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Using direct versus indirect selection in plant breeding in the genomics and phenomics era

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Statement of the Problem: Recent advances in genomics and phenomics have opened the path for many new strategies in plant breeding. Selection for many traits related to abiotic and biotic stress resistance was once only selected on using direct measures. Genomics and high-throughput phenotyping now offers the advantage of making gains using indirect selection methods. The ability to select for these traits using indirect selection methods may advance the rate of gain for these correlated traits.

Methodology & Theoretical Orientation: Two large diversity panels of wheat were developed and grown over four years in the Pacific Northwest. Data was collected on both populations for agronomic traits, yield potential, canopy spectral reflectance, and disease resistance. Models built using one panel were used on the second panel to make selections. Analysis was completed to see if these models were able to indirectly select for resistance to abiotic and biotic stress better than direct methods.

Findings: Using a limited number of molecular markers associated with traits of interest for abiotic stress resistance, increased gains were not made. Utilization of whole genome approaches like genomic selection was able to select lines with improved performance. High-throughput phenotyping was also able to select the best performing lines, and was robust across years and locations. Selection using molecular markers was very useful in selecting for biotic stress resistance. Either direct or indirect selection methods can be useful in abiotic stress resistance, mainly dependent on the difficulty of the direct disease selection method.

Conclusion & Significance: The use of indirect selection can be as useful as direct selection when selecting for biotic stress resistance. When doing abiotic stress resistance selection, whole genome or whole plant approaches appears to be more useful and can assist with selecting in earlier generations of plant breeding.

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