ACCELERATING HEAT TOLERANT WHEAT BREEDING FOR CLIMATE CHANGE ADAPTATION IN BANGLADESH

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Introduction

- After rice, wheat is the second most important cereal crop in Bangladesh with annual demand of 4 million metric tons (mmt) outpacing a production of 1.3 mmt.
- For each degree C increase in night time temperatures, thousand kernel weight is reduced by 3% and grain yield by 4%.

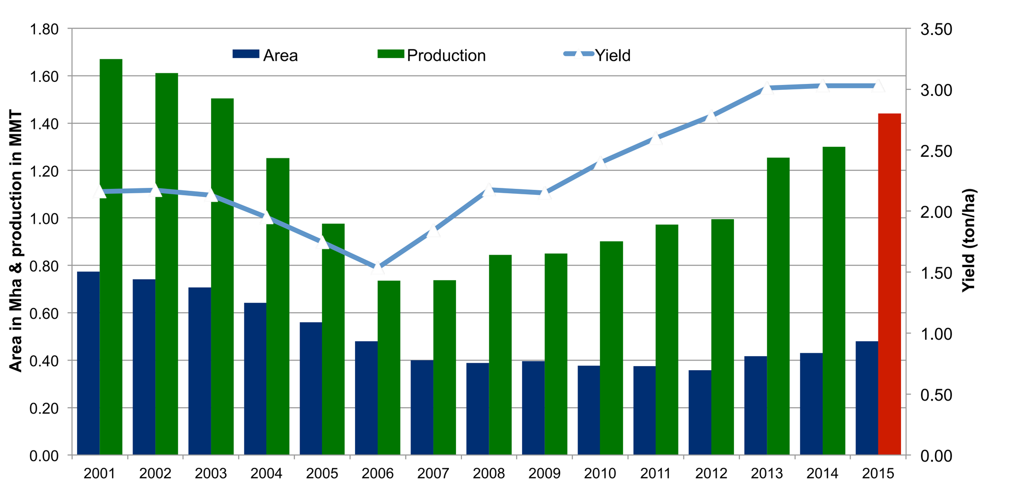

Fig 1: Area, production, and average yield of wheat in Bangladesh.

Current wheat breeding in Bangladesh

- Completely conventional breeding.
- Narrow genetic base.
- High-throughput phenotyping not available.
- Genomic selection has never been tried..

My research objectives

- Introduce high-throughput phenotyping (HTP)
- Association mapping to locate heat tolerant QTL
- Implement genomic selection
- Identify heat tolerant wheat varieties

Materials and Methods

Plant material

- A set of 600 spring wheat lines were evaluated using alpha lattice design in ten yield trials in Bangladesh.

Fig 2: Sensors and tools used for data collection

Phenotypic trait evaluation

- Utilized the HTP Phenocart platform.
- We collected heading date, grain yield, thousand kernel weight, canopy temperature (CT) and spectral reflectance normalized difference vegetation index (NDVI).

Genotyping

- Genotyping was completed using genotyping-by-sequencin

Data Analysis

- Data were analyzed using the R program and the model $Y = X\beta + Z_1\delta + Z_2\alpha + \varepsilon$

Results and Discussion

Variability was observed among the lines for their phenotypic traits as well as yield and yield components across the trials. Selection was completed on the basis of grain yield and related traits.

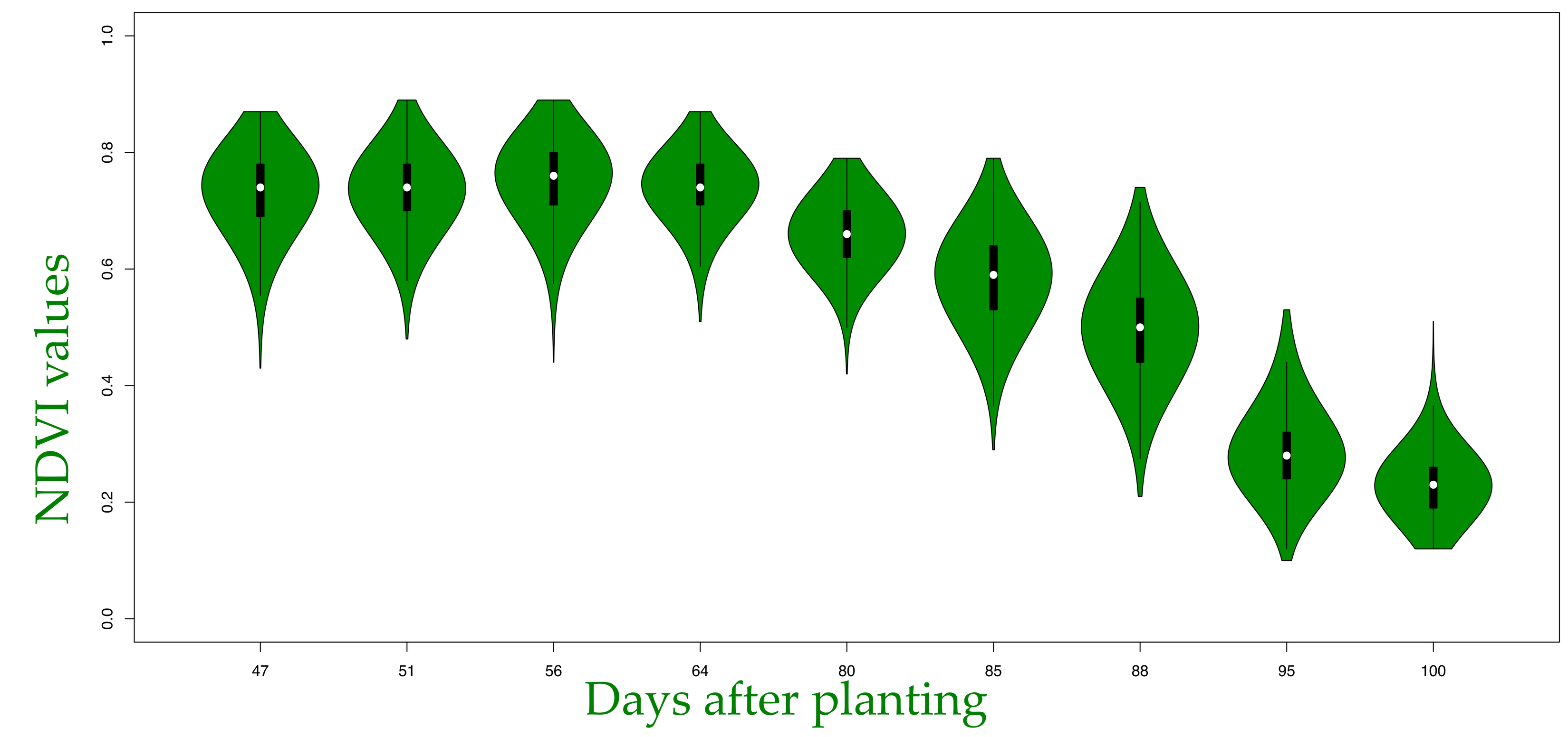

Fig 3: Violinplot showing distribution of NDVI values at different growth stages

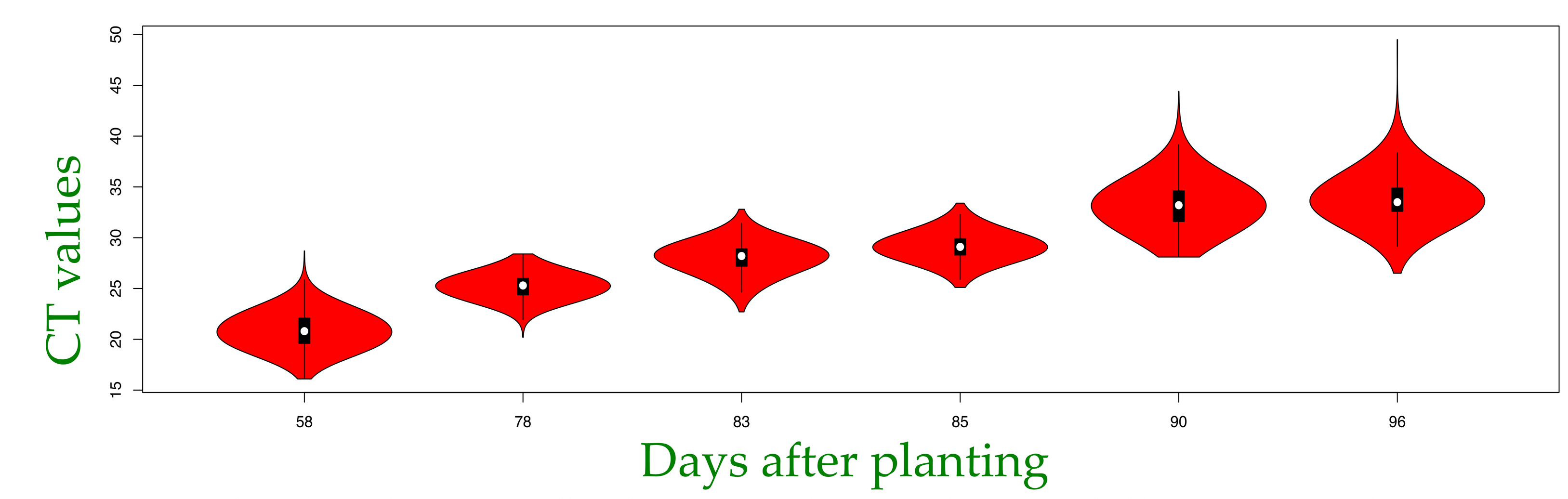

Fig 4: Violinplot showing distribution of CT values at different growth stages

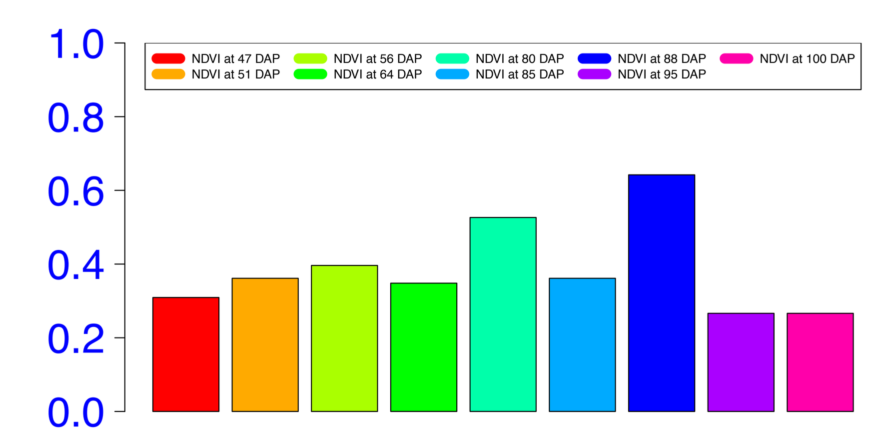

Fig 5: Broad-sense heritability of NDVI

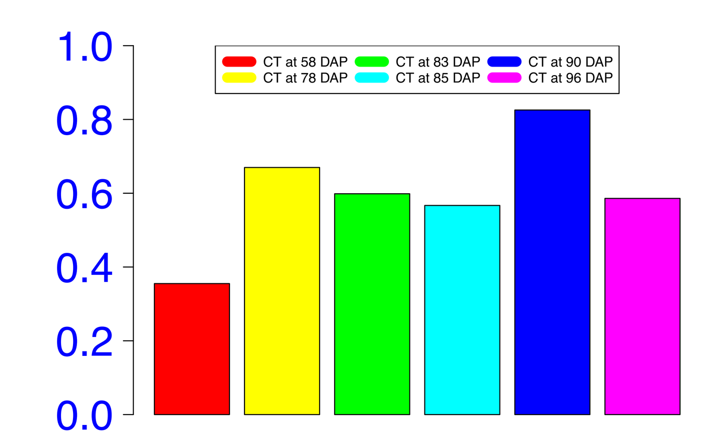

Fig 6: Broad-sense heritability of CT

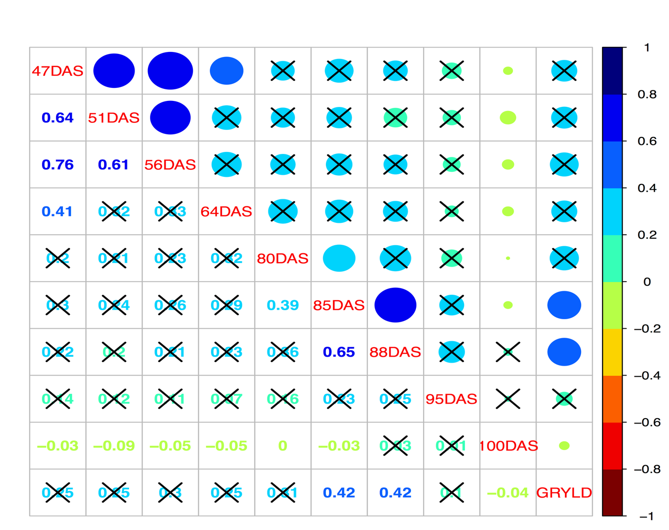

Fig 7: Correlations of NDVI and grain yield. ✕=non-insignificant

Fig 8: Correlations of CT and grain yield. ✕=non-significant

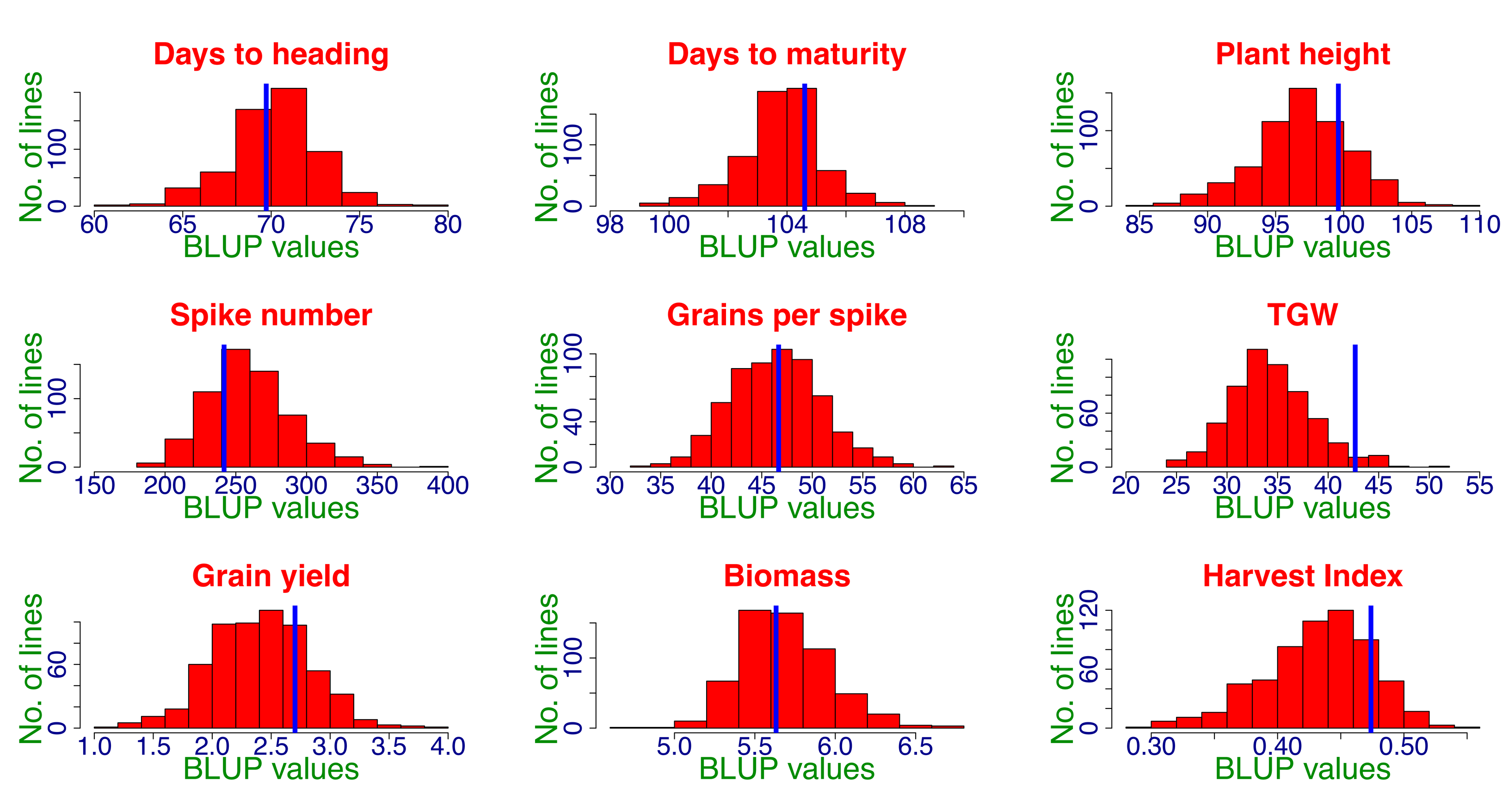

Fig 9: Histograms showing distribution of different physiological traits

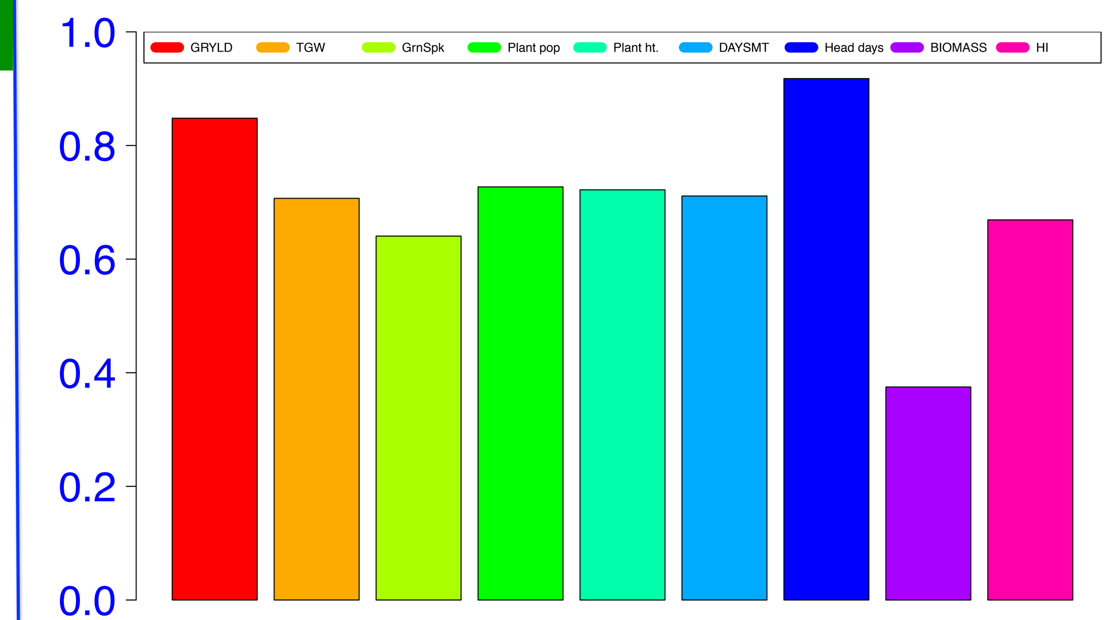

Fig 10: Broad-sense heritability of different agronomic trait

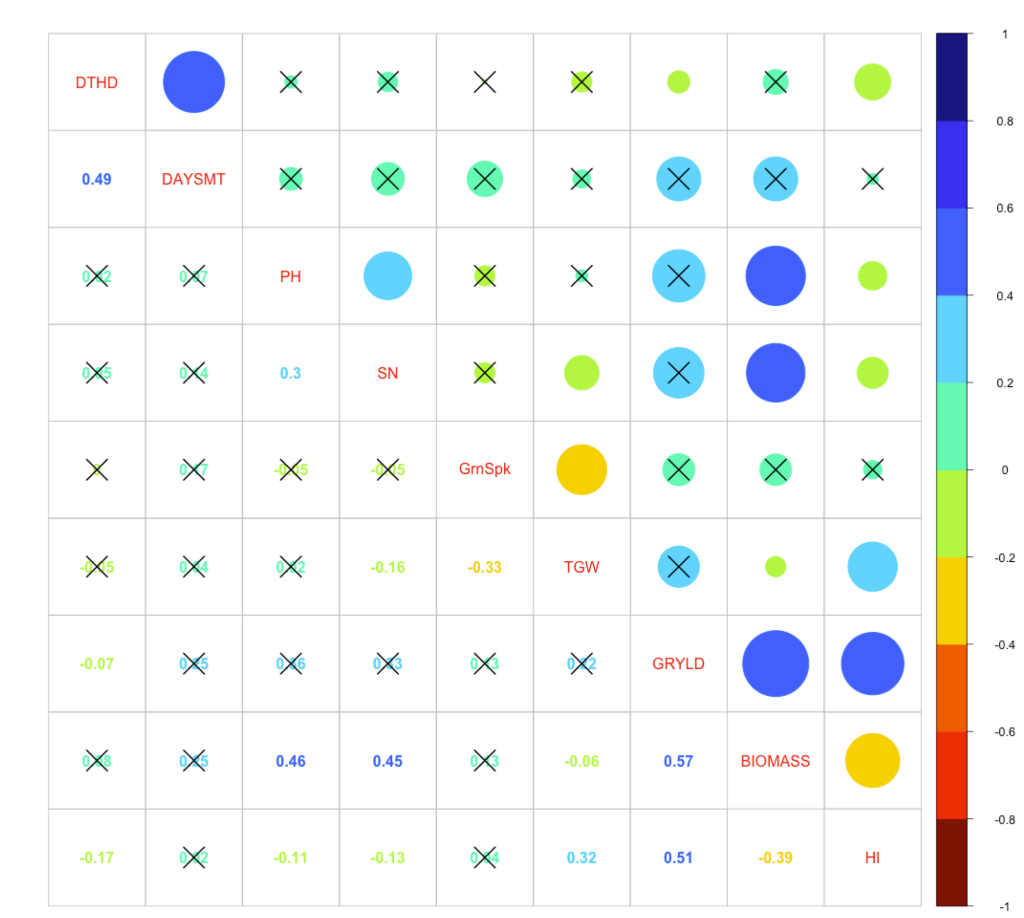

Fig 11: Correlation among different traits. ✕=non-significant

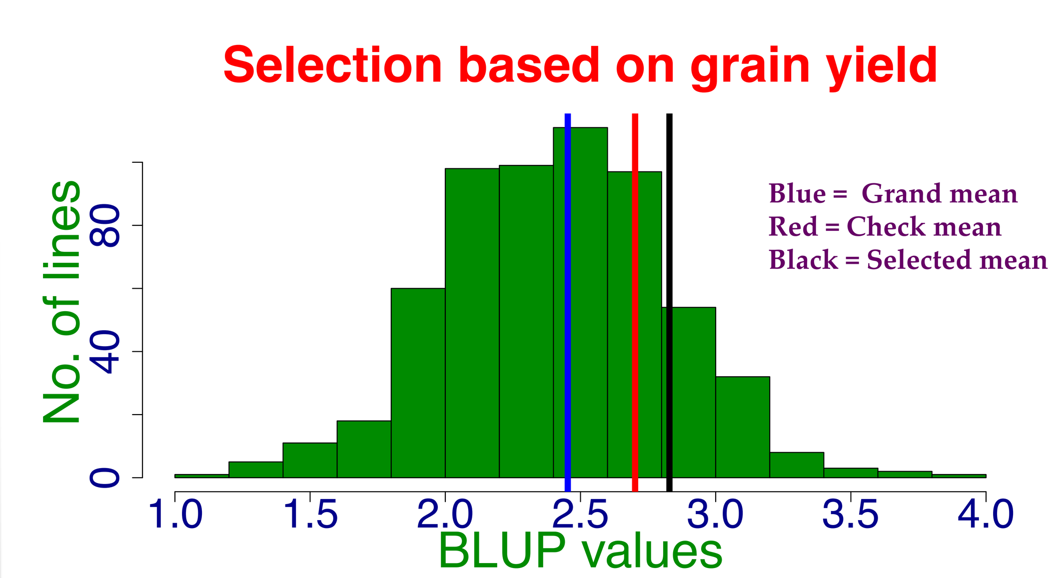

Fig 12: Histogram showing selected lines' performance

Conclusion

Fifty-four lines showing superior grain yield than the national check variety were selected. These selected lines will be further tested in the national wheat breeding program. The trials will be repeated for two more seasons. Then GWAS will be run to identify heat tolerant QTLs. High throughput phenotyping and genomic selection will accelerate the national wheat breeding program in Bangladesh.

Acknowledgements

Applied Wheat Genomics

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CIMMYT International Maize and Wheat Improvement Center

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