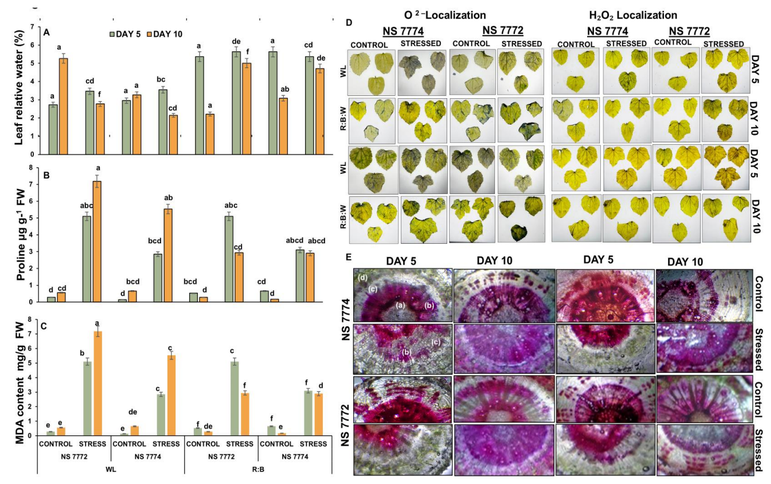


Fig.2 CRD design of experiment at white fluorescent light system (WL and multi-spectrum LED light system at controlled climatic conditions. Infrared thermographic images depicting elevated canopy temperature distribution indicate reduced transpiration and relative water content during day 5 and day 10 of drought stress.

(3)



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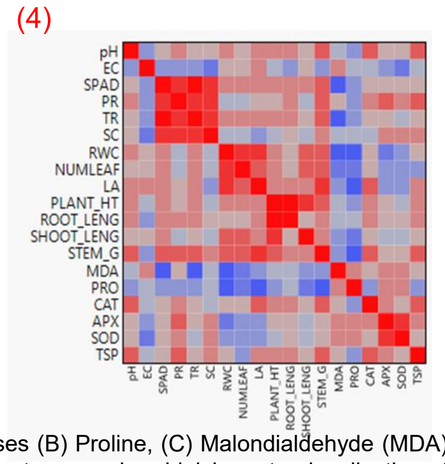

Fig.3 Physiological (A) Leaf relative water content, and oxidative stress responses (B) Proline, (C) Malondialdehyde (MDA) content (D) ROS differential accumulation (brownish spots - localization of H_2O_2 stress marker; bluish spots - localization of $O2^{-1}$ marker) and (e) representing relative water transport by vascular bundles [a) Phloem ; b) Xylem; c) Cortex; d) Epidermis respectively] of okra genotypes under WL (100%) and R:B:W during drought stress.
Fig. 4 Karl Pearson's correlation (r) heat map of physiological and biochemical traits

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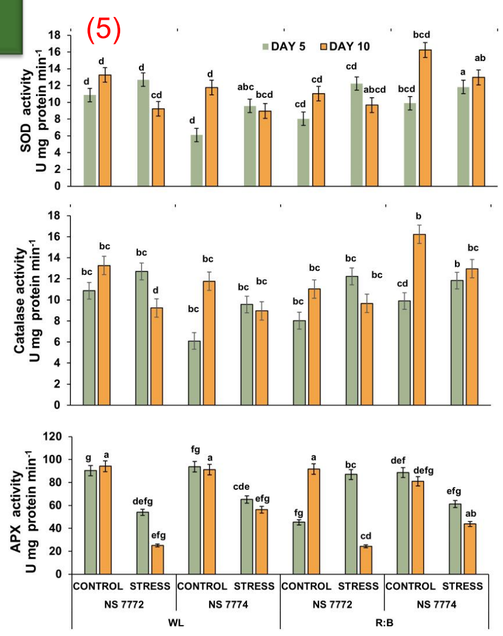

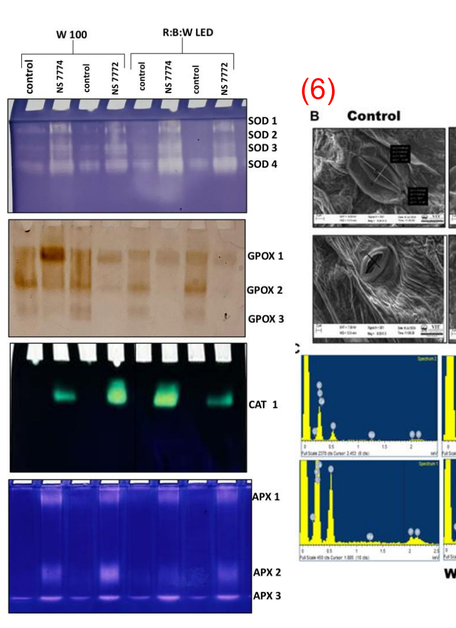

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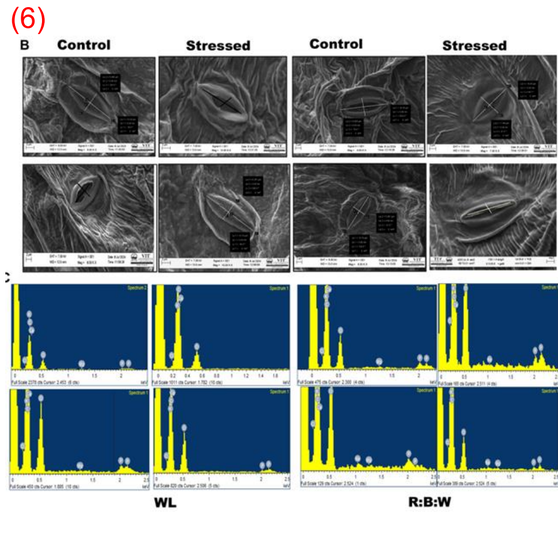

Fig 5: Modification in enzymatic antioxidant defenses and isoenzyme distribution (A) Antioxidant enzyme activity modifications (SOD, CAT, and APX) and (B) Native PAGE-based isozyme profiling of antioxidants (SOD, GPOX, CAT and APX) and Fig. 6 represents scanning electron microscopic images with (C) EDAX of okra genotypes (viz., NS 7772 and NS 7774) under white fluorescent light system (WL) and multi-spectrum LED (R:B) light system during severe (day 10) drought stress

(7)

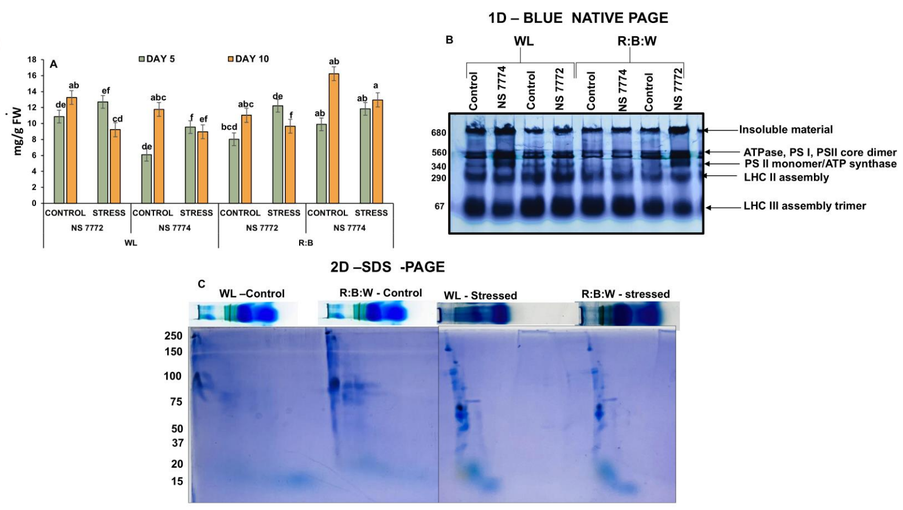

Fig 7: Stress-induced comparative proteomic analysis (A) Total soluble protein (B) First-dimension blue-native PAGE (BN-PAGE), (C) Second-dimension SDS-PAGE profile of denatured subunits derived from BN-PAGE of okra genotypes (viz., NS 7772 and NS 7774, along with respective controls) under white fluorescent light system (WL) and a multi-spectrum LED (R:B:W) light system during day 10 drought stress.

FUTURE WORK / REFERENCES

- Rapid nursery scale-up is made possible by its inexpensive LED benches and straightforward cleft technique. Widespread adoption is expected to boost rural livelihoods and sustainable agriculture with consistent okra output during unpredictable monsoons, offering smallholders a cost-effective pathway to maintain yield stability, nutritional quality, and viral resistance under accelerating climate variability.
- Farmer-friendly and affordable lights can be designed with the same combinations to initiate graft healing of vegetable crops in Indian climatic zones

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