



# «Identification and Preservation of Wheat Cultivars with Tolerance Mechanisms to Major Fungal Diseases» for 2022–2024



Project Leader: A.S. Rsaliev, Candidate of Agricultural Sciences, Professor in the Specialty "Biology"

The aim of the project is to identify and preserve wheat cultivars with tolerance mechanisms to major fungal diseases. In Kazakhstan’s grain-producing regions, the continued cultivation of susceptible varieties, insufficient plant protection measures, and favorable weather conditions have led to the accumulation of infectious agents of rust and leaf spot diseases in wheat fields. This project will generate new insights into wheat disease resistance and help develop novel methods for identifying tolerant wheat varieties. A collection of wheat varieties and lines tolerant to rust species and yellow leaf spot will be created and preserved. The scientific data and methodological developments obtained during the implementation of this project will be utilized by breeding and genetic research institutions in Kazakhstan and potentially in neighboring and distant countries.

**Relevance:** Various methods for combating wheat pathogens have been developed worldwide to date. Plant defense mechanisms against pathogens can be divided into two categories: resistance and tolerance. While there is extensive literature on wheat resistance to pathogens, comparatively less attention has been given to tolerance. In particular, many parameters of wheat tolerance to diseases remain insufficiently studied. A review of global literature indicates that enhancing tolerance in cereal crops is currently regarded as an additional approach to disease management, as it minimizes the impact of disease on yield. Unlike resistance and fungicide application, tolerance is also considered a potentially sustainable strategy for disease control, as it is expected to exert minimal selection pressure on pathogen populations. Therefore, studying the scientific foundations of wheat tolerance to fungal diseases is one of the key issues in modern phytopathology. The new knowledge gained from such research will play a leading role in shaping future plant protection strategies.

## Introduction

Climate change, soil degradation, imbalanced mineral nutrition, and pesticide pressure all intensify competition between plants and pathogens, destabilizing and complicating the agricultural landscape. In this context, a priority area in wheat breeding for resistance to phytopathogens is the identification of varieties with high tolerance. Such varieties, even when infected to a moderate degree, suffer significantly less yield loss compared to susceptible ones. The proposed project aims to identify wheat accessions with tolerance mechanisms against major fungal diseases. As a result of the project, candidate traits responsible for wheat tolerance to pathogens will be identified, and a collection of soft wheat varieties tolerant to diseases will be established.

## Project Objectives

- To assess the influence of morphological and immunological traits of wheat on tolerance to major fungal diseases;
- To identify wheat accessions with tolerance mechanisms to various races of rust and yellow spot pathogens;
- To study the effectiveness of genetically protected wheat varieties in the formation of tolerance to key fungal diseases;
- To create and maintain a collection of wheat varieties and lines tolerant to major fungal diseases.

## Current Results

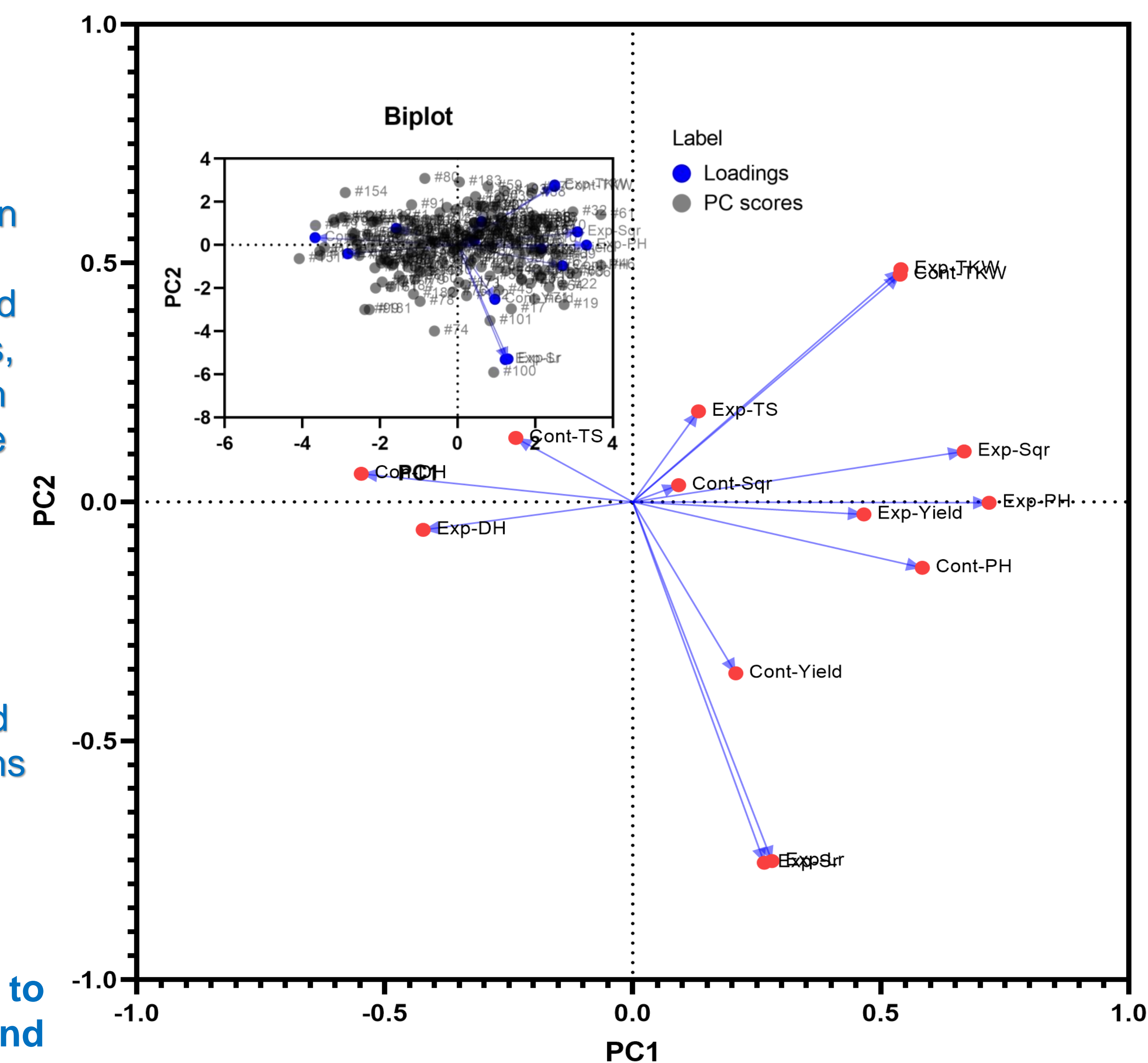
In field conditions, the influence of stem, leaf, and spike traits, as well as plant development stages, on tolerance to major fungal diseases has been studied. The impact of infection type and disease severity on plant tolerance to fungal pathogens has also been investigated. Under controlled conditions, the effects of different races of *Puccinia graminis*, *P. striiformis*, *P. triticea*, and *Pyrenophora tritici-repentis* on wheat tolerance have been evaluated. The role of wheat varieties containing Lr, Sr, and Yr resistance genes in developing tolerance to leaf, stem, and yellow rust has been assessed.

## Work Progress

In controlled greenhouse conditions, the influence of wheat varieties carrying the *Tsn1* gene on tolerance to yellow spot is being studied. Field evaluations are being conducted on wheat lines, varieties, and accessions from Kazakhstan and other countries for their tolerance to fungal diseases. The studies will ultimately determine the interaction between resistance genes (juvenile and adult) and wheat tolerance to diseases.

**Publications:** Maulenbay A., Rsaliev A. Studies of plant tolerance to diseases: current state // Proceedings of the “Biotechnology and biological safety: achievements and development prospects”— 2023. Kurymbayeva, N., Maulenbay, A., Kurmangali, A., Yskakova, G., Savin, T., & Rsaliev, A. (2023). Screening of new wheat cultivars originating from Kazakhstan for stem and leaf rust resistance genes using PCR markers // Eurasian Journal of Applied Biotechnology.

**Next steps:** A collection of wheat varieties and lines tolerant to rust and yellow spot will be created and preserved. A methodical recommendation for identifying wheat varieties tolerant to the main fungal diseases will be developed.



The application of the principal component analysis revealed a statistically significant effect of flag leaf area and plant height on the main factors (PC1), explaining 39.19% of the total variance. Immunological parameters also had an effect on the main factors (PC1), explaining 32.10% of the variability.

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