Image Based Phenotyping for Screening Drought Tolerance in Spring Wheat (*Triticum aestivum* L.)

Pravin Pawar[1,2], KJ Yashavanthakumar[1,2]* , Sudhir Navathe[1,2], Manoj Oak[1,2], Jagadish Rane[3]

[1] MACS- Agharkar Research Institute, Pune, India, [2] Savitribai Phule Pune University, Pune, India,
[3] ICAR-National Institute for Abiotic Stress Management, Malegaon, Baramati, India

INTRODUCTION

Drought is one of the important abiotic stresses affecting all growth stages of wheat (*Triticum aestivum* L.) crops; it becomes more severe during the flowering, grain-filling phases (terminal drought) and can cause up to 78% yield loss. Across the world, various breeding work is underway to develop terminal drought-tolerant varieties. Being a complex trait, governed by many genes it is highly affected by the environment, hence precise phenotyping is a prerequisite. In this context, a diverse set of genotypes were evaluated for post anthesis (Terminal) drought using non-destructive image-based phenotyping and other traits at different developmental stages

Materials and Methods

- 500 spring wheat genotypes were screened during the field trial conducted at the experimental and research farm of the Agharkar Research Institute, Pune
- The experiment was conducted in replicated augmented design under two environments viz. Post anthesis drought and Irrigated (Control)

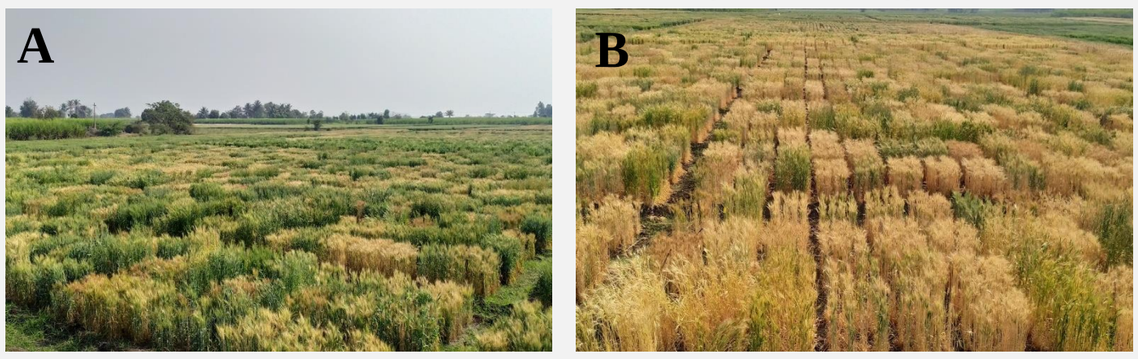

Figure 1. (A) Irrigated field trial **(B)** Drought field trial

- The same set of genotypes were screened using infra-red imaging and other traits to study significant physiological responses in both the environments

Figure 2. Infrared images recorded using handheld Infrared thermal camera

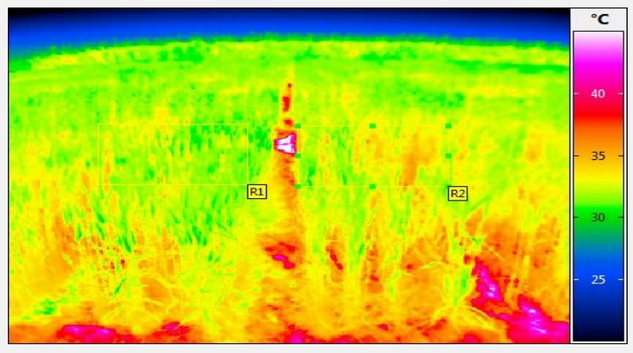

Figure 3. Thermographic image obtained after image analysis in IRBIS® 3 software for data acquisition

- Grain characteristics study of 500 genotypes were done by using CSIRO GrainScan software for both the environments to evaluate the effect of drought on grain morphological traits Fig. 4 and Fig. 5

Figure 4. Scanned grain image using an Epson Perfection V700

Figure 5. Grain scan result image obtained after data acquisition by using CSIRO GrainScan software

- Image-based technique are standardized to seminal root trait phenotyping like root angle and number of seminal roots by using cocopeat+vermicompost as a media in transparent plastic cups
- Seeds were sowed in transparent cups in a way that embryo should be facing towards wall Fig. 6, additionally black cloth was used, which allowed clear and visible images of seminal roots Fig. 7

Figure 6. Seeds sowed in plastic cups outside the black cloth

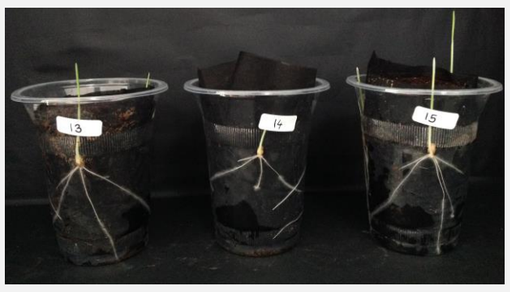

Figure 7. Visible seminal roots after 5 days of sowing

Results & Discussion

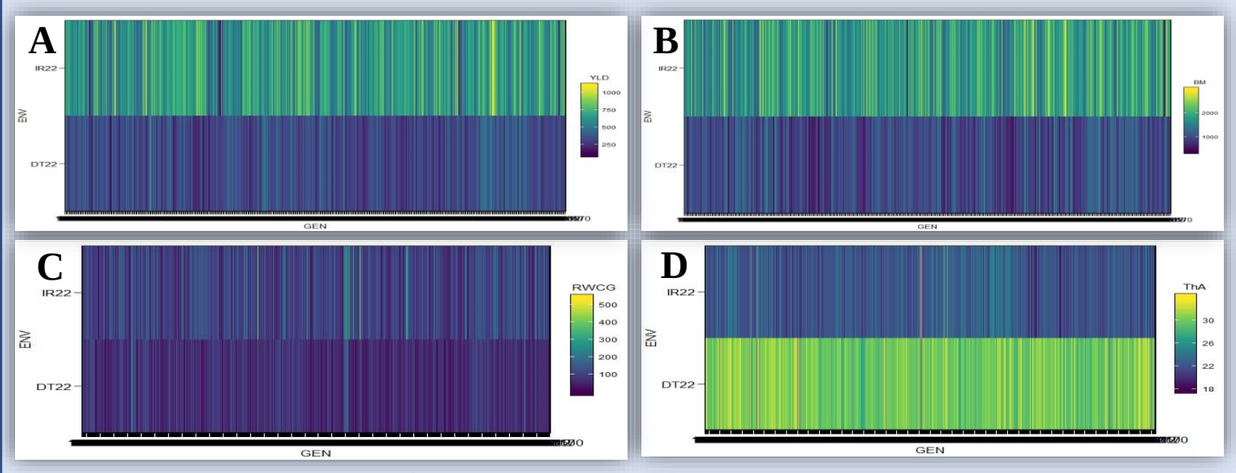

Figure 8. Genotypes performance across the environment **A.** Yield **B.** Biomass **C.** Relative water content at grain filling stage **D.** Thermal imaging at anthesis

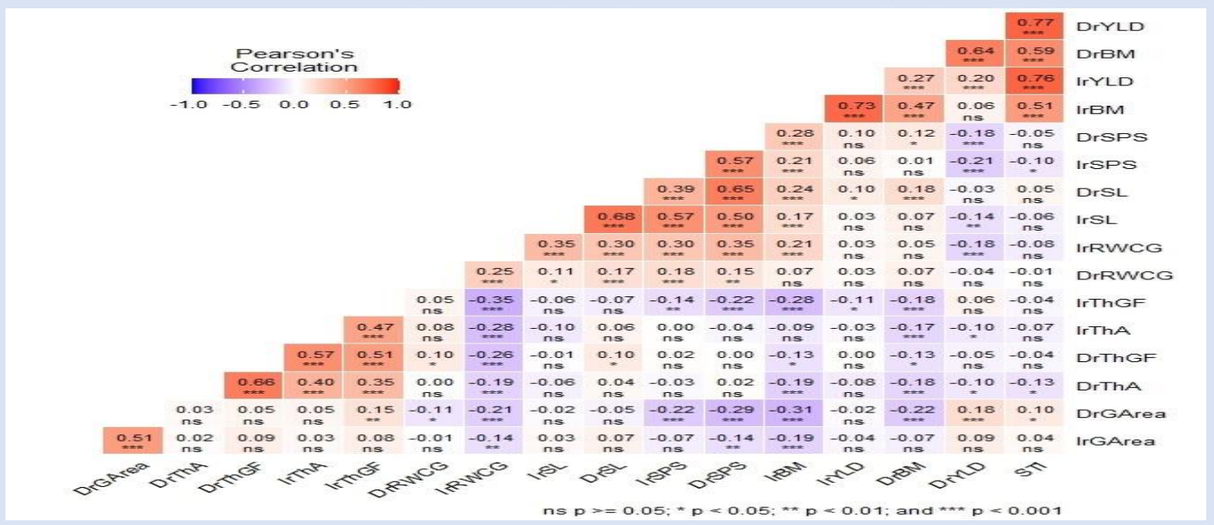

Figure 9. Pearson's Corelation analysis between the traits

Based on the data obtained from this study, it was found that:

- Sufficient genetic diversity and genotype performance across the environment available for measurement and selection for non-destructive phenotyping protocols necessary to identify drought tolerance
- Thermal imaging during grain filling (DrThGF) showed significant negative correlation with the relative water content (RWC) under irrigated while contrasting in drought environment
- Thermal imaging during grain filling was found to be negatively significant and highly correlated with biomass (BM) produced under both the environments Fig. 9
- RWC during grain filling showed highly significant positive correlation with the spike characters under both the environments
- The grain area one of the appearance trait showed significant positive correlation with grain yield and stress tolerance index (STI), while contrasting result with biomass under drought

Conclusion

Development of high-throughput and non-destructive phenotyping protocols necessary to identify drought tolerance and physiological responses at field experiments to screen a large set of diverse genotypes. Hence, our preliminary results emphasize thermal imaging, grain scan and early seminal root phenotyping to identify drought tolerant genotypes. The experimental setup and protocols thus developed will be further tested to validate the results.

Acknowledgement

1. Financial support: Department of Biotechnology, Government of India
2. Infrastructural support: MACS-Agharkar Research Institute, Pune, India
3. Academic support: Savitribai Phule Pune University, Pune, India