Genetic variability and multivariate evaluation of mungbean genotypes for heat stress tolerance and yield stability

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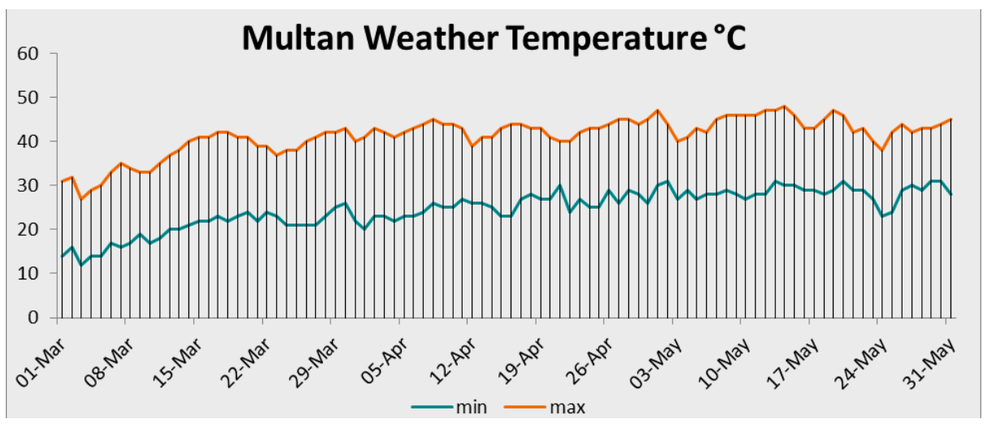
Introduction

Mungbean (*Vigna radiata*) is a nutrient-rich pulse crop, but its yield is severely affected by heat stress, which impairs fertilization, reduces pollen viability, and disrupts photosynthesis. Rising temperatures above 40 °C cause chlorophyll degradation, protein damage, and excessive flower shedding, leading to yield losses. Screening genotypes using stress tolerance indices (STI, GMP, YI, TOL, SSI) and agronomic traits is vital for breeding heat-tolerant cultivars.

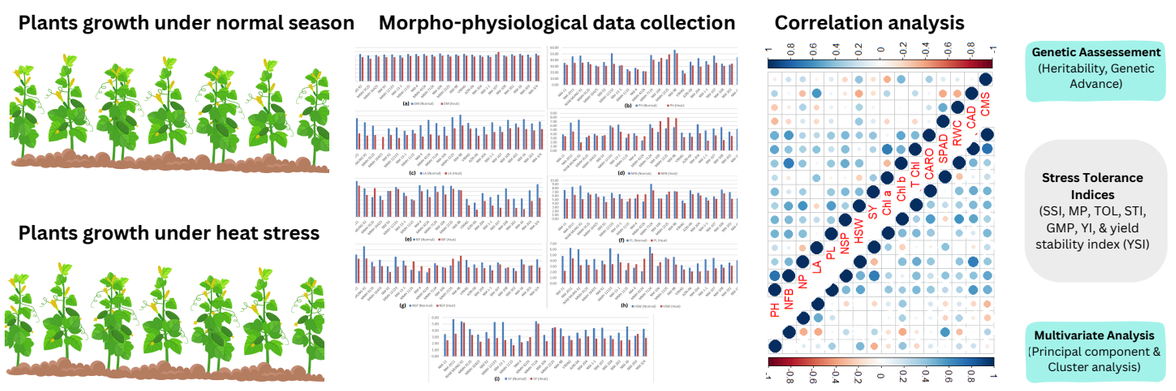
Figure 1: Multan 2022 (PMD): mungbean flowering temps ~39/26°C (3rd March sowing) vs ~47/30°C (1st April sowing).



Methodology

- Field trials with 25 mungbean accessions were conducted at Multan (Pakistan), under normal and heat-stress sowing using RCBD with 3 replications.
- Data were collected on yield traits (plant height, pods per plant, seed yield, etc.) and physiological traits (CTD, SPAD, RWC, chlorophylls, carotenoids) to assess genetic variability.
- Stress indices were computed, and results were analyzed through ANOVA, correlation, PCA, and cluster analysis in R.

Figure 2. Graphical presentation of plant materials methods.



Results

- Significant genetic variation was observed, with genotypes like NM-98, NM-2011, MMH-2225, and NM-7124 excelling in pods/plant, seed weight, and seed yield under heat stress.
- Correlation analysis showed plant height, seeds per pod, and 100-seed weight positively influenced yield, while PCA highlighted STI, GMP, MP, and YI as key heat-tolerance indicators.
- Cluster analysis grouped tolerant genotypes (e.g., NM-2225, NM-7124) based on high stress indices, RWC, and chlorophyll content.

Figure 3: Genetic variability and Correlation analysis under normal and stress conditions.

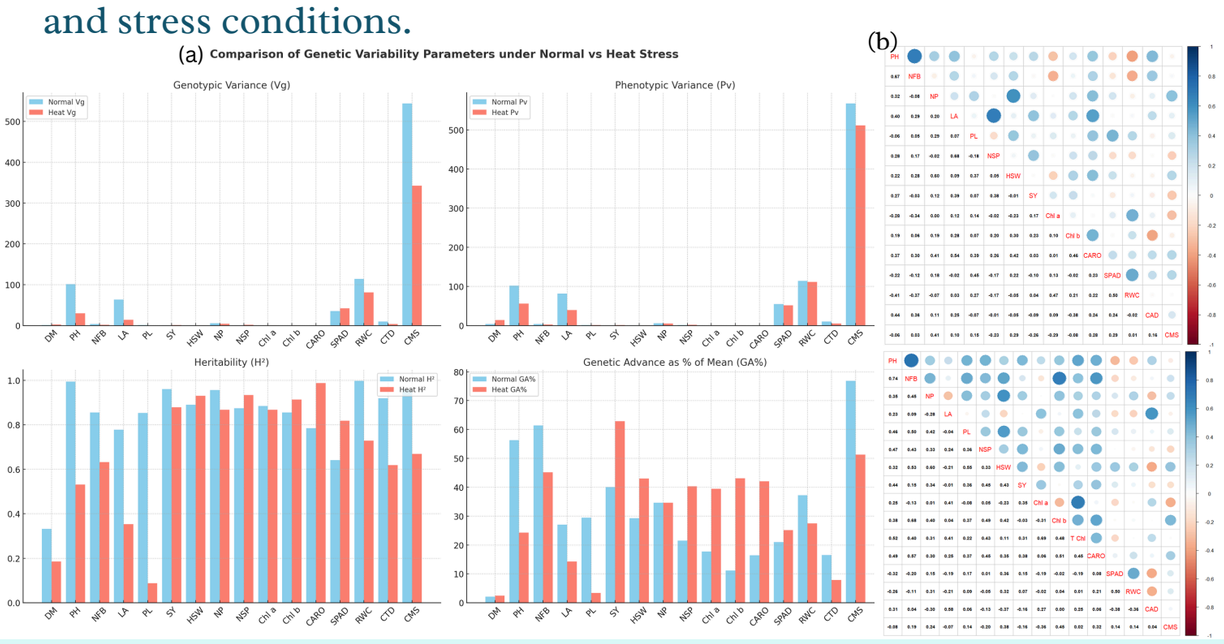
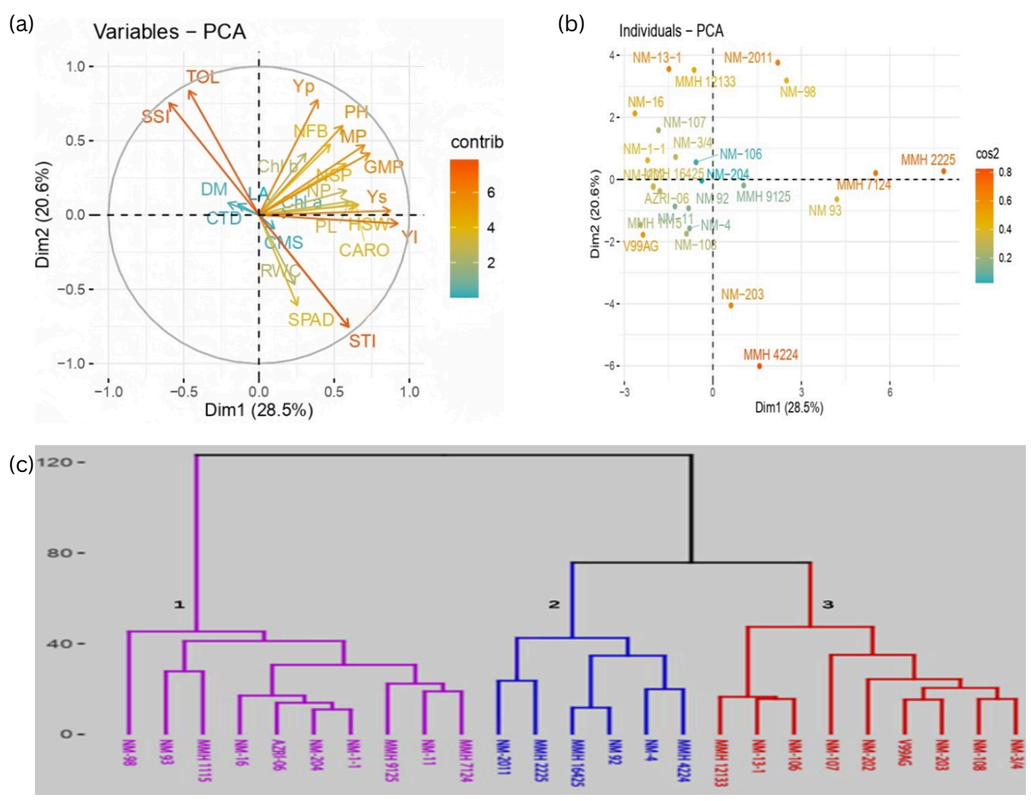


Figure 4: Genetic variability, PCA, and clustering analysis under normal and stress conditions.



Conclusion

- Physiological traits and stress indices reliably assess mungbean heat tolerance and yield stability.
- Yield traits such as NFB, NP, NSP, HSW, and PH contribute significantly to heat tolerance and yield stability.
- Genotypes NM-98, NM-108, NM-2011, NM-2225, NM-93, NM-203, and NM-7124 were identified as potential candidates for heat tolerance breeding.

Recommendations

- Future breeding should focus on integrating heat-tolerant traits (seed weight, SPAD, stress indices) into elite mungbean varieties and evaluating them across environments for stability.

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