USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

Research Brief

# Genotype, Environment and Management Dffect on Oat Yield and Milling Quality in Northern Great Plains

**Dhurba Neupane[1], Sharon K Schneider[1], Patrick M. Ewing[1,2]**

[1]USDA-ARS Integrated Cropping Systems Research Unit, Brookings, South Dakota, USA

[2] USDA-ARS Food Systems Research Unit, Burlington, Vermont, USA




## Key Findings

- Variety, environment, and management alter oat yield, milling quality, and nutritional content.
- Oat seeding rate influenced grain quality, nutrition, and agronomic traits.
- Minimal impact of intercropped medium red clover was observed on oat yield or quality.
- Variety-specific tradeoffs existed among yield, milling quality, and nutrient content.
- Variety and management may target specific markets and emphasize weather resilience.

## Background

In the western Corn Belt region of the USA, lower economic returns from oats compared to corn and soybeans significantly constrain oat production. The region's warm and highly variable summers present unique challenges. However, integrating oats into corn-soybean rotations offers several benefits, including enhanced resource-use efficiency, improved short-term yields of other crops, and stabilized long-term farm profitability. Oat integration also facilitates the establishment of perennial forages, such as alfalfa or medium red clover, which further amplify rotational benefits while providing animal fodder.

Given the increasing demand for high-quality grain, understanding the interplay of genotype (G), environment (E), and management (M) practices on oat yield and quality is crucial. While previous studies have explored two-way interactions (G×E or G×M), it's important to recognize that the growing environment can influence management decisions, which ultimately affect crop performance.

## Objective

The overall goal of this research study was to evaluate the impact of genotype, environment, and crop management practices on oat grain yield, milling quality, and nutritional content. We hypothesized that some cultivars may perform better in specific conditions, and that no single cultivar will be optimal across all environments and management practices. We expected tradeoffs between different oat parameters (i.e., yield versus quality), so that the definition of “optimum” may shift based on the importance of specific quality parameters like grain nutrient content versus milling quality.

## Methods

A three-year (2021-2023) field study was conducted at the Eastern South Dakota Soil and Water Research Farm in Brookings, South Dakota (44º 19’ N, 96º 46’ W; 500 m elevation). The field was managed using no-till practices with synthetic fertilizer and herbicide application. The preceding crop was corn in the first year and soybeans in the subsequent years.

Treatments included three oat genotypes (Reins, Sumo, and Natty), three oat plant populations, and two clover establishment treatments (clover under-seeded with oats and fallow with no clover). Oat seeding rates were adjusted to achieve target plant populations of 225, 300, and 375 plants $m^{-2}$. These treatments were arranged in a 3×3×3 factorial using a row-column design with four replications of each treatment combination. Clover treatments were randomized within rows, while genotype and plant population combinations were randomized among columns within each block.

Data were collected on temperature and precipitation. Agronomic data, including grain yield and lodging severity, were also recorded. Additionally, data were gathered on nutritional content (i.e., β-glucan, protein, and oil content) and milling quality (such as plump6, groat content, plump groat, plump-, mid-, and thin kernels, and thousand seed weight).

# Results

## Overall Findings

### Figure 1—Genotype comparison

⇒ Reins and Natty outperformed Sumo in grain yield, test weight, and groat content. Beta-glucan content was highest for Reins.

⇒ Protein content and plump values were higher for Sumo.

⇒ There was no single optimum genotype.

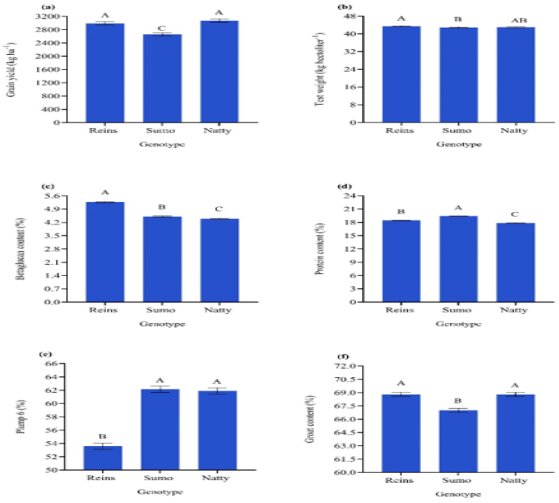



**Figure 1.** Genotype affect on grain yield and milling quality of oats.

### Figure 2—Weather environment comparison

⇒ In 2022, cool and wet weather conditions resulted in the highest grain yield, test weight, and plump6 kernels.

⇒ Reins exhibited greater sensitivity to weather, performing well in favorable conditions and poorly in unfavorable ones.

⇒ These variations are likely due to the influence of weather conditions and implemented management practices.

⇒ Consider growing variety that favor different weather and management conditions.

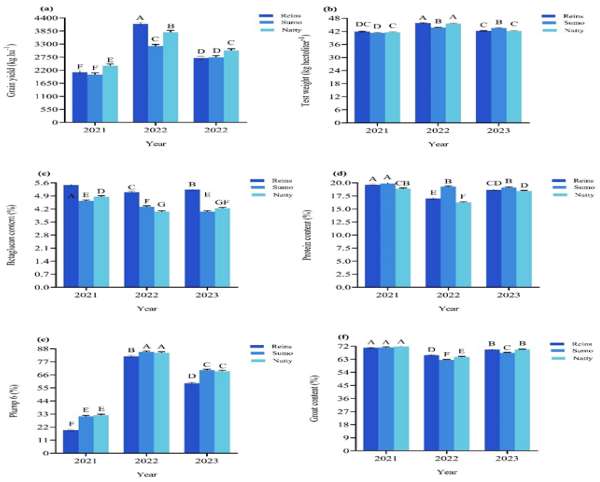



**Figure 2.** Weather effects grain yield, nutritional profile, and milling quality

### Figure 3—Tradeoff analysis

⇒ Grain yield was positively correlated with test weight and milling quality. However, it was negatively correlated with β-glucan.

⇒ Variety-specific tradeoffs were observed among these parameters.

⇒ A genotype that decouples the yield and quality relationship is valuable for developing market specific varieties.

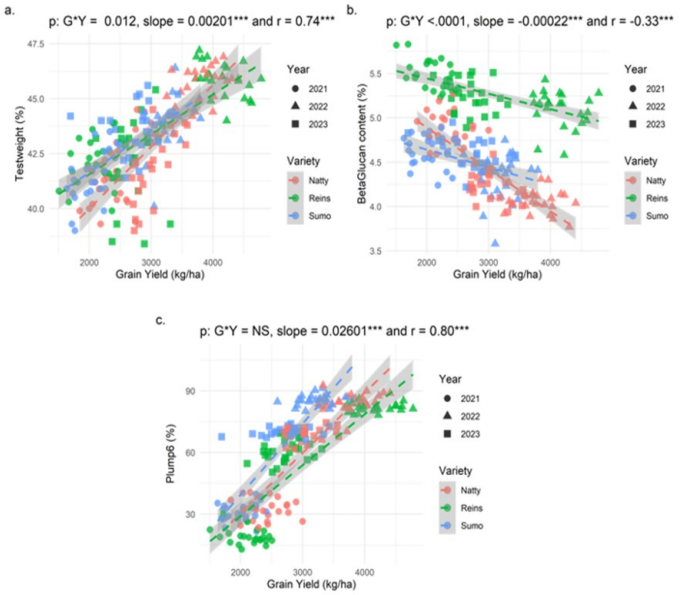



**Figure 3.** Grain yield relationship with quality and nutritional profile.

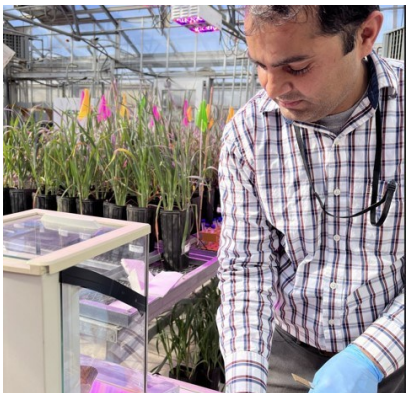
Full publication available at https://doi.org/10.1016/j.fcr.2025.110259

USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

## Next Steps

To further explore the breadth of interactions between crop genotypes, growing environments, and crop management, we will implement a multi-location, multi-year field study incorporating diverse oat varieties. These trials will span multiple locations with varying soil types, weather patterns, and growing conditions to assess cultivar stability and adaptability across many environments. Additionally, we will continue and expand our oat-legume-brassicas polyculture project within locally and regionally specific cropping systems. Additional studies will explore variable-rate fertilization and alternative weed control strategies to further optimize oat production systems in the northern Great Plains.

**Dhurba Neupane**
Research Agronomist



**Questions or comments?**
**Email:** Dhurba.Neupane@usda.gov

## About NCARL

The North Central Agricultural Research Laboratory (NCARL) is a USDA-Agricultural Research Service laboratory located in Brookings, SD. The goal of NCARL is to develop, document, and promote soil, crop, and pest management practices that are ecologically sustainable while maintaining producer profitability.