Evaluating the breeding potential of cultivated lentils for protein and amino acid concentration and quality

unpublished

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Contents

- Derek Wright, Jiayi Hang, James D House & Kirstin E Bett (2020) **Evaluating the breeding potential of cultivated lentils for protein and amino acid concentration and quality**. *unpublished*

which is follow-up to:

- Jiayi Hang, Da Shi, Jason Neufeld, Kirstin E. Bett & James D. House. **Prediction of protein and amino acid concentration in whole and ground lentils using near-infrared reflectance spectroscopy**. *LWT*. (**2022**) 165: 113669. doi.org/10.1016/j.lwt.2022.113669

&

- Derek M. Wright, Sandesh Neupane, Taryn Heidecker, Teketel A. Haile, Crystal Chan, Clarice J. Coyne, Rebecca J. McGee, Sripada Udupa, Fatima Henkrar, Eleonora Barilli, Diego Rubiales, Tania Gioia, Giuseppina Logozzo, Stefania Marzario, Reena Mehra, Ashutosh Sarker, Rajeev Dhakal, Babul Anwar, Debashish Sarker, Albert Vandenberg & Kirstin E. Bett. **Understanding photothermal interactions can help expand production range and increase genetic diversity of lentil (*Lens culinaris* Medik.)**. *Plants, People, Planet*. (**2020**) 3(2): 171-181. doi.org/10.1002/ppp3.10158

- https://github.com/derekmichaelwright/AGILE_LDP_Protein
- View as pdf
- View as HTML
- Source Code Vignette (LDP_Protein_Vignette.html)

Contents

AGILE

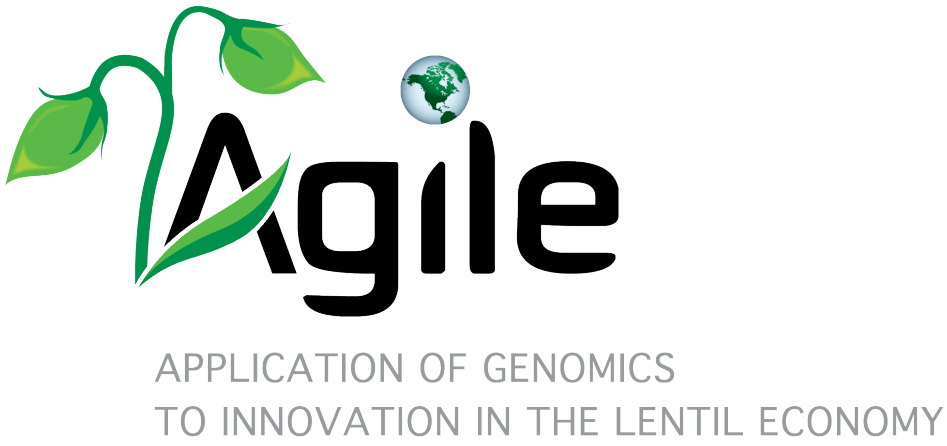

Figure 1: https://knowpulse.usask.ca/study/AGILE-Application-of-Genomic-Innovation-in-the-Lentil-Economy

Figure 2: https://knowpulse.usask.ca/study/EVOLVES-Enhancing-the-Value-of-Lentil-Variation-for-Ecosystem-Survival

Collaborators

- Department of Plant Sciences and Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
- Department of Food and Human Nutritional Sciences, Faculty of Agriculture and Food Science, University of Manitoba, Winnipeg, MB, Canada

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Supplemental Table 1

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Supplemental Table 2

Supplemental_table_02.csv

Figures

Figure 1

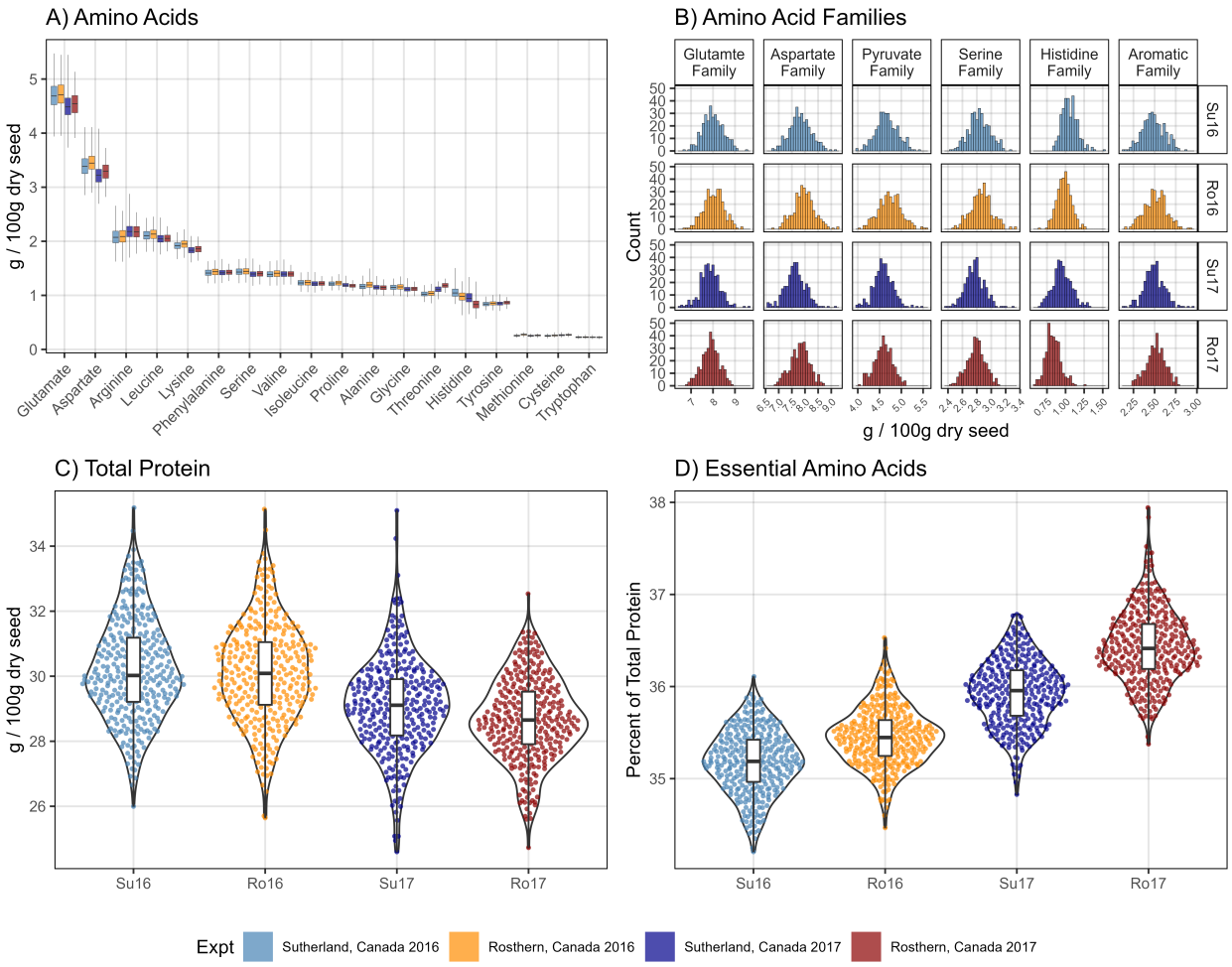


Figure 2

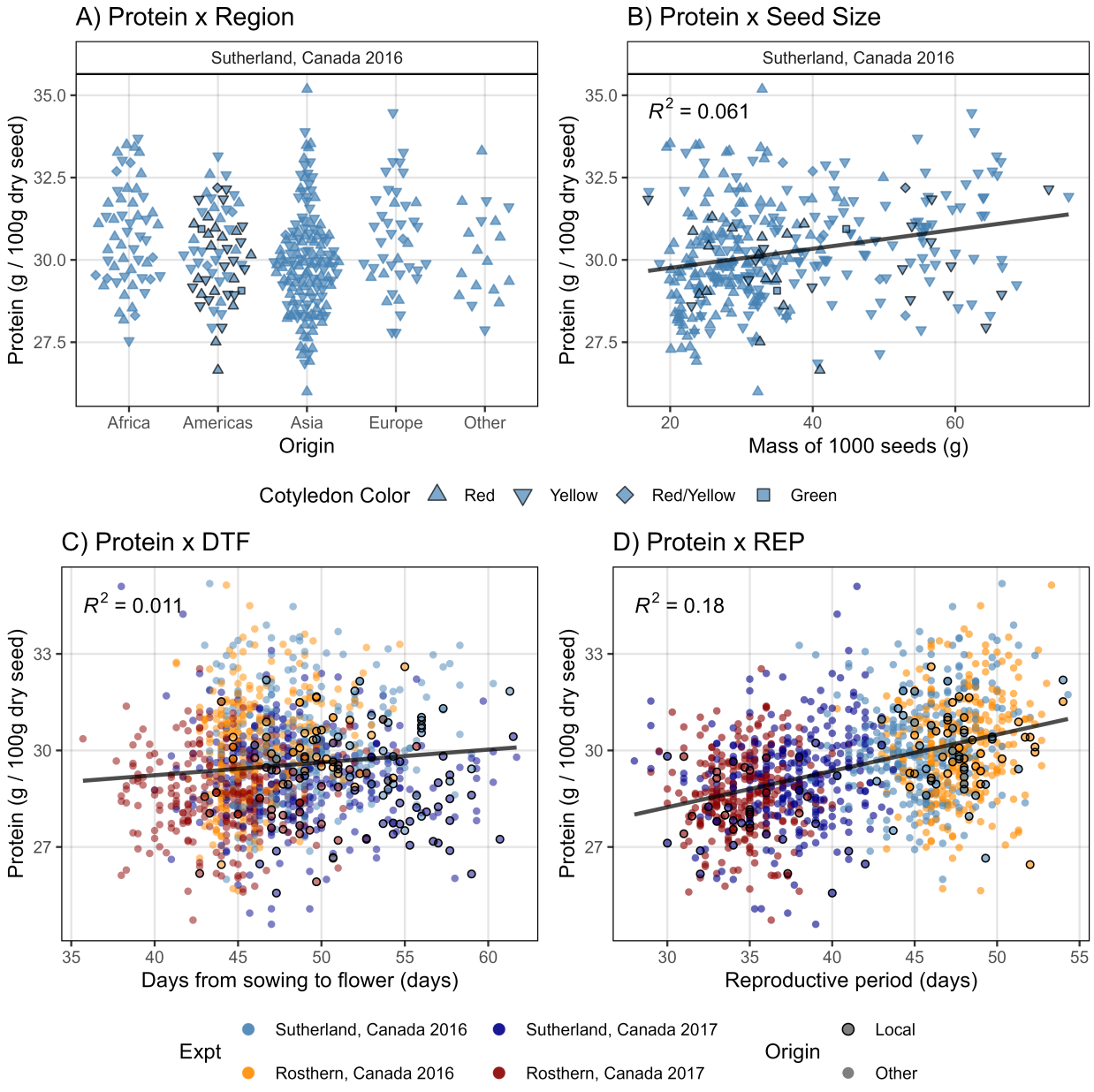


Figure 2: Protein concentration of whole lentil seed in a lentil diversity panel. (A) Protein concentration in Sutherland, Canada 2016 (Su16) based on region of origin. (B) Protein concentration in Su16 correlated with thousand seed mass in Su16. Protein concentration in Su16, Sutherland, Canada, 2017 (Su17), Rosthern, Canada, 2016, and Rosthern, Canada, 2017 correlated with (C) days from sowing to flower (DTF) and (D) reproductive period (REP).

Figure 3

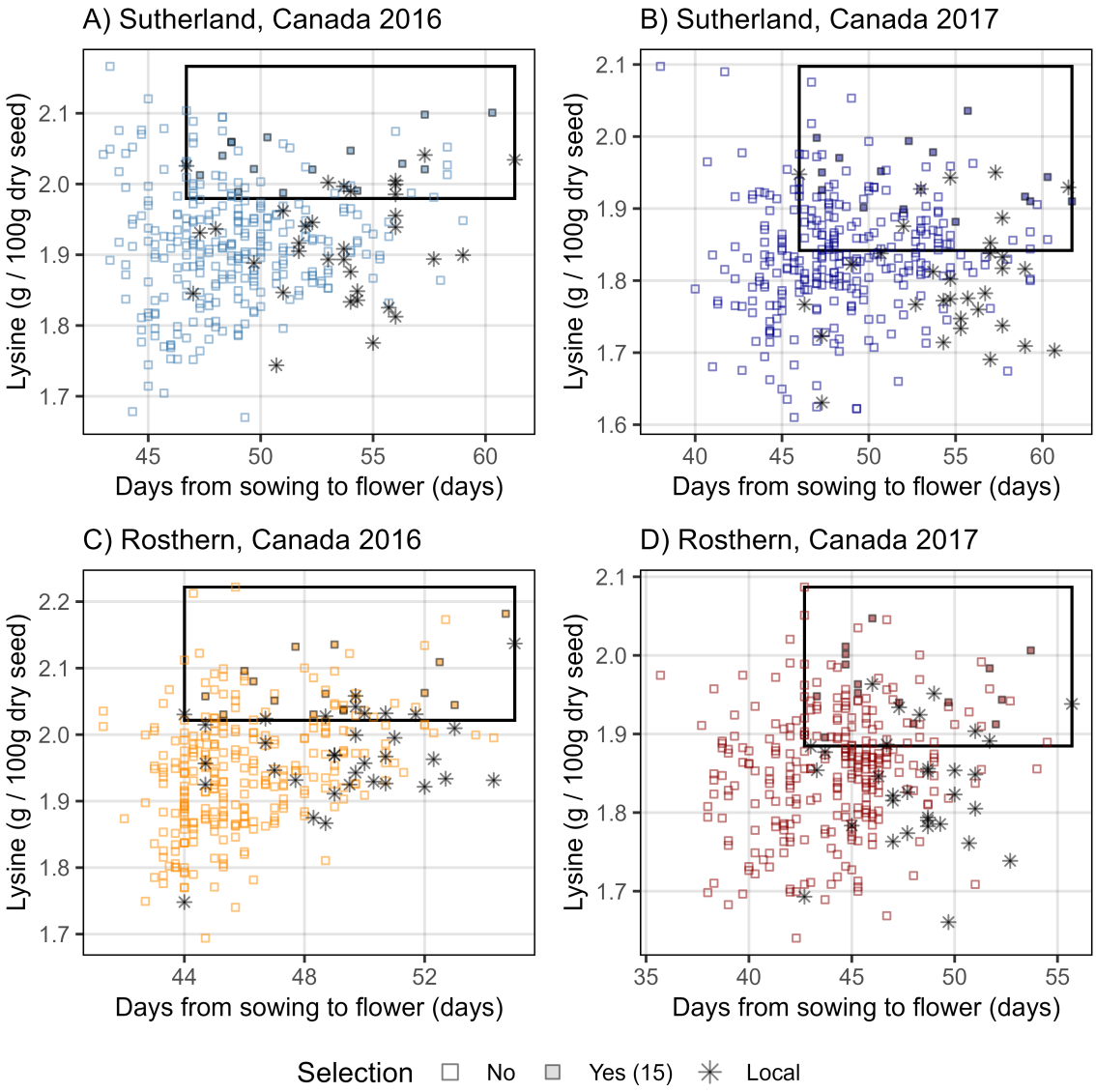
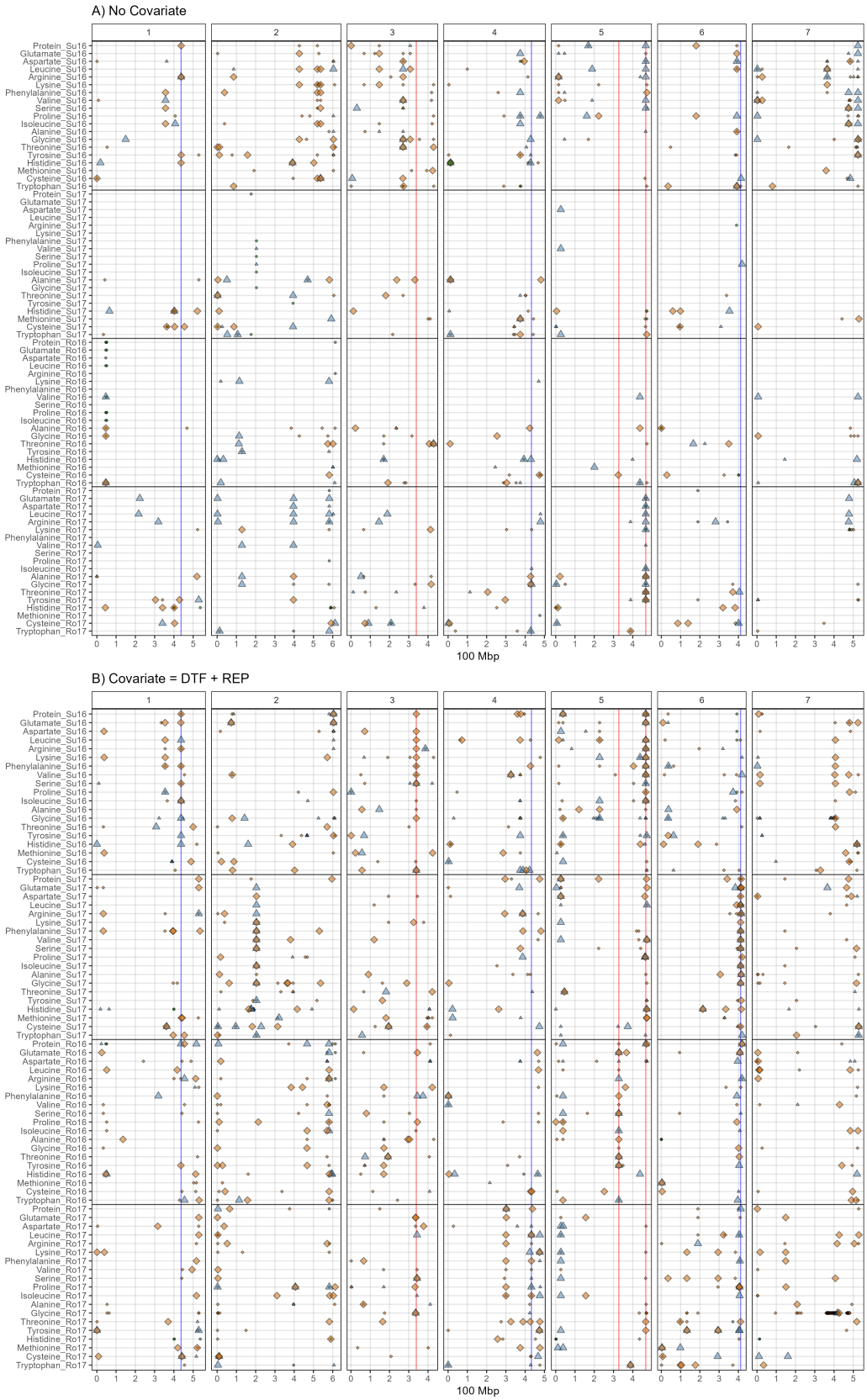


Figure 3: Lysine concentration of whole lentil seed in a diversity panel by location. Accessions with increased lysine concentration and appropriate days from sowing to flower (DTF) based on local adaptation across all four locations are highlighted with a black outline. Large black boxes represent range of days from sowing to flower for accessions originating from the Northern Great Plains of Canada and the USA and the top 25% for lysine concentration.

Figure 4


A) No Covariate
B) Covariate = DTF + REP
1
2
3
4
5
6
7
Protein_Su16
Glutamate_Su16
Aspartate_Su16
Leucine_Su16
Arginine_Su16
Lysine_Su16
Phenylalanine_Su16
Valine_Su16
Serine_Su16
Proline_Su16
Isoleucine_Su16
Alanine_Su16
Glycine_Su16
Threonine_Su16
Tyrosine_Su16
Histidine_Su16
Methionine_Su16
Cysteine_Su16
Tryptophan_Su16
Protein_Su17
Glutamate_Su17
Aspartate_Su17
Leucine_Su17
Arginine_Su17
Lysine_Su17
Phenylalanine_Su17
Valine_Su17
Serine_Su17
Proline_Su17
Isoleucine_Su17
Alanine_Su17
Glycine_Su17
Threonine_Su17
Tyrosine_Su17
Histidine_Su17
Methionine_Su17
Cysteine_Su17
Tryptophan_Su17
Protein_Ro16
Glutamate_Ro16
Aspartate_Ro16
Leucine_Ro16
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Lysine_Ro17
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Glycine_Ro17
Threonine_Ro17
Tyrosine_Ro17
Histidine_Ro17
Methionine_Ro17
Cysteine_Ro17
Tryptophan_Ro17
0 1 2 3 4 5
0 1 2 3 4 5 6
0 1 2 3 4
0 1 2 3 4 5
0 1 2 3 4
0 1 2 3 4 5
100 Mbp
Model
MLM
BLINK
FarmCPU
Marker
Lcu.2RBY.Chr3p339102503
Lcu.2RBY.Chr5p327505937
Lcu.2RBY.Chr5p467479275
Lcu.2RBY.Chr1p437385632
Lcu.2RBY.Chr4p432694216
Lcu.2RBY.Chr6p411536500

Figure 4: Summary of genome-wide association results using MLM, FarmCPU, and Blink models for protein and amino acid concentration in whole lentil seeds from a diversity panel, across four site-years: Sutherland, Canada, 2016 (Su16); Sutherland, Canada, 2017 (Su17); Rosthern, Canada, 2016 (Ro16); and Rosthern, Canada 2017 (Ro17). (A) without the use of covariates, and (B) with days from sowing to flower (DTF) and reproductive period (REP) as covariates. Larger points represent a significant association (-log10(p) > 6.7) with a trait of interest under one of the GWAS models, while smaller points represent a suggestive association (-log10(p) > 5.3). Vertical lines represent specific base-pair locations to facilitate comparisons across trials.

Figure 5

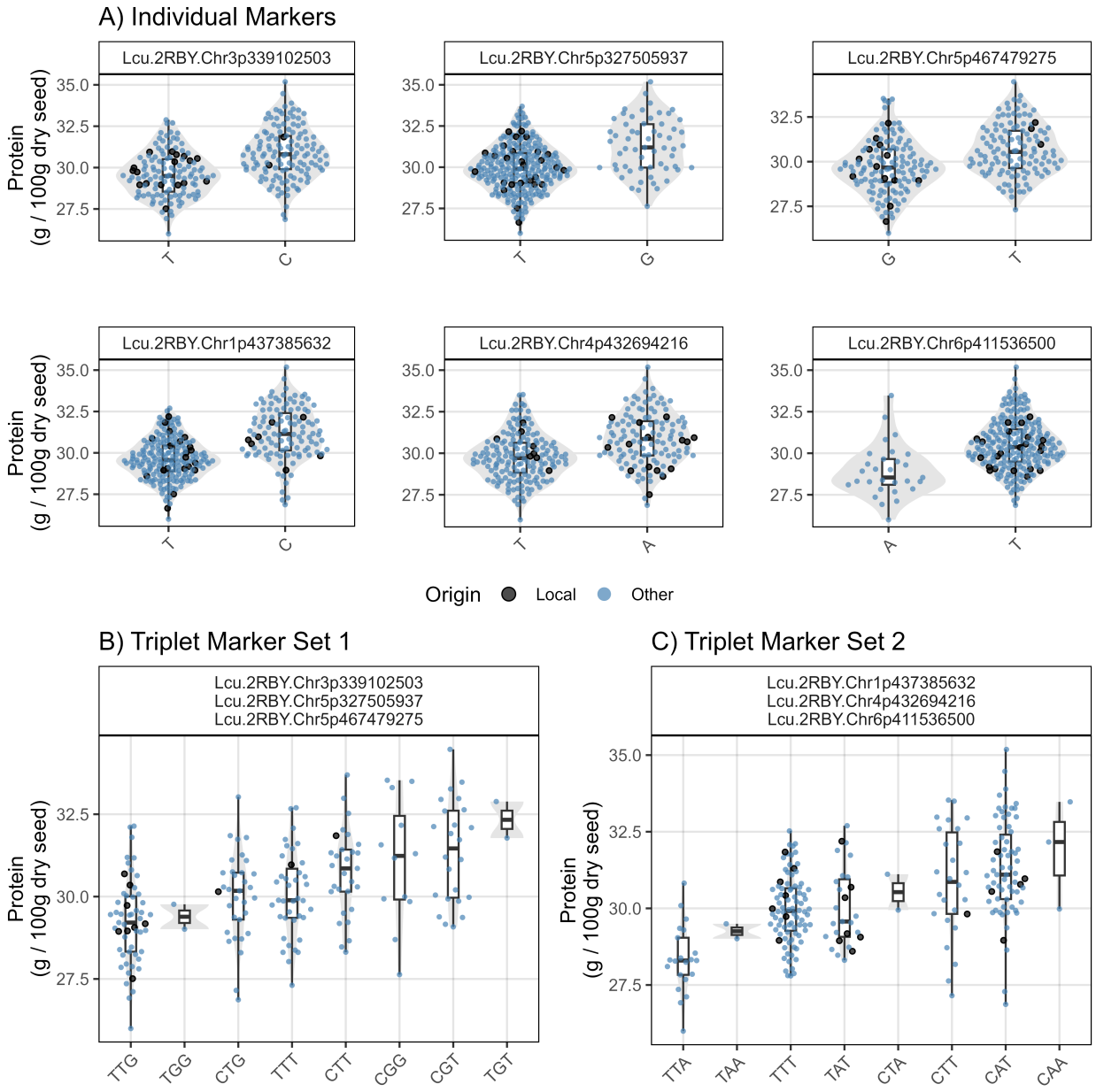
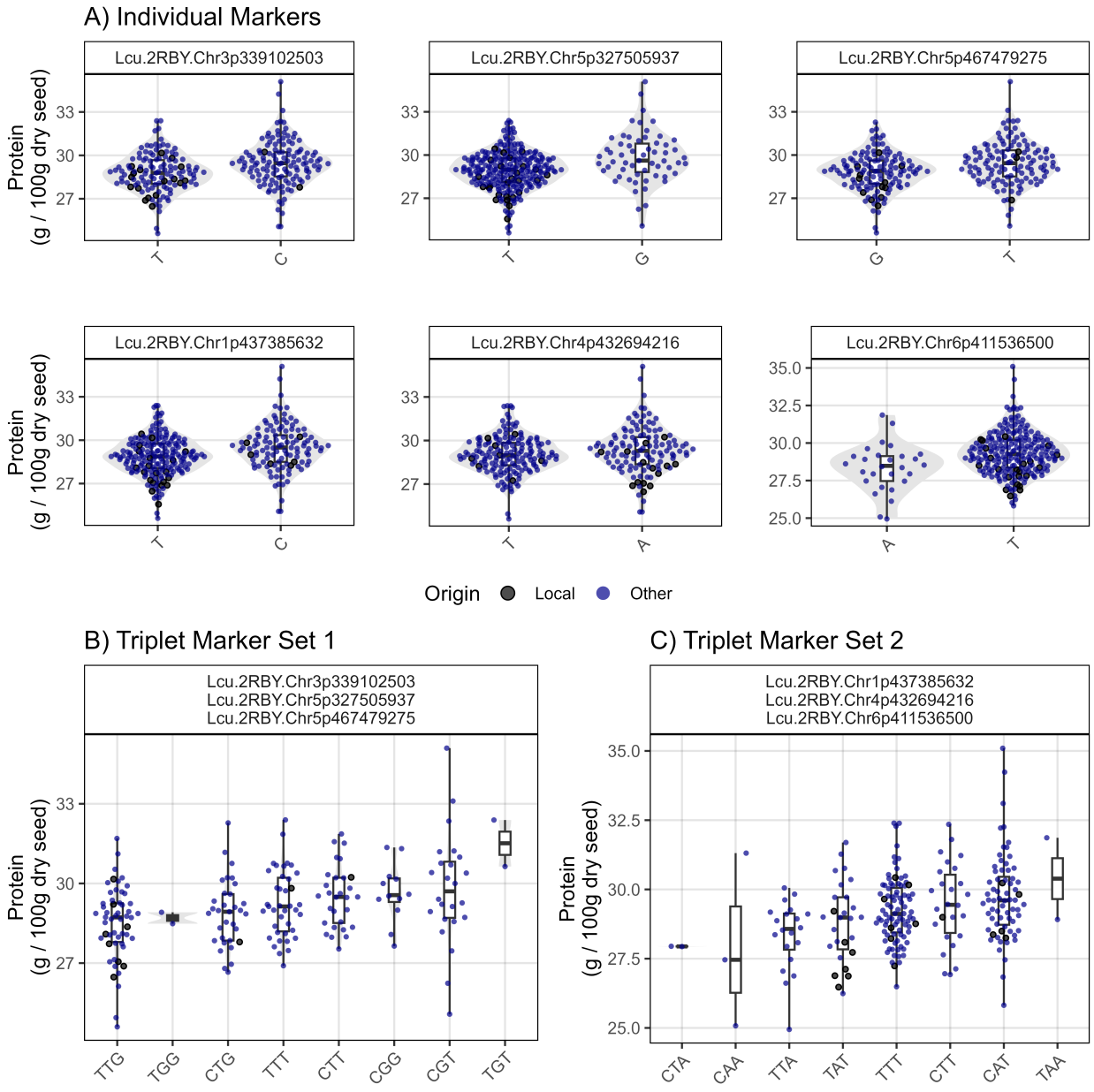
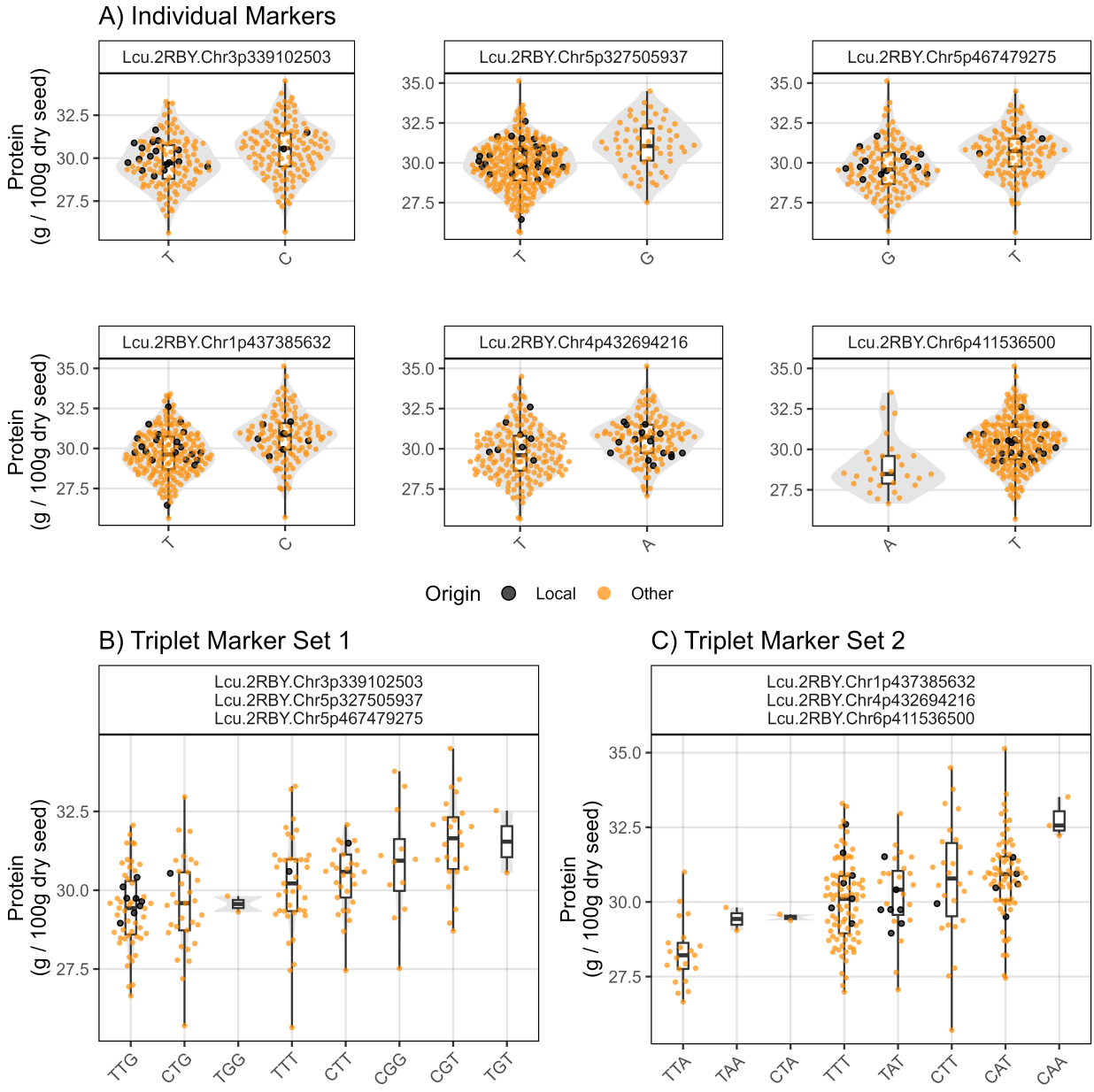


Figure 5: Allelic effects of the six markers highlighted from the genome-wide association studies on total protein and amino acid concentration of whole lentil seed in a lentil diversity panel, grown in Sutherland, Canada, 2016. (A) Individual marker effects. (B and C) Two proposed triplet sets of markers for use in a breeding program to select for increased seed protein concentration. For each plot, only individuals homozygous for the alleles were included.

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Lcu.2RBY.Chr3p339102503
Lcu.2RBY.Chr5p327505937
Lcu.2RBY.Chr5p467479275
Lcu.2RBY.Chr1p437385632
Lcu.2RBY.Chr4p432694216
Lcu.2RBY.Chr6p411536500
Protein (g / 100g dry seed)
Origin
Local
Other
B) Triplet Marker Set 1
Lcu.2RBY.Chr3p339102503
Lcu.2RBY.Chr5p327505937
Lcu.2RBY.Chr5p467479275
TTG
CTG
TGG
TTT
CTT
CGG
CGT
TGT
C) Triplet Marker Set 2
Lcu.2RBY.Chr1p437385632
Lcu.2RBY.Chr4p432694216
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TAA
CTA
TTT
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CTT
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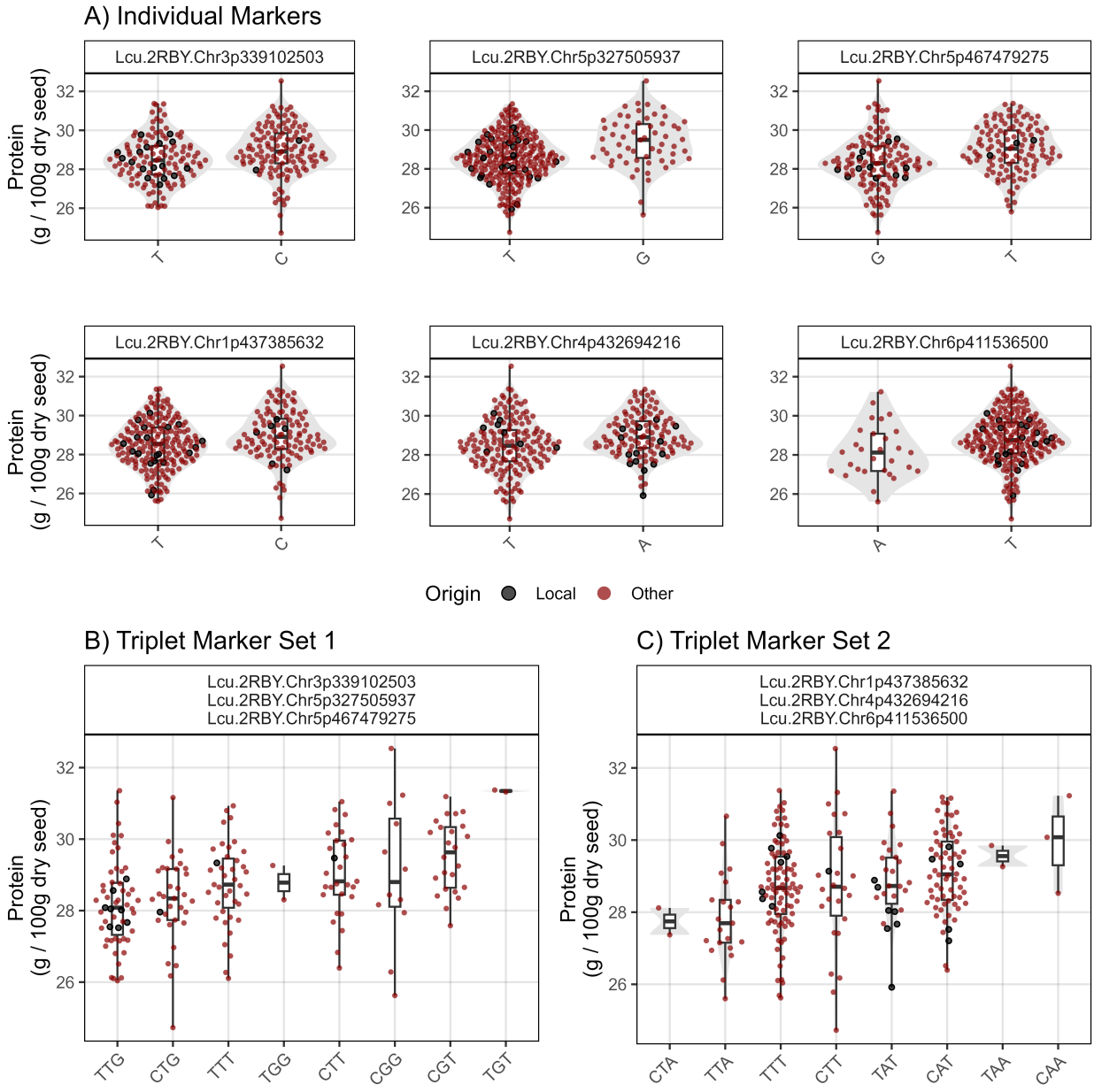
CAA


A) Individual Markers
Lcu.2RBY.Chr3p339102503
Lcu.2RBY.Chr5p327505937
Lcu.2RBY.Chr5p467479275
Lcu.2RBY.Chr1p437385632
Lcu.2RBY.Chr4p432694216
Lcu.2RBY.Chr6p411536500
Protein (g / 100g dry seed)
Origin
Local
Other
B) Triplet Marker Set 1
Lcu.2RBY.Chr3p339102503
Lcu.2RBY.Chr5p327505937
Lcu.2RBY.Chr5p467479275
TTG
CTG
TTT
TGG
CTT
CGG
CGT
TGT
C) Triplet Marker Set 2
Lcu.2RBY.Chr1p437385632
Lcu.2RBY.Chr4p432694216
Lcu.2RBY.Chr6p411536500
CTA
TTA
TTT
CTT
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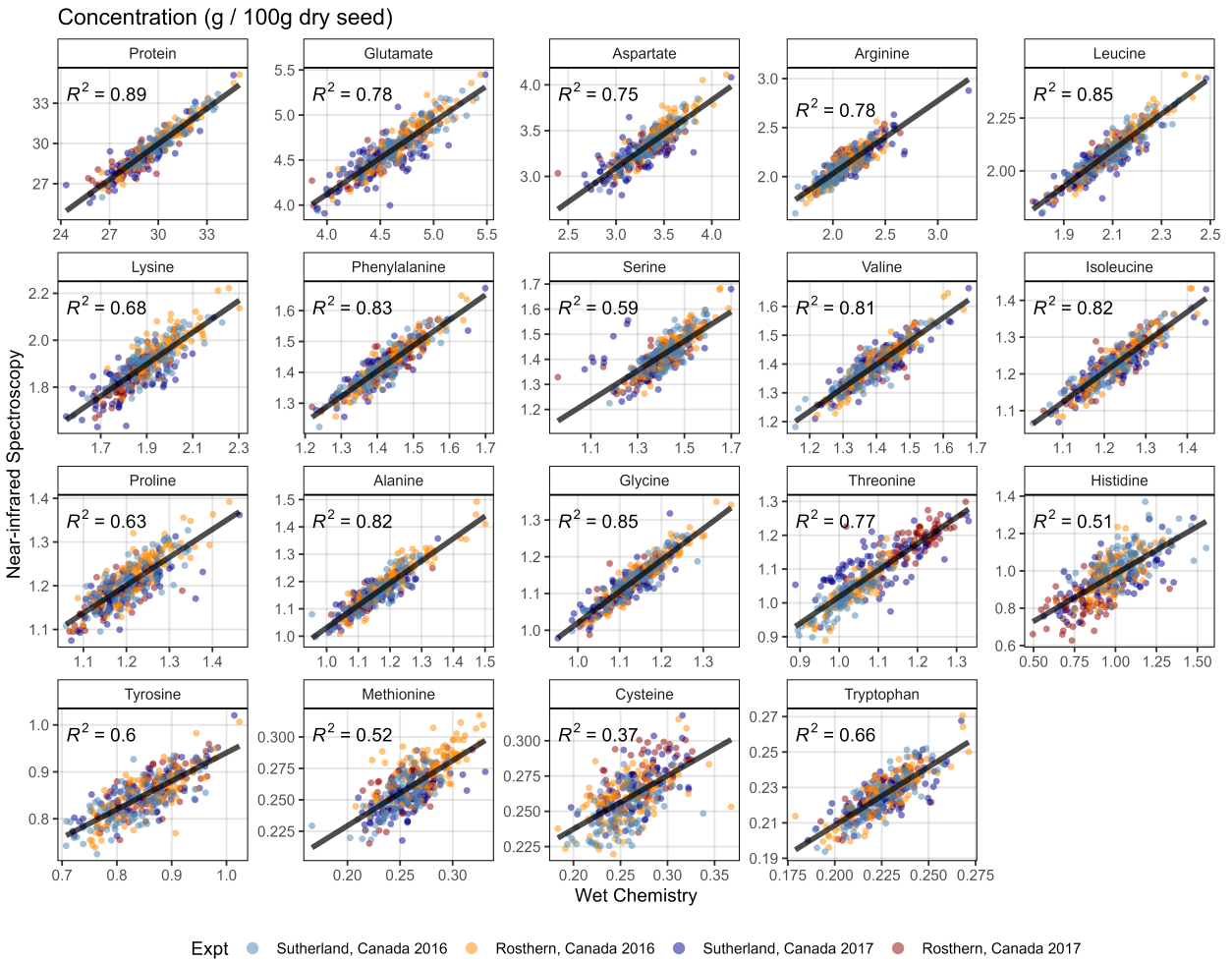
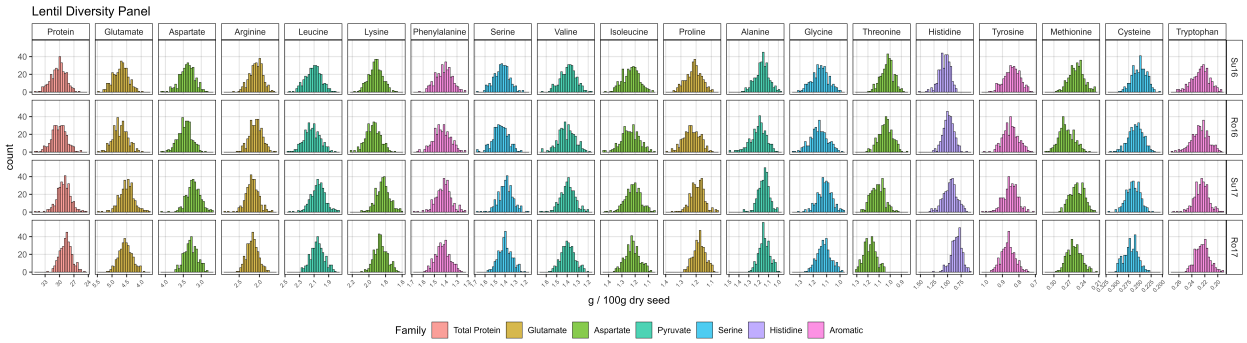
Supplemental Figures

Supplemental Figure 1



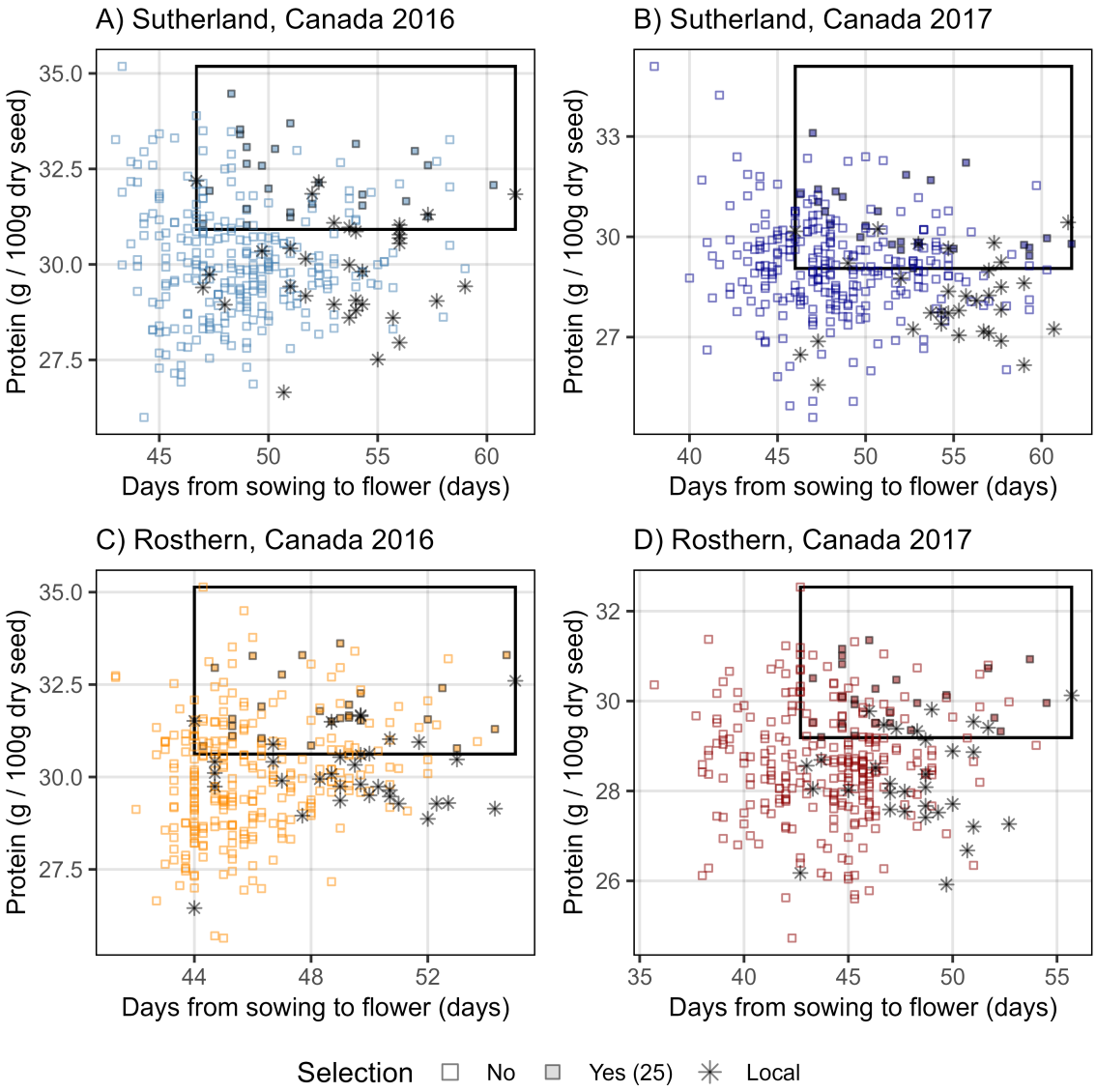
Supplemental Figure 1: Correlations of protein and amino acid concentration of whole lentil seed derived from wet chemistry and near-infrared spectroscopy measurements in a lentil diversity panel. Data from Hang et al. 2022.

Supplemental Figure 2



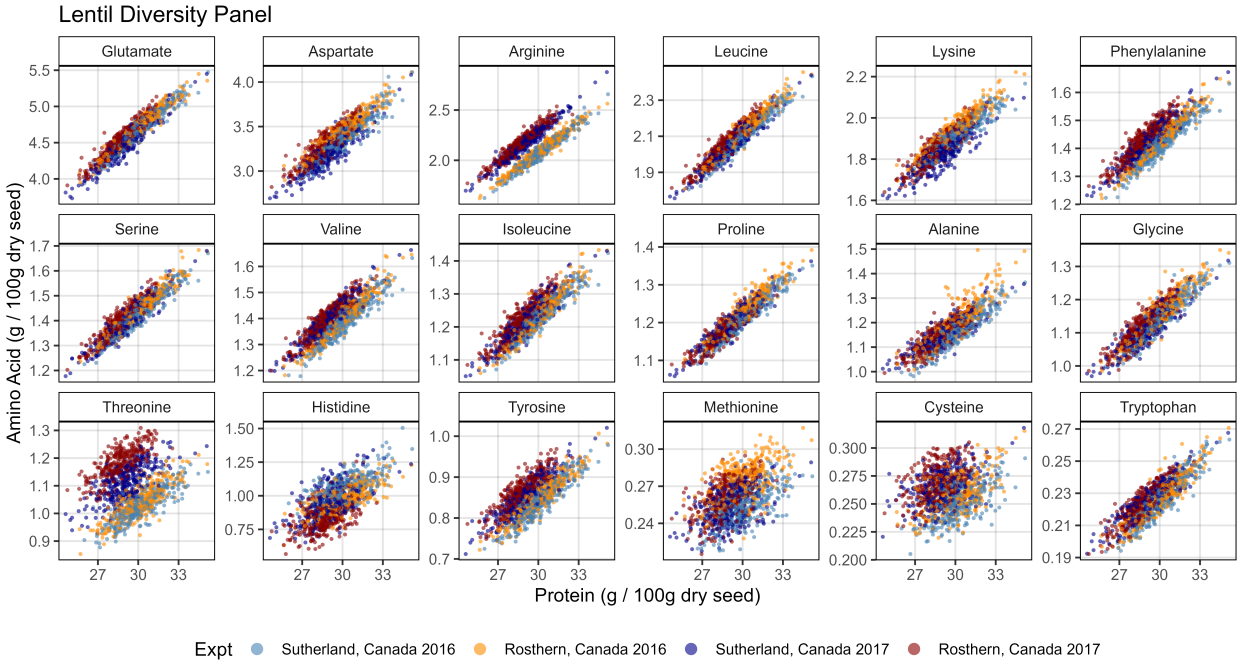
Supplemental Figure 2: Distribution of protein and amino acid concentration of whole lentil seed derived from near-infrared spectroscopy in a lentil diversity panel.

Supplemental Figure 3



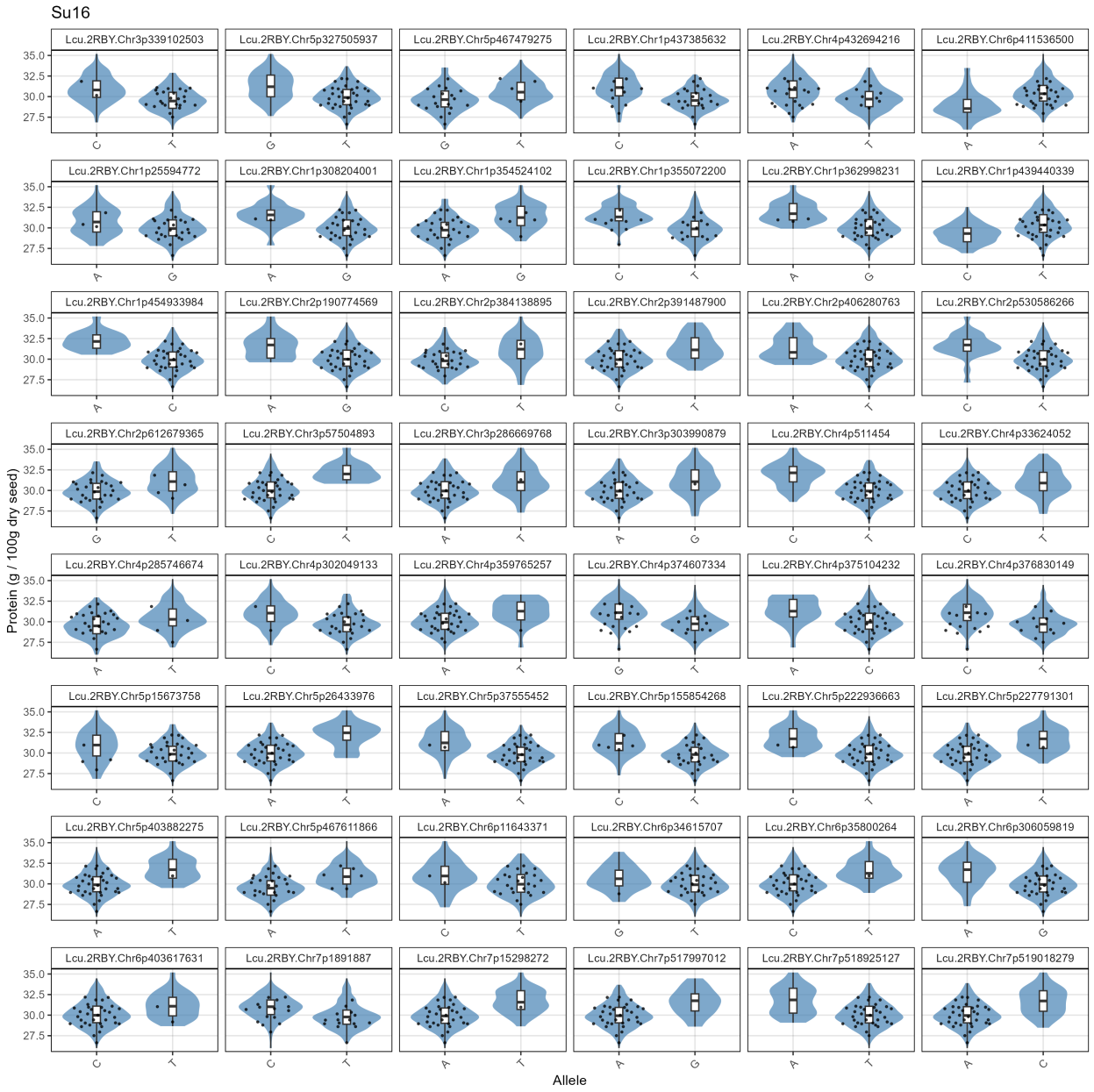
Supplemental Figure 3: Protein concentration of whole lentil seed in a diversity panel by location. Accessions with increased protein concentration and appropriate days from sowing to flower (DTF) based on local adaptation across all four locations are highlighted with a black outline. Large black boxes represent range of days from sowing to flower for accessions originating from the Northern Great Plains of Canada and the USA and the top 25% for protein concentration.

Supplemental Figure 4

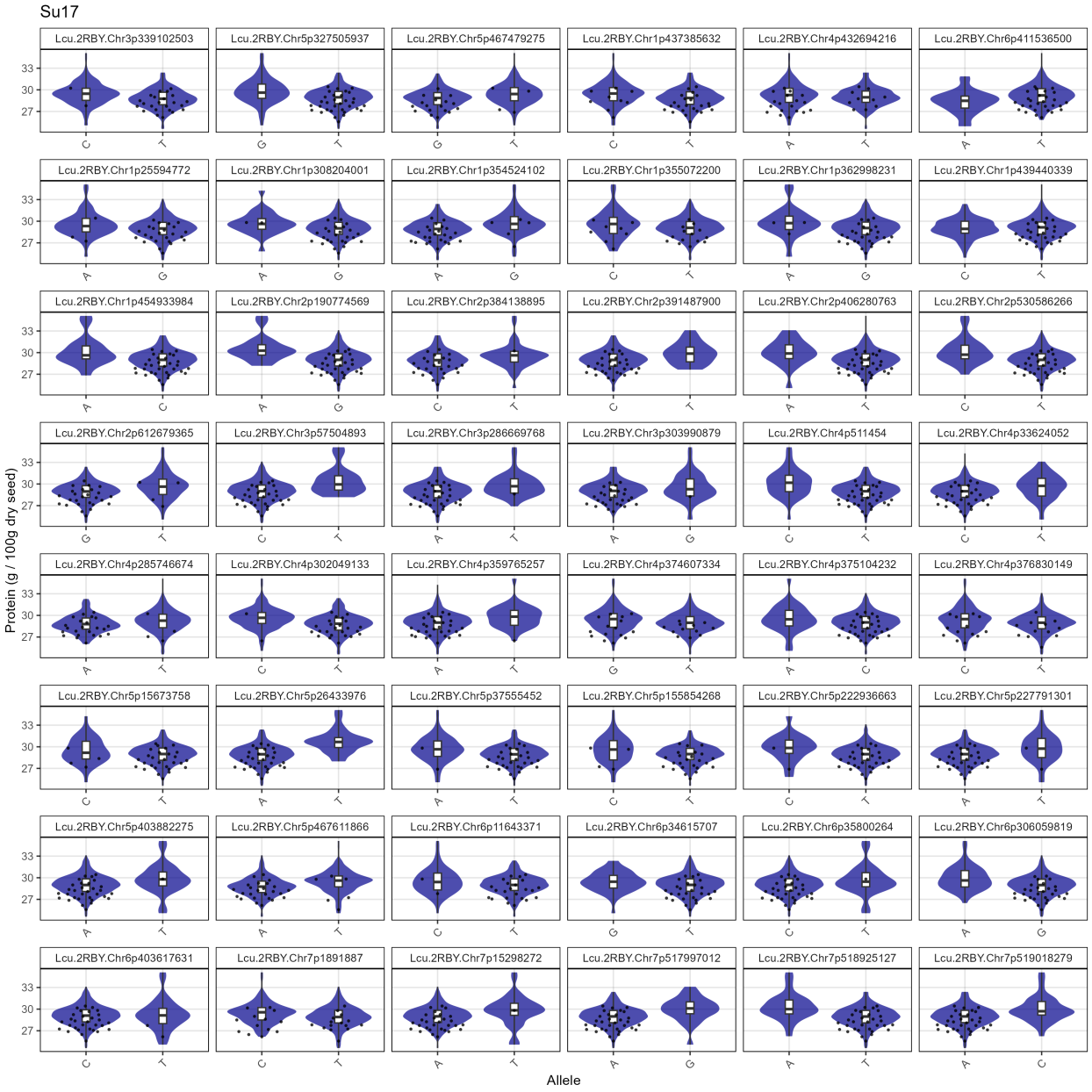


Supplemental Figure 4: Correlations of protein and amino acid concentration of whole lentil seed from a diversity panel derived from wet chemistry and near-infrared spectroscopy (NIRS).

Supplemental Figure 5



Supplemental Figure 5: Markers identified for potential use by breeders to select for increased protein concentration. Black dots represent genotypes originating in Canada. Data from Sutherland, Canada 2016 (Su16).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30
27
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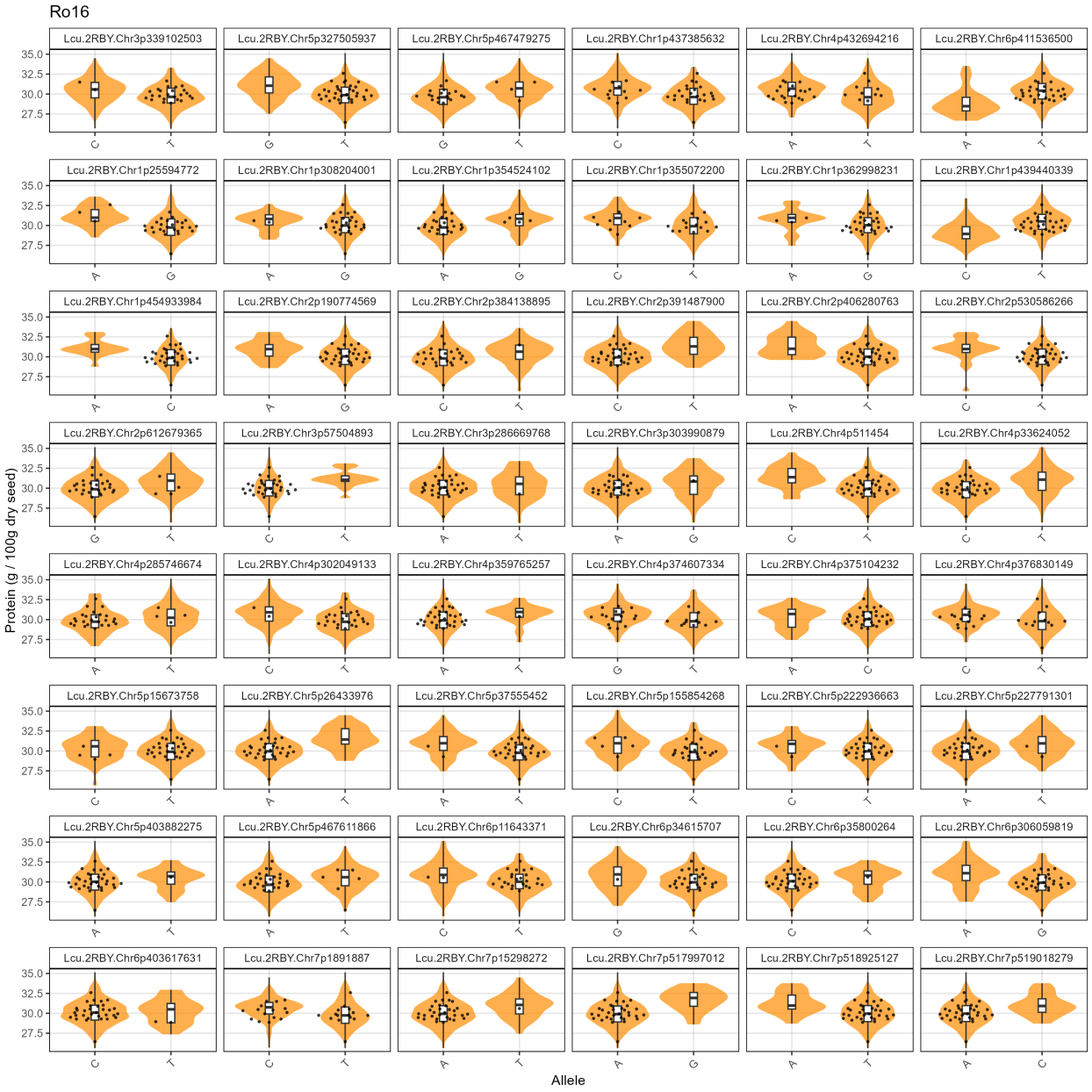
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Protein (g / 100g dry seed)
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32.5
30.0
27.5
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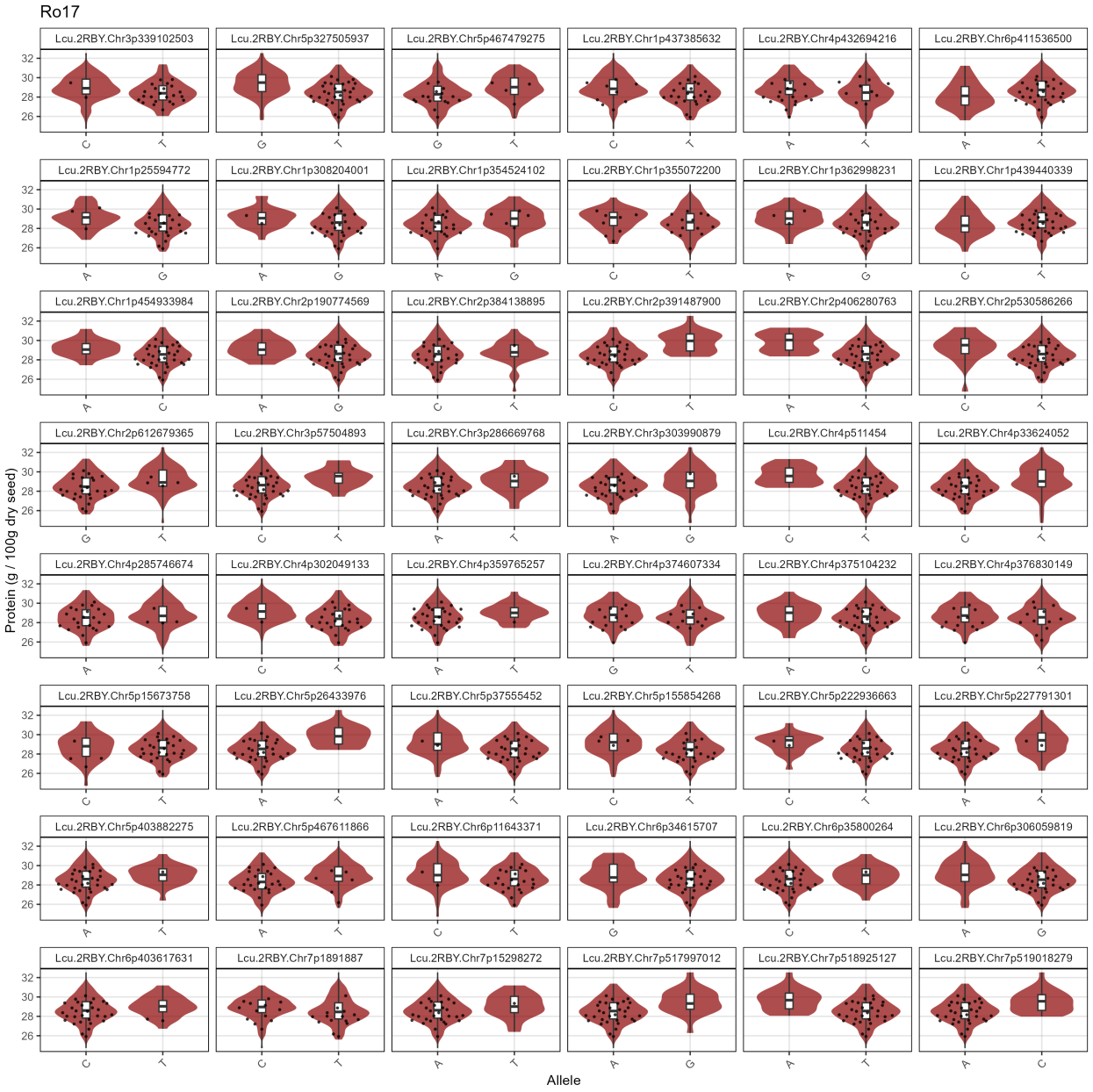
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Lcu.2RBY.Chr7p517997012
Lcu.2RBY.Chr7p518925127
Lcu.2RBY.Chr7p519018279
Protein (g / 100g dry seed)
Allele

Additional Figures

Amino Acid Selections

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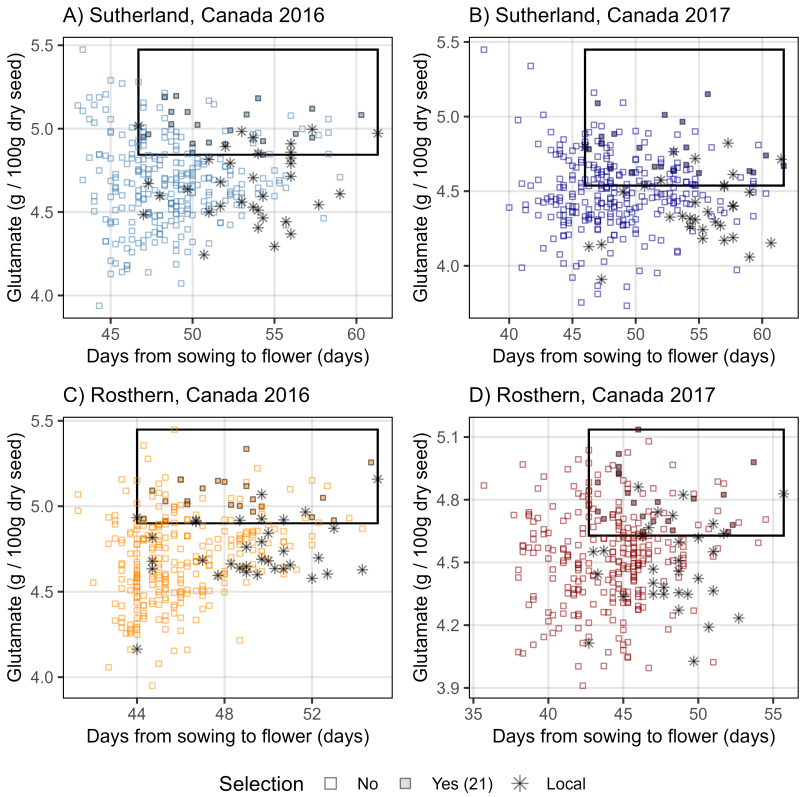
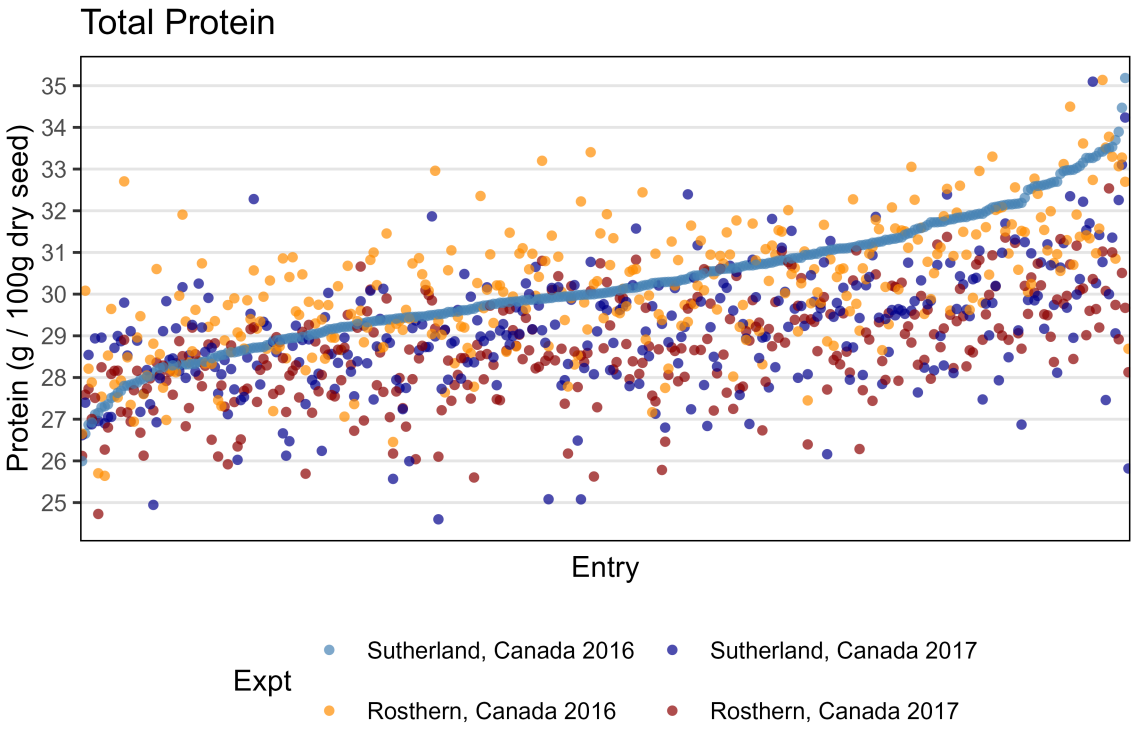
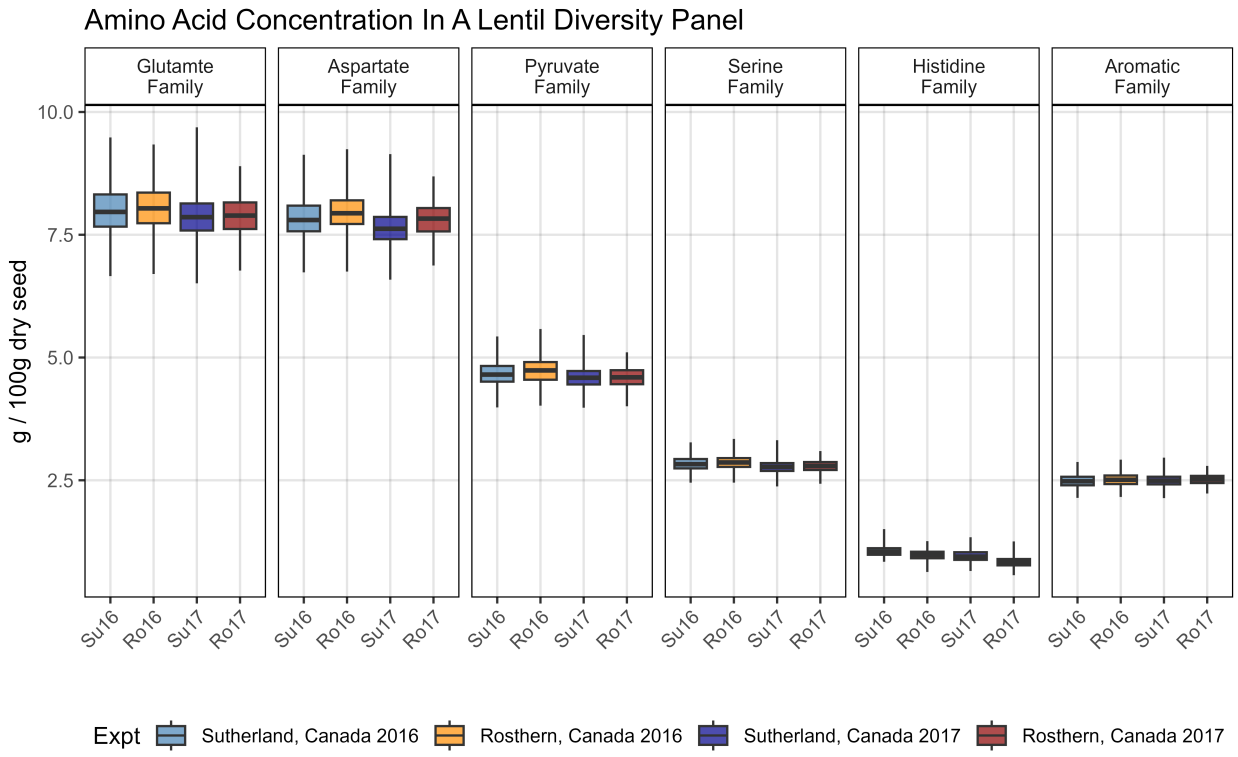


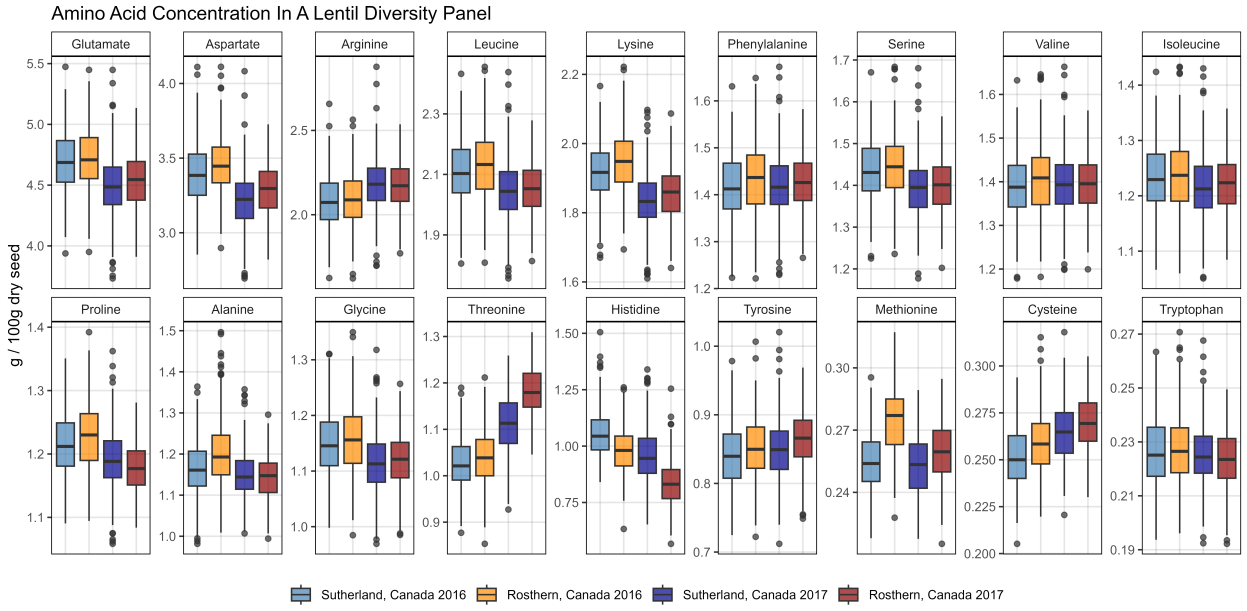
Additional Figure 1



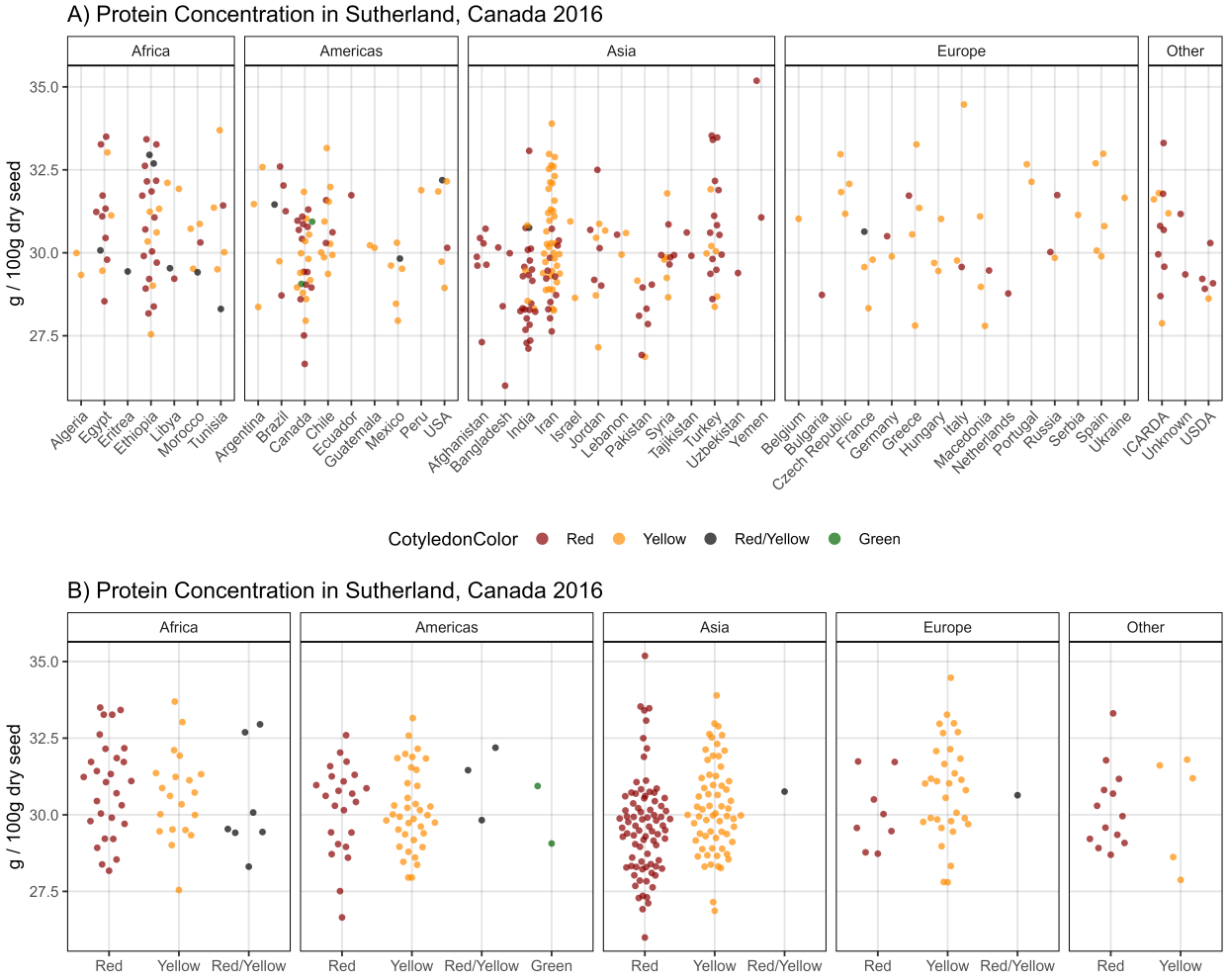
Additional Figure 2



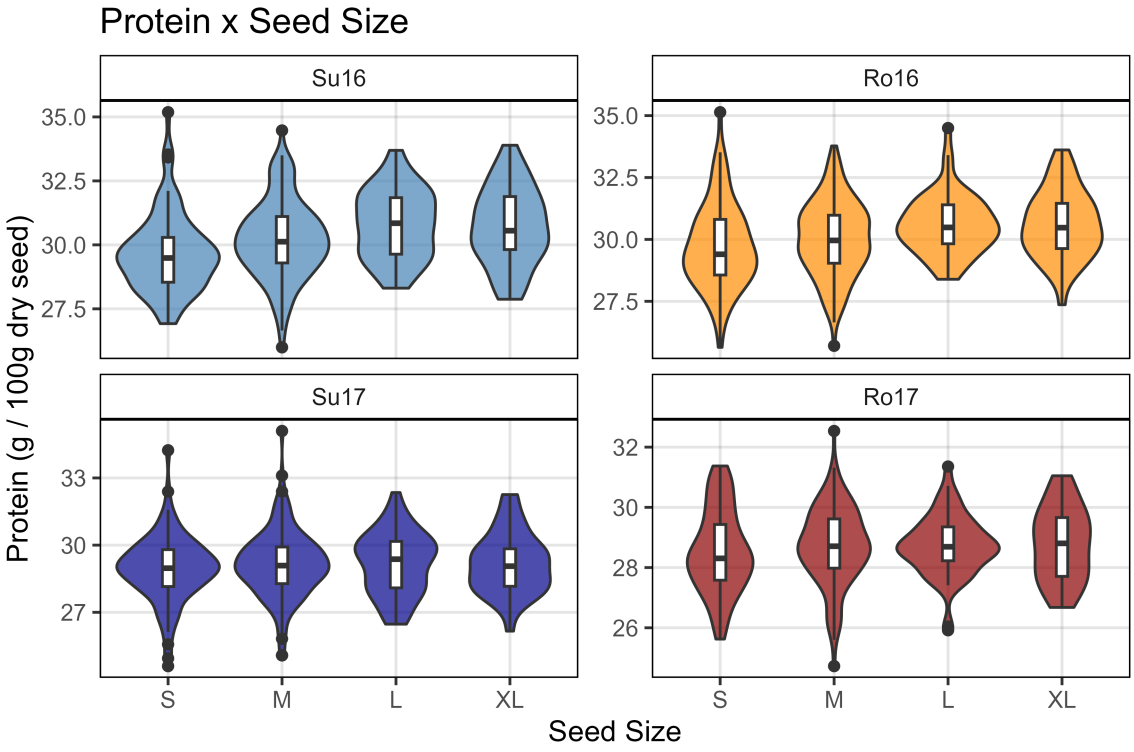
Additional Figure 3



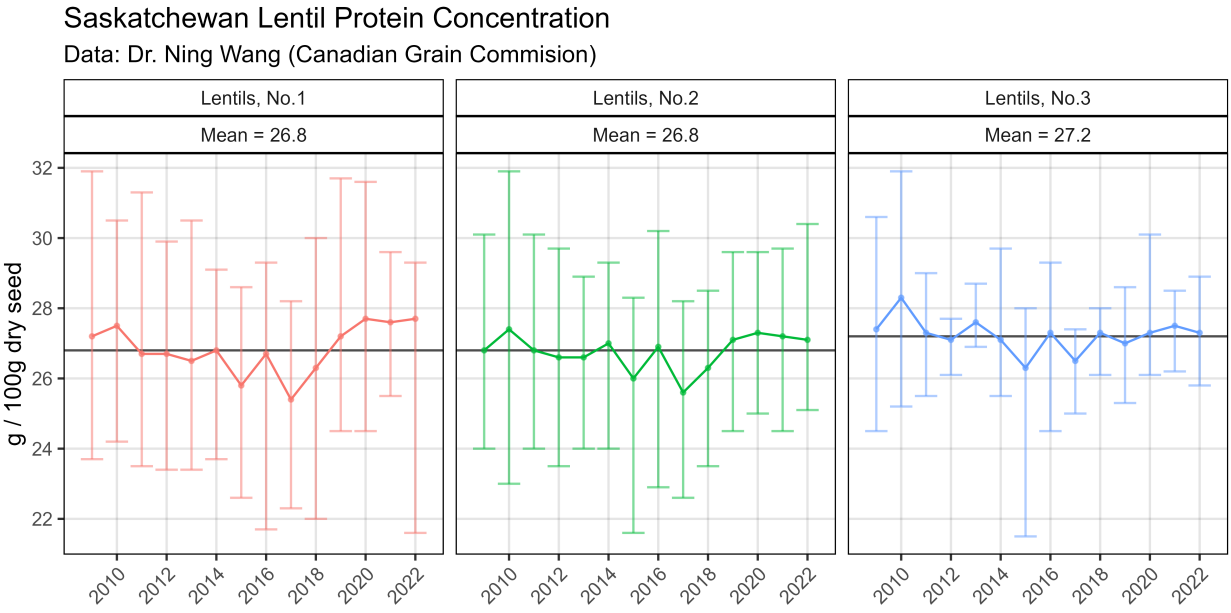
Additional Figure 4



Additional Figure 5



Additional Figure 6



Additional Figure 7