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ARTICLE

# The Influence of Organic and Mineral Fertilizers on the Development of Winter Wheat in Meadow–Saz Soils

**Muhammadkarim Z. Mamadaliev**[1,*]

[1] Department of Effective Use of Household Plots and Medicinal Plants, Agrarian Joint Faculty, Fergana State University, 19, Murabbiylar Street, Fergana City, 712000, Uzbekistan

## Abstract

**The article presents the results of research on the effect of local and mineral fertilizer rates used with rice straw on the number and growth of winter wheat in the conditions of grassland soils.amino acids, leading to decreased humus content and transformation of nitrogen-containing compounds.**

**Keywords**: winter wheat, bush number, development periods, rice straw, local fertilizer, mineral fertilizers.

## 1 Introduction

The primary determinant of achieving high yields from winter wheat is the number of tillers. In other words, when optimal seedling density is attained, the effectiveness of the applied agronomic practices increases.

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***Corresponding author:**
✉ Muhammadkarim Z. Mamadaliev
mmamadaliyev087@gmail.com

Thus, the germination of winter wheat seedlings and the formation of an optimal number of tillers depend on the agronomic measures employed. Under the conditions of meadow–saz soils, improving the agronomic practices for cultivating winter wheat following rice as the main crop and studying the application rates of organic fertilizers to enhance the efficiency of mineral fertilizers are considered among the key issues.

In this regard, according to the views of many scholars, the formation of an optimal number of tillers—along with achieving high grain yield and greater cold resistance—varies depending on such agronomic factors as sowing time, seeding rate, sowing method, sowing depth, moisture availability, and soil preparation. Likewise, if the crop stand is sparse, even though the productivity of each individual plant may be high, the total yield obtained from a given area will be low. As plant density increases, the productivity of individual plants decreases, but the overall yield per unit area increases to a certain extent. At this point, the number of plants per unit area becomes optimal and the yield reaches its maximum; however, further increases in tiller number lead to a decline in yield [1, 2].

Regardless of the soil conditions under which it is cultivated, winter wheat is considered one of the cereal crops most demanding of soil fertility. The application of cattle manure and compost, in addition to the recommended mineral fertilizer rate of $N_{200}P_{140}K_{100}$ kg/ha for winter wheat, contributes—at least partially—to an increase in the nutrient content of the soil. As a result, the growth and development of winter wheat improve, leading to additional yield gains [3].

## 2 Research Methods

Under the meadow–saz soil conditions, research was conducted during the 2020–2023 seasons to determine the effects of rice straw, organic fertilizers, and mineral fertilizer application rates on the germination, tiller formation, and winter hardiness of winter wheat. The study was carried out in accordance with the methodological guidelines outlined in "Methods of Conducting Field Experiments" [4].

In the research, the effects of mineral fertilizer rates of $N_{100}P_{75}K_{50}$ kg/ha and $N_{150}P_{105}K_{75}$ kg/ha on the germination, tiller number, and winter hardiness of winter wheat were studied under conditions where 6 t/ha of rice straw was applied alone, as well as in combination with 10 and 20 t/ha of manure. As controls, both an unfertilized treatment and the production-level recommended rate for winter wheat ($N_{200}P_{140}K_{100}$ kg/ha) were included. The studied variants were compared against the control treatments.

## 3 Research Results

Light-colored, more precisely light gray meadow soils in our conditions are formed under the influence of mineralized groundwater in the desert zone and are characterized by varying degrees of salinity and cultivation. Their parent materials consist of weakly stratified alluvial and proluvial deposits.

As noted by a number of researchers, the soils of the region affected by natural and anthropogenic factors—including meadow–saz soils—contain relatively low amounts of humus; in other words, the humus content is indeed quite limited [5].

When the research results obtained under meadow–saz soil conditions were analyzed using the 2021–2022 season data, it was found that the number of emerged seedlings in the control (unfertilized) treatment amounted to 372.6 plants/m², while in Variant 2, where the recommended mineral fertilizer rate was applied, this indicator was 276.0–372.6 plants/m². In the treatments where rice straw was applied separately as green manure and in combination with manure, these indicators increased slightly.

This can be explained by the fact that the applied rice straw and manure improved moisture retention, enhanced the availability of phosphorus and potassium fertilizers, and activated microbial activity, thereby contributing to better seed germination.

A decrease in the number of winter wheat tillers after overwintering varied across the treatments. The highest proportion of winter mortality was observed in the control (unfertilized) treatment, amounting to 18.7%, with a remaining tiller density of 302.9 plants/m². In Variant 2, where a high mineral fertilizer rate of $N_{200}P_{140}K_{100}$ kg/ha was applied, winter mortality decreased to 10.3%, with a tiller density of 337.3 plants/m². Compared to the unfertilized control, 8.4% fewer seedlings perished.

The best results among the treatments involving rice straw and organic fertilizer (manure) were recorded in Variants 7 and 8, where 6 t/ha of rice straw was applied together with 20 t/ha of manure. In these treatments, plant mortality amounted to 6.7% and 6.3%, respectively, and the post-winter tiller density was 368.2 and 366.6 plants/m². The data are presented in Table 1.

**Table 1.** Emergence, Post-Winter Tiller Number, and Final Tiller Number of Winter Wheat, 2021–2022 Seasons

| № | Experimental Treatments | Mineral Fertilizer Rates, kg/ha | Number of Emerged Seedlings, plants/m² | Post-Winter Tiller Number, plants/m² | Final Tiller Number at the End of the Season, plants/m² | Winter Mortality, % |
|---|---|---|---|---|---|---|
| 1 | Control | unfertilized | 372,6 | 302,9 | 273,5 | 18,7 |
| 2 | Control | $N_{200}P_{140}K_{100}$ | 376,0 | 337,3 | 315,0 | 10,3 |
| 3 | 6 t of rice straw | $N_{100}P_{75}K_{50}$ | 381,3 | 337,1 | 313,5 | 11,6 |
| 4 | | $N_{150}P_{105}K_{75}$ | 374,7 | 333,5 | 325,8 | 11,0 |
| 5 | 10 t of manure + 6 t of rice straw | $N_{100}P_{75}K_{50}$ | 383,2 | 349,9 | 329,9 | 8,7 |
| 6 | | $N_{150}P_{105}K_{75}$ | 380,1 | 351,6 | 333,0 | 7,5 |
| 7 | 20 t of manure + 6 t of rice straw | $N_{100}P_{75}K_{50}$ | 394,6 | 368,2 | 349,4 | 6,7 |
| 8 | | $N_{150}P_{105}K_{75}$ | 391,3 | 366,6 | 347,9 | 6,3 |

A similar pattern was observed across the plant development stages. In Variants 7 and 8, where 6 t/ha of rice straw was applied together with 20 t/ha of manure, plant height reached 76.3 and 77.5 cm during stem elongation, 83.0 and 84.6 cm during heading, and 82.6 and 94.7 cm at full maturity. Compared to the unfertilized control, these values were higher by 28.4 and 29.6 cm during stem elongation, 23.8 and 25.4 cm during heading, and 23.9 and 26.0 cm at full maturity.

In Variant 2, where a high rate of mineral fertilizers ($N_{200}P_{140}K_{100}$ kg/ha) was applied, plant height reached 74.8, 82.5, and 93.7 cm, respectively, which is close to the values recorded in Variants 7 and 8, where 20 t/ha of manure was applied together with 6 t/ha of rice straw. Thus, the application of 20 t/ha of manure in combination with rice straw not only improves soil properties but also enhances the efficiency of mineral fertilizers. As a result, better seedling emergence and higher tiller numbers are achieved, contributing to reduced seedling mortality during winter.

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**Mukhammadkarim Zoirjon ugli Mamadaliyev** Doctor of Philosophy (PhD) in Agricultural Sciences, Senior Lecturer

Mukhammadkarim Zoirjon ugli Mamadaliyev is currently working as a Senior Lecturer at the Department of Effective Use of Household Plots and Medicinal Plants, Agrarian Joint Faculty, Fergana State University, where he carries out scientific and pedagogical activities.

Mukhammadkarim Zoirjon ugli Mamadaliyev was born on 9 October 1994 in an educated family in Fergana region. He completed his bachelor's degree in Plant Protection at the Andijan branch of Tashkent State Agrarian University in 2018 and earned his master's degree in 2020.

He has been engaged in scientific and pedagogical activity in higher education for 5 years.

He is the author of more than 50 scientific publications, including 1 textbook, 3 educational manuals, 2 methodological guides, 1 monograph, and 34 scientific articles (published in journals listed by the Higher Attestation Commission as well as in international journals), along with numerous conference theses.

Mukhammadkarim Zoirjon ugli Mamadaliyev has served as a senior researcher in one fundamental project and has also worked as the head of one applied project within the framework of state scientific–technical programs.