

ANNUAL VARIATION IN WHEAT VARIETIES JASPER, LCS SHINE, PIRANHA CL+, AND SOCKEYE CL+



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AIM

- **Provides Sustainability and Adaptability of Varieties:** Understand how varieties respond to different environments for the breeding program.
- **Evaluate Ranking:** Assess the four winter wheat varieties based on five different traits across 12 site-year locations to determine the best overall performing variety.
- **Determine Heritability:** Analyze the heritability of the five traits to determine which are genetically influenced and can be selected during breeding versus the traits that are environmentally-driven.

INTRODUCTION

- Drone-mounted multispectral sensors measure multiple bands of light that can be used to calculate vegetation indices. There are a variety of vegetation indices that are available that can quantify different metrics of plant health.
- Broad-sense heritability estimates the proportion of phenotypic variance due to genetic causes. Understanding what traits to select for helps guide future breeding progress.
- The four soft white winter wheat varieties investigated in this study are LCS Shine, Piranha CL+, Sockeye CL+, and Jasper. These varieties are commercially available and widely grown in eastern Washington.

AGRONOMIC DATA COLLECTION

- 12 Site-Year Locations:
 - Harrington (2022, 2023, 2024)
 - Kincaid/Pullman (2022, 2023)
 - Kahlotus (2023, 2024)
 - Prescott (2022)
 - Ritzville (2022, 2023, 2024)
 - Walla Walla (2022)
 - Varieties: Jasper, LCS Shine, Piranha CL+, Sockeye CL+
 - Traits: normalized yield (Bushels per Acre, BUAC), Normalized Difference Vegetation Index (NDVI), test weight (TW), plant height (PH), head date (HD)
- Multispectral data was collected via drone over three years; remaining data came from harvest and processing.

METHODS

FIGURE 1: FLOWCHART OF STATISTICAL ANALYSIS

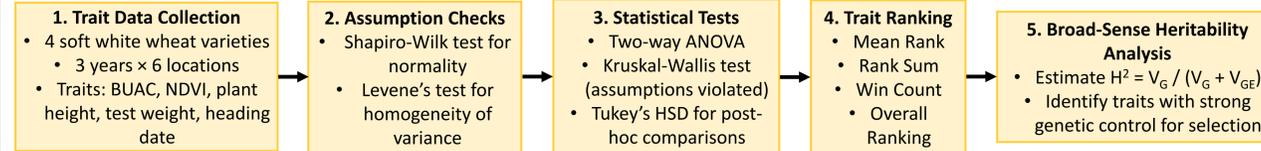


Figure 1 summarizes the statistical methods and data analysis used to evaluate wheat variety performance, the predictive value of NDVI, and trait heritability. The outlined steps illustrate a comprehensive approach to identifying top-tier varieties.

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RESULTS

TABLE 1: SUMMARY OF STATISTICAL TESTS FOR TRAIT DIFFERENCES

Trait	ANOVA F (p-value)	Kruskal-Wallis p-value	Shapiro-Wilk p-value	Conclusion
Yield (BUAC)	0.043 (0.988)	0.9882	p = 6.97e-8	☐ No significant difference
Test Weight	1.897 (0.133)	0.0416	p < 2.2e-16	◻ Marginal difference
NDVI	1.617 (0.188)	0.2261	p = 0.037	☐ No significant difference
Plant Height	11.49 (1.01e-6)	2.09e-5	p = 8.35e-8	☑ Highly significant different
Head Date	0.204 (0.893)	0.7817	p = 0.01175	☐ No significant difference

TABLE 2: VARIETIES RANKED ON AVERAGE BUAC PER SITE-YEAR

Site Year	1st	2nd	3rd	4th
2022 Harrington	LCS Shine	Sockeye CL+	Piranha CL+	Jasper
2022 Kincaid/Pullman	Jasper	LCS Shine	Piranha CL+	Sockeye CL+
2022 Prescott	Piranha CL+	Jasper	LCS Shine	Sockeye CL+
2022 Ritzville	LCS Shine	Sockeye CL+	Jasper	Piranha CL+
2022 Walla Walla	LCS Shine	Sockeye CL+	Jasper	Piranha CL+
2023 Harrington	Piranha CL+	Sockeye CL+	Jasper	LCS Shine
2023 Kahlotus	Piranha CL+	Sockeye CL+	LCS Shine	Jasper
2023 Kincaid/Pullman	Jasper	Sockeye CL+	LCS Shine	Piranha CL+
2023 Ritzville	Sockeye CL+	LCS Shine	Jasper	Piranha CL+
2024 Harrington	LCS Shine	Jasper	Sockeye CL+	Piranha CL+
2024 Kahlotus	Sockeye CL+	Piranha CL+	Jasper	LCS Shine
2024 Ritzville	LCS Shine	Piranha CL+	Sockeye CL+	Jasper

TABLE 3: BROAD-SENSE HERITABILITY INDICES FOR EACH TRAIT

Trait	V _G	V _{GE}	H ²	Selection Potential
Yield (BUAC)	0	23.50316	0	None
Test Weight	2.96989e-05	27.39911	1.3007e-05	Low / Env. Driven
NDVI	0.00092919	0.0006162	0.9476344	High
Plant Height	11.74496	1.167682	0.9917831	Extremely High
Head Date	0.00092919	0.0006162	0.9476344	High

- ANOVA results in **Table 1** show no significant differences for BUAC, NDVI, test weight, or head date meaning they perform very similar across all varieties and site-year locations.

- Using the trait data for each variety at each site-year location, the varieties can be ranked within each site year location based on each of the five traits, **Table 2** shows just the Average BUAC. This will result in a winning variety at each site-year location.

- Previous studies have identified NDVI as a reliable predictor of yield. **Figure 2** presents the relationship between NDVI and BUAC across each wheat variety.

- Using the broad-sense heritability equation, **Table 3** represents the resulting traits that lead to important selection potential. NDVI, plant height, and head date have the highest broad-sense heritability.

- Overall rankings (**Figure 3**) were based on total wins, mean rank, and rank sum, calculated using the agronomic traits. Varieties with more wins and lower ranks scored higher – Sockeye CL+ ranked the highest by this method.

FIGURE 2: RELATIONSHIP BETWEEN NDVI AND BUAC ACROSS WHEAT VARIETIES

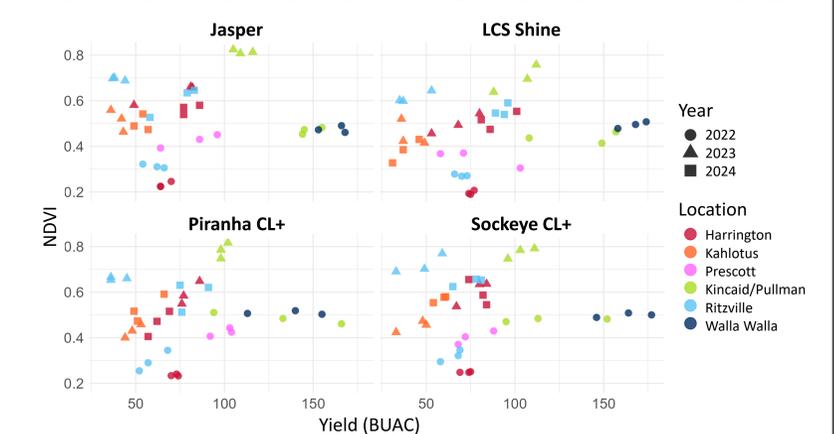
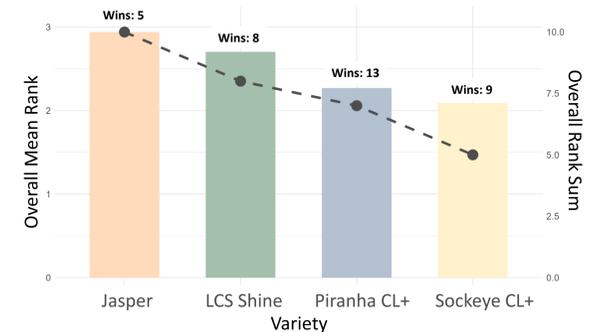


FIGURE 3: OVERALL MEAN RANK, RANK SUM, AND WINS OF EACH VARIETY



CONCLUSION

- Sockeye CL+ performed the best out of the four varieties with Piranha CL+, LCS Shine, and Jasper following.
- LCS Shine consistently exhibited significantly shorter plant height (by 6-7cm), while other traits – BUAC, test weight, and NDVI – showed no significant different among varieties.
- Broad-sense heritability analyses reveal NDVI, head date, and plant height are highly heritable traits with sufficient genetic variation, making them strong candidates for selection, whereas test weight and yield appear to be predominantly influenced by environmental factors.
- Additional data and analysis are required to confidently establish a positive correlation and predictive relationship between NDVI and BUAC.

FURTHER WORKS

- Correlate NDVI and test weight to evaluate potential for an early-season predictor of grain yield.
- Further research into narrow-sense heritability with a larger population.
- Apply selection indices to the traits to increase the accuracy of the rankings.
- Test the correlation between NDVI and grain yield across each location.