The performance and stability of spring wheat cultivars mixtures in contrasting management conditions in western Canada

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INTRODUCTION

- Production of mixtures of wheat cultivars that belong to the same market class with similar end-use quality profiles, but variable levels of abiotic and biotic stresses can be successfully implemented in large scale mechanized farming systems.
- Although the cultivation of cultivar mixtures has been reported in increasing genetic diversity and providing desirable traits that are unlikely to be present when each cultivar is grown in monoculture, the results are inconsistent due to high genotype by environment (G × E) interactions.
- This study compared the yield potential and stability of five Canada Western Red Spring (CWRS) and five Canada Prairie Spring Red (CPSR) cultivars using monoculture and their two-way and three-mixtures.

MATERIAL AND METHODS

- This study was based on five CWRS (Carberry, Glenn, Go Early, Lillian, and CDC Titanium) and five CPSR (Crossfield, Foray, HY2082, Penhold, and AAC Tenacious) cultivars planted in monoculture (sole) plus two-way and three-way mixtures.
- A total of twenty-five treatments in each of CWRS and CPSR milling classes that consisted of monocultures (5) with two-way (10) and three-way (10) mixtures were evaluated in 2021 at six environments (Figure 1) using a randomized complete block design with three replications.
- For each treatment, we recorded grain yield, the number of tillers, days to maturity, plant height, lodging, test weight, grain protein content, and reaction to diseases. This poster, however, summarizes only the grain yield data.
- Variance component analyses, broad-sense heritability, correlations analyses, stability analyses, and specific mixing ability (SMA) were computed using different statistical programs.

RESULTS

- The phenotypic correlations among environments for CWRS varied from -0.18 between Lethbridge and St. Albert to 0.68 between South Campus and Kernen. For CPSR cultivars, phenotypic correlations varied from -0.33 between Kernen and Lethbridge to 0.78 between Edmonton and St. Albert.
- The plot-based broad-sense heritability computed from all environments was 0.54 for CWRS cultivars and 0.75 for CPSR cultivars.
- The overall mean grain yield of the CWRS and CPSR cultivars per environment varied from 1.3 t ha^{-1} in Beaverlodge to 4.7 t ha^{-1} in Lethbridge (**Figure 1**). The high and low yield potential of the Lethbridge and Beaverlodge, respectively, were also evident from the additive main effect and multiplicative interaction (AMMI) plot in **Figure 2**.
- AMMI showed highly significant ($P<0.01$) differences among treatments (G), environments (E), and G × E interaction effects. However, 95% of phenotypic variation was due to differences among environments, and the remaining due to treatments (2%) and G × E interaction (3%).
- In the AMMI biplot (**Figure 2**), treatments and environments with Factor 1 (PC1) score of nearly zero were considered stable (not sensitive to environmental interactions). The former included Entry 19 (Go Early, Glenn, and CDC Titanium), Entry 20 (Go Early, Glenn, and Lillian), and Entry 25 (Glenn, CDC Titanium, and Lillian) mixtures. Glenn was identified as one of the cultivars in all these stable mixtures. Go Early, CDC Titanium, and Lillian were identified in two of the three stable mixtures.

RESULTS

- In the CPSR cultivars (**Figure 2**), the Factor 1 scores suggest stable grain yield performance for Entry 8 (Crossfield-Penhold), Entry 9 (Crossfield-Tenacious), Entry 20 (Crossfield-HY2082-Tenacious), and Entry 22 (Foray-HY2082-Penhold).
- Twelve out of the twenty CWRS cultivars mixtures had a specific mixing ability (SMA) a greater than zero (range: 1.8-56.8), which suggests greater contribution of each cultivar than its expected share in the monoculture. Titanium-Lillian, Glenn-Carberry, and Glenn-Titanium-Lillian had the three highest SMA that varied from 35.0 to 56.8 (**Figure 3**).
- For the CPSR cultivars, we found SMA > 0 (range 0.6-8.6) for grain yield recorded in ten mixtures. HY2082-Penhold, HY2082-Foray, and Foray-Crossfield mixtures had the three highest specific mixing abilities ranging from 4.7 to 8.6.

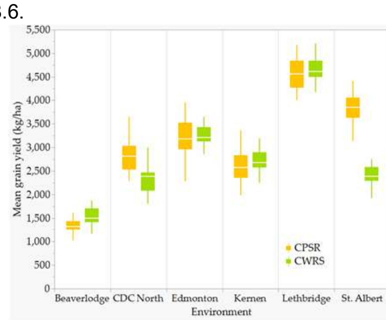

Figure 1. Box plots of mean grain yield of the 25 monoculture, two-way and three-way mixtures of CWRS and CPSR cultivars evaluated in 2021 growing season at six environments.

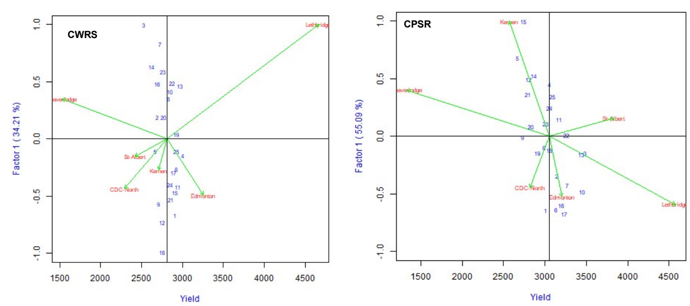

Figure 2. AMMI biplot of grain yield (kg/ha) and Factor 1 of 25 treatments involving CWRS sole cultivars (Entry 1-5), two-way mixtures (Entry 6-15) and three-way mixtures (Entry 16-25) evaluated in 2021 growing season at six environments in western Canada.

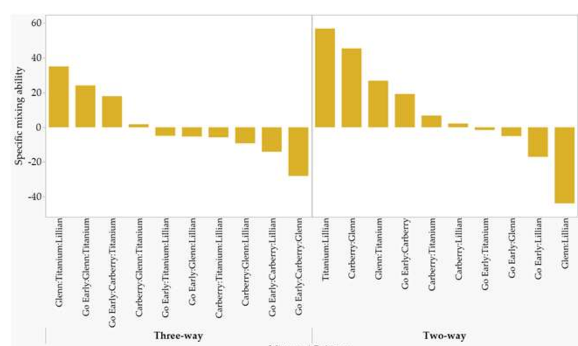

Figure 3. Comparison of specific mixing ability of two-way and three-way mixtures of five CWRS cultivars evaluated in 2021 growing season at six environments in western Canada.

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THE WAY FORWARD

A final data analysis on both the CWRS and CPSR classes will be done in mid-2023 by combining the 2021 and 2022 phenotype data recorded in six environments. In addition to grain yield, the analysis will include the number of tillers, days to maturity, plant height, test weight, grain protein content, and reactions to diseases.

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