Predicting Sorghum Hybrid Performance using Genomic and Phenomic Data

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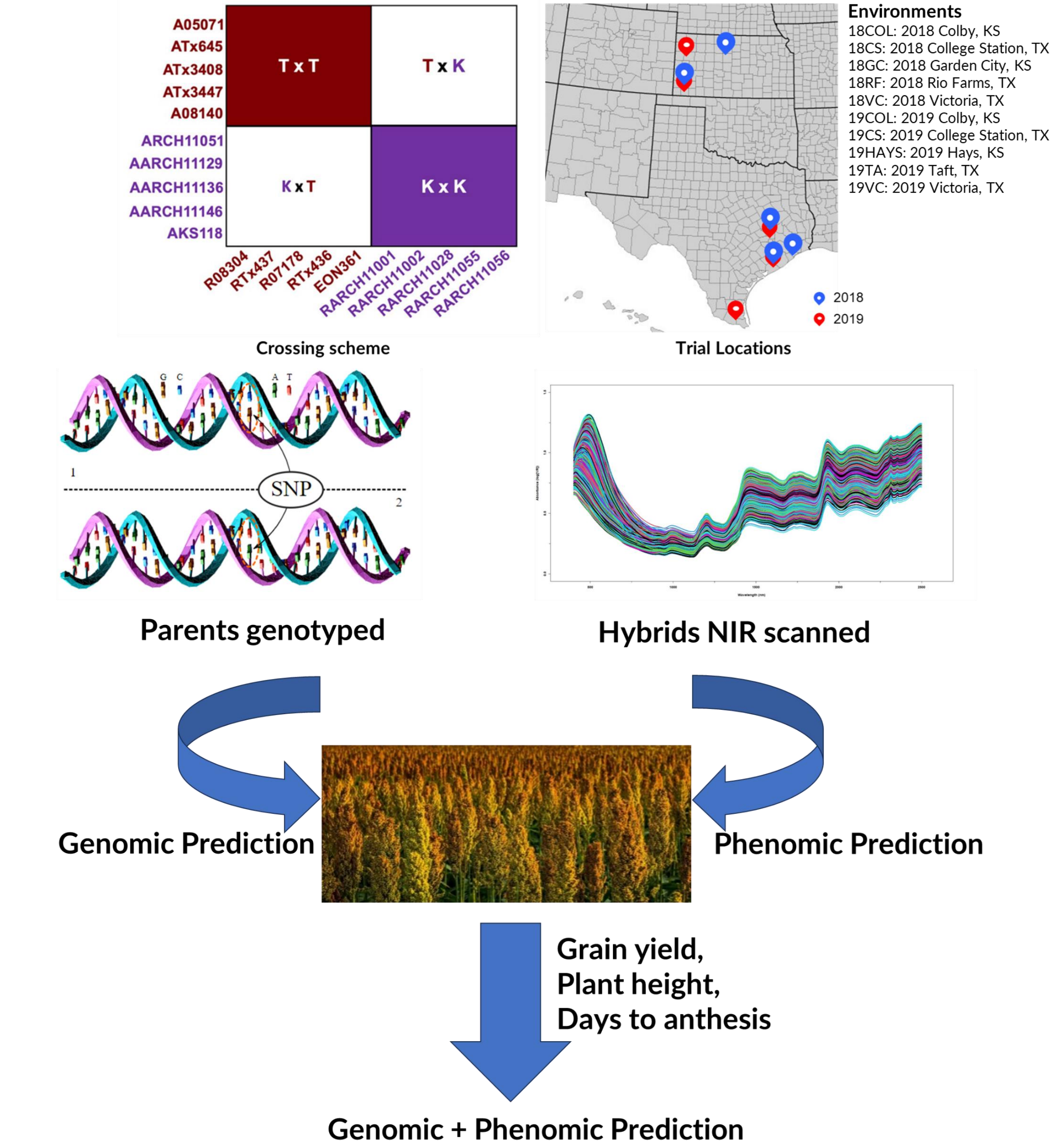
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BACKGROUND: Genomic Prediction (GP) and Phenomic Prediction (PP) could accelerate the rate of genetic gain in plant breeding programs. Near Infrared Spectroscopy (NIR) is widely employed to predict composition traits, however, it could also be used in the same way as genetic markers to predict agronomic performance.

Research Questions

Could NIR effectively predict agronomic traits of sorghum hybrids ?
Can inclusion of NIR improve prediction accuracy of genomic prediction models ?

METHODS

Crossing scheme

Trial Locations

Environments
18COL: 2018 Colby, KS
18CS: 2018 College Station, TX
18GC: 2018 Garden City, KS
18RF: 2018 Rio Farms, TX
18VC: 2018 Victoria, TX
19COL: 2019 Colby, KS
19CS: 2019 College Station, TX
19HAYS: 2019 Hays, KS
19TA: 2019 Taft, TX
19VC: 2019 Victoria, TX

2018
2019

Parents genotyped

Hybrids NIR scanned

Genomic Prediction

Phenomic Prediction

Grain yield,
Plant height,
Days to anthesis

Genomic + Phenomic Prediction

Prediction Models

G   : Genomic markers
NIR1   : First derivative of NIR
NIR2   : Second derivative of NIR
G + NIR1: markers + NIR1
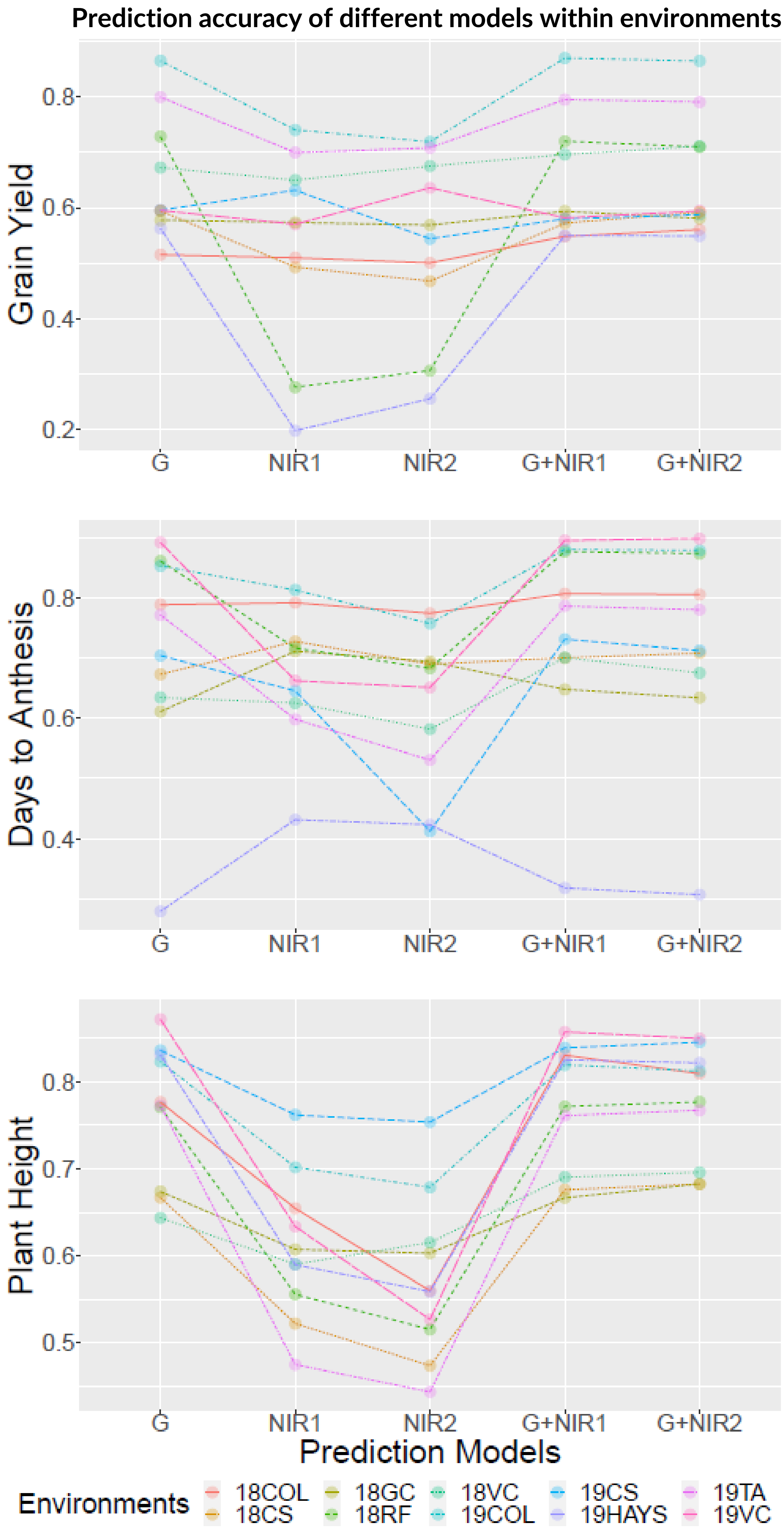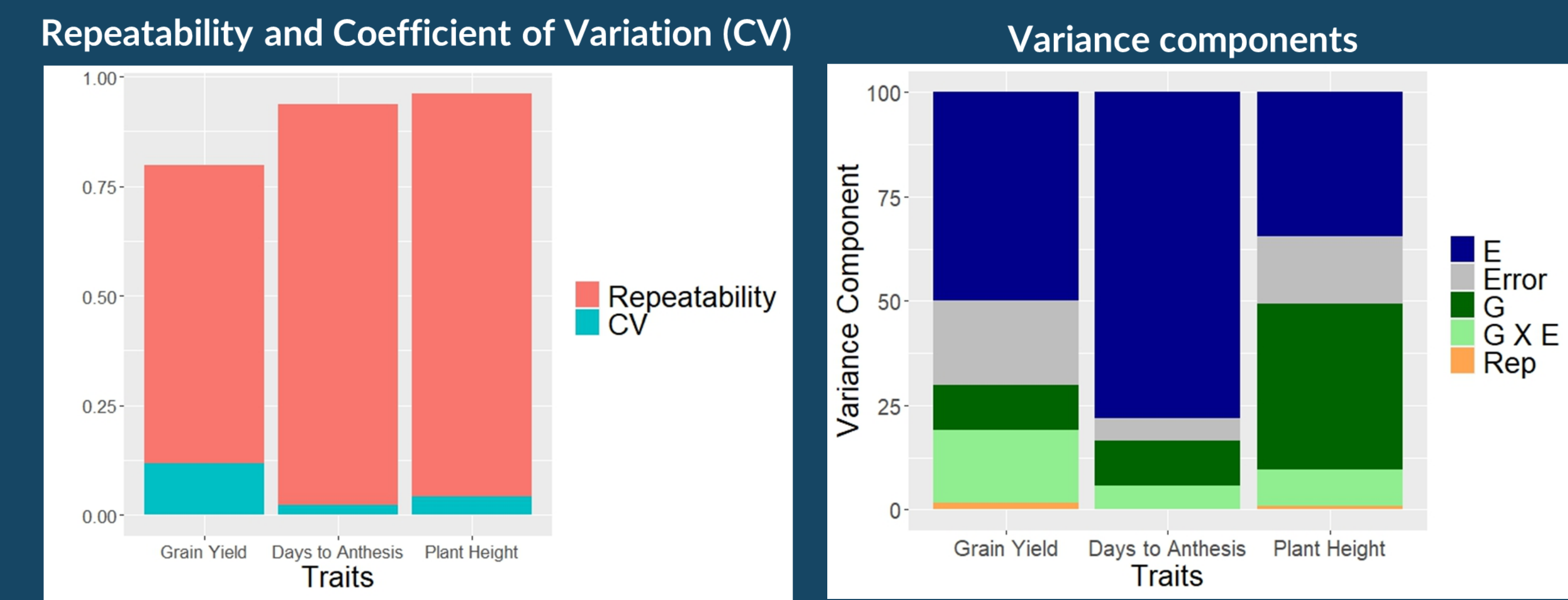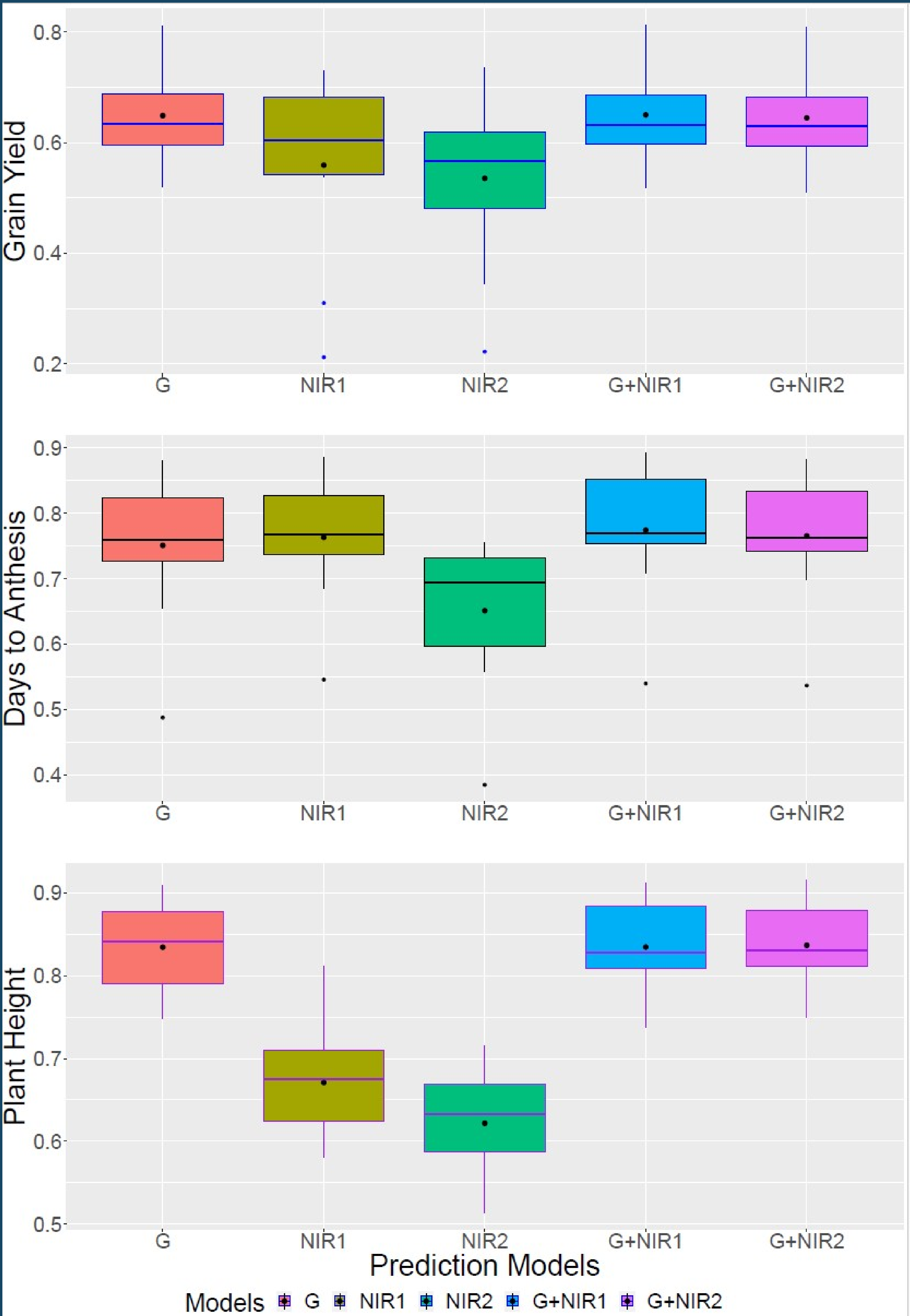G + NIR2: markers + NIR2

❖ Kernel based GBLUP models with 70:30 were fitted with 20 repetitions

MAJOR FINDINGS

❖ NIR has the potential to predict agronomic traits in sorghum when there are grain samples from a range of environments
❖ NIR1 performs better than NIR2 in general showing data smoothing of spectra with first derivative is reliable

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Phenomic prediction performed statistically as good as genomic prediction for traits related to grain physiochemical properties i.e. grain yield, and days to anthesis

Overall prediction accuracy of prediction models across all the environments

Models ⊞ G ⊞ NIR1 ⊞ NIR2 ⊞ G+NIR1 ⊞ G+NIR2

Repeatability and Coefficient of Variation (CV)

Repeatability
CV

Traits: Grain Yield, Days to Anthesis, Plant Height

Variance components

E
Error
G
G X E
Rep

Traits: Grain Yield, Days to Anthesis, Plant Height

Prediction accuracy of different models within environments

Prediction Models: G, NIR1, NIR2, G+NIR1, G+NIR2

Traits: Grain Yield, Days to Anthesis, Plant Height

Environments
— 18COL — 18GC — 18VC — 19CS — 19TA
— 18CS — 18RF — 19COL — 19HAYS — 19VC

❖ NIR could supplement/complement genomic prediction models depending on traits of interest

❖ Characterizing spectra to capture G X E would be interesting when grain samples from diverse environments are available

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