

The Effect of Organomineral Fertilization on Yield and Yield Components in Rice (*Oryza sativa* L.)*

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Abstract

Objective: This study aimed to determine the effects of different doses of sheep wool fertilizer on rice yield and yield components.

Materials and Methods: This research was conducted in 2022 in an unheated semi-polycarbonate-plastic research greenhouse belonging to the Faculty of Agriculture, Ordu University. The experiment was set up in a randomized block design with 4 replications. The Kocamaninci rice variety was used as the material in the study. Sheep wool fertilizer doses were applied at 0, 50, 100, 150, 200, 250, 300, 350, and 400 kg/da.

Research and Findings: In the study, the number of panicles per pot was 15.00-24.75, the number of grains per panicle was 35.36-90.83, the grain weight per panicle was 0.75-1.90 g, the thousand-grain weight was 29.39-31.46 g, yield per pot was 10.67-34.41 g/pot, yield per plant was 0.60-2.14 g/plant, rice yield was 64.78%-71.15%, and broken-free yield was 53.86%-60.78%.

Conclusion: The study observed that the application of sheep wool fertilizer caused statistically significant differences in the parameters examined. Accordingly, it was observed that the best results in terms of yield and yield components were obtained from the application of 400 kg/da of sheep wool fertilizer.

Keywords: Rice, Sheep Wool Fertilizer, Organomineral Fertilization, Yield, Yield Components

Çeltikte (*Oryza sativa* L.) Organomineral Gübrelemenin Verim ve Verim Ögelerine Etkisi*

Öz

Amaç: Bu çalışma farklı dozlarda koyun yünü gübresinin çeltik bitkisinde verim ve verim ögeleri üzerine etkilerini belirlemeyi amaçlamıştır.

Materyal ve Yöntem: Bu araştırma, 2022 yılında Ordu Üniversitesi Ziraat Fakültesine ait ısıtmasız yarı polikarbon-plastik araştırma serasında yürütülmüştür. Deneme tesadüf parseller deneme desenine göre 4 tekerrürlü olarak kurulmuştur. Çalışmada materyal olarak Kocamaninci çeltik çeşidi kullanılmıştır. Koyun yünü gübresi dozları 0, 50, 100, 150, 200, 250, 300, 350, 400 kg/da olarak uygulanmıştır.

Araştırma Bulguları: Yapılan çalışmada saksı salkım sayısı 15.00-24.75 adet, salkımda tane sayısı 35.36-90.83 adet, salkım tane ağırlığı 0.75-1.90 g, bin tane ağırlığı 29.39-31.46 g, saksı başına verim 10.67-34.41 g/saksı, bitki başına verim 0.60-2.14 g/bitki, pirinç randımanı %64.78-%71.15 ve kırksız randıman %53.86-%60.78 arasında bulunmuştur.

Sonuç: Çalışmada koyun yünü gübresi uygulanmasının incelenen parametreler bakımından istatistiksel olarak çok önemli farklılıklara neden olduğu gözlemlenmiştir. Buna göre verim ve verim ögeleri bakımından en iyi sonucun 400 kg/da koyun yünü gübresi uygulamasından elde edildiği gözlemlenmiştir.

Anahtar kelimeler: Çeltik, Koyun Yünü Gübresi, Organomineral Gübreleme, Verim, Verim Ögeleri

Introduction

Cereals are among the leading food groups in meeting the world's food needs. One of the most important cereal crops, which more than half of the world's population uses as a food source, is rice, a warm-climate cereal. This makes rice an important foodstuff. In 2023, the world's rice cultivation area was approximately 168,356,566 ha, production was 799,999,504 tons, and average yield was 475 kg/da (FAO, 2025). According to 2024 data for our country, the planting area was 128,903 ha, production was 1,019,000 tons, and yield was 791 kg/da (TUIK, 2025). Since rice removes large amounts of dry matter from the field in the form of grains and stalks, it also requires significant amounts of plant nutrients. Proper fertilization is crucial for achieving good yields. In studies conducted on fertilization in our country, researchers generally prefer chemical fertilizers, and the limited research on organic fertilization has become important in terms of sustainable soil properties and soil fertility. Results from studies using organic fertilizers indicate that organomineral fertilization has positive effects on crop yield components, plant mineral nutrition, and soil properties. Therefore, increasing research on organomineral fertilizers and encouraging their use is considered to be quite beneficial for sustainable agriculture in terms of sustainable soil fertility and our country's agriculture (Erdal, 2018). Organic fertilizers include manure (cattle, horse, sheep, poultry manure), green manure, municipal waste fertilizers, and compost fertilizers, as well as wool. Wool contains keratin protein as well as nitrogen, carbon, and sulfur, which are important for plant nutrition. Studies have also observed positive effects on the productivity of many plant species (Tüfekci and Olfaz, 2015). Based on the analysis of the nutrient content in plants, it has been seen that sheep wool fertilizer pellets can successfully replace mineral fertilizers for some plant cultures (Böhme et al., 2010). The aim of this study is to investigate the effects of organomineral fertilization on yield and yield components in rice plants (*Oryza sativa* L.).

Materials and Methods

The research was conducted in an unheated semi-polycarbonate-plastic research greenhouse belonging to the Faculty of Agriculture at Ordu University. The material used in the study was the Kocamaninci rice variety developed by the Black Sea Agricultural Research Institute.

Sheep wool fertilizer is produced by removing harmful substances from wool obtained during shearing seasons, grinding it, and pelletizing it. This fertilizer contains 70% total organic matter (30% of which is total organic carbon and 42% is total humic and fulvic acid), 7% total nitrogen (N), and 5% water-soluble potassium oxide (K₂O). The pH value of sheep wool fertilizer is between 11 and 13. The soil sample used in the experiment had a sandy-loamy structure, neutral pH, no salt content, very little lime, and a low organic matter content. The experiment was conducted in 4 replicates according to a randomized block design. Thirty-six pots (9x4=36) with a volume of 12.5 L and containing 10 kg of sieved soil each were used in the experiment. The transplanting process was carried out on August 9, 2022 (Kün, 1985), with approximately 20 cm tall seedlings obtained from seedbeds, placing 16 rice plants in each pot. Basic fertilization was carried out at a rate of 15 kg N (CaNO₃), 10 kg P, and 10 kg K (KH₂PO₄) per decare. While all phosphorus and potassium fertilizers were applied at planting, nitrogen fertilizer was applied in two separate periods (half at planting and the other half at the end of the tillering stage). Nine different sheep wool fertilizer doses (0, 50, 100, 150, 200, 250, 300, 350, 400 kg/da) were used in the study. The sheep wool fertilizer doses were applied proportionally to pots containing 10 kg of soil. For 100 kg of sheep wool fertilizer per decare, 4 g of fertilizer was applied. (0:0, 50kg:2g, 100kg:4g, 150kg:6g, 200kg:8g, 250kg:10g, 300kg:12g, 350kg:14g, 400kg:16g). The sheep wool fertilizer was mixed into the soil prior to the transplanting process. Watering continued from the time of planting until one week before the harvest date. Weed control was done manually. Rice plants were harvested when the grains in the panicles reached full maturity, based on prior physiological maturity indicators. After the harvest, the crops (grains) obtained in the trial were weighed and then subjected to statistical analysis after being adjusted to 14% moisture content. The observation and evaluation of the characteristics were performed according to the technical instructions for rice plants published by the Seed Registration and Certification Center (TTSM) number of panicles per pot (number), number of grains per panicle (number), ear grain weight (g), thousand grain weight (g), yield per pot (g/pot), yield per plant (g/plant), rice yield (%), broken grain yield (%) such yield and yield elements were examined (Anonymous, 2003).

The data obtained from the study were evaluated using the JMP 13.0 statistical package program. The significant means obtained from the analysis were grouped according to the LSD multiple comparison test.

Results and Discussion

Pot Panicle Count

The average values and statistical groupings for the number of panicles per pot in the study are presented in Table 1.

Measurements showed that the number of panicles per pot ranged from 15.00 to 24.75. The highest number of panicles per pot was 24.75 on average at a dose of 400 kg/da, while the lowest number of panicles was 15.00 at a dose of 0 (control). It was observed that as the amount of fertilizer applied increased, the number of clusters per pot also increased linearly. Therefore, it can be said that there is a positive relationship between nitrogen and the

number of clusters. In addition, the number of plants per plant and the number of siblings forming clusters are among the most important characteristics directly affecting overall yield, and an increase up to a certain number has a negative effect due to excessive competition after a certain point. Yıldırım and Yılmaz (2023) found that the number of clusters ranged between 18.00 and 25.00 as a result of their application of worm castings at different doses. Although the study found no statistically significant effect of the application on the number of clusters, they observed a continuous decrease in the Aslı variety as the dose increased, while in the Osmancık-97 and Terme Baldo varieties, the number increased slightly before decreasing. Diedhiou et al. (2025) found the lowest number of panicles to be 9.60 from the control dose and the highest number of panicles to be 32.30 from the NPK+Urea application in their organic and mineral fertilization study on rice.

Table 1. Averages and Statistical Groups Regarding the Effect of Sheep Wool Fertilizer on Panicle Number, Grain Number per Panicle, Grain Weight per Panicle, Thousand Grain Weight, Yield per Pot, Yield per Plant, Rice Yield, and Unbroken Yield in Rice Plants

SWF (kg/da)	PCC (piece/pot) **	NGC (piece) **	GWC (g) **	TGW (g) **	YpPot (g/pot) **	YpPlant (g/plant) **	RY (%) **	URY (%) **
0	15.00 f*	35.36 h	0.75 h	30.31 b	10.67 g	0.60 h	64.78 d	55.32 cd
50	17.00 e	48.09 g	1.04 g	30.42 b	15.72 f	0.91 g	69.00 bc	56.36 bcd
100	18.63 d	54.13 f	1.14 f	29.39 c	16.10 f	1.03 f	71.15 a	57.1 bc
150	18.75 d	69.08 e	1.37 e	30.44 b	18.90 e	1.32 e	69.90 ab	57.33 bc
200	19.47 d	76.06 c	1.66 c	31.46 a	27.37 d	1.45 d	70.83 a	57.78 bc
250	20.75 c	75.67 c	1.67 c	30.43 b	32.71 bc	1.61 c	68.99 bc	60.78 a
300	21.33 bc	90.83 a	1.82 b	30.9 ab	32.22 c	1.82 b	69.23 bc	55.42 cd
350	22.25 b	73.04 d	1.53 d	30.72ab	33.60 ab	1.88 b	70.43 ab	53.86 d
400	24.75 a	79.34 b	1.90 a	30.73ab	34.41 a	2.14 a	68.03 c	58.83 ab
mean	19.77	66.84	1.43	30.53	24.63	1.42	69.15	56.98

*Differences between values with different letters in the same column are statistically significant. **: 1% significance SWF: Sheep Wool Fertilizer, PCC: Pot Panicle Count (piece/pot), NGC: Number of Grains per Panicle (piece), GWC: Grain Weight per Panicle (g), TGW: Thousand Grain Weight (g), YpPot:Yield per Pot (g/pot), YpPlant: Yield per Plant (g), RY: Rice Yield (%), URY: Unbroken Rice Yield (%)

Number of Grains per Panicle

The average values and statistical groupings for the number of grains per panicle of the rice plant are presented in Table 1.

Measurements showed that the lowest number of berries per cluster was 35.36 at the 0 (control) dose,

while the highest was 90.83 at the 300 kg/ha dose. The application resulted in a continuous increase in berries per cluster up to the 200 kg/ha dose. Although a decrease was observed at the 250 kg/da dose, followed by fluctuations, the highest number of berries per cluster was measured at the 300 kg/da dose. The number of berries formed in each cluster

provides direct information about the grain filling period and fertility capacity. The presence of excess berries in the cluster demonstrates the effect of the application.

Sezer et al. (2017) found that the number of grains per cluster ranged from 58.90 to 95.48 in their trial of different sowing methods; Şahin et al. (2012) observed that the number of grains per cluster ranged from 43.63 to 113.13 under Kızılırmak conditions; Yılmaz and Boz (2022) observed that it ranged from 53.77 to 66.37.

Grain Weight per Panicle (g)

The average values and statistical groupings for the grain weight of the rice plant in the study are given in Table 1.

As a result of the measurements, the lowest panicle grain weight was 0.75 grams at the 0 (control) dose, while the highest panicle grain weight was measured at 1.90 grams at the 400 kg/da dose. The average panicle grain weight was found to be 1.43 grams, and it was observed that doses of 200 kg/da and above were also above average. As a result of the application, it was observed that the panicle grain weight in rice plants increased with increasing nitrogen dose, except for the 350 kg/da dose. The parameter of total grain weight per panicle (), which is the total weight of all grains in a panicle, is directly related to the grain filling period and is an indirect indicator of both nutrient uptake and photosynthetic activity. A decrease in panicle grain weight may indicate an excess of empty or half-filled grains.

Temür (2016) reported in his master's thesis that the cluster grain weight in rice plants treated with silicon fertilizer ranged from 2.70 to 3.81 g, while Yılmaz and Boz (2022) reported a range of 1.62 g to 2.07 g. Bahuguna et al. (2023) obtained the lowest grain weight of 1.93 g from the control dose with different rates of NPK fertilization, while they found the highest grain weight of 2.26 g from the 150% RDF (180 kg N, 90 kg P, 60 kg K/ha) application (Kumar et al., 2024).

Thousand Grain Weight (g)

The average values and statistical groupings for thousand-grain weight are presented in Table 1.

As a result of the measurements, the lowest thousand-grain weight was measured as 29.39 grams at a dose of 100 kg/da, while the highest thousand-grain weight was obtained at a dose of 200 kg/da (31.46 g). The average thousand-grain weight was found to be 30.53 grams, and it was observed that the 200 kg/da,

300 kg/da, 350 kg/da, and 400 kg/da doses were above the average.

At the same time, since the doses above the average were statistically in the same classification, there was no statistical difference between them. This value provides information about grain size and quality, the appearance of rice for consumption, and is also related to the effectiveness of the applications as well as genetic potential.

Yılmaz and Boz (2022) reported a thousand-grain weight of 30.31-31.65 g in a study where they applied humic acid and different forms of nitrogen; Özcan and Taban (2018) reported that the lowest thousand-grain weight was 23.61 g in the KA080 variety and the highest thousand-grain weight was 28.25 g in the GA7721 variety as a result of applying different doses of zinc to different varieties.

Yield per Pot (g/pot)

The study presents the average values and statistical groupings for yield per pot in rice plants in Table 1.

As a result of the measurements, the yield per pot varied between 10.67 and 34.41 g/pot. The highest yield per pot was measured at a dose of 400 kg/da, while the lowest yield was obtained from the 0 (control) dose. A continuous increase was observed as a result of the applied doses, except for the 300 kg/da dose. In the application, doses of 200 kg/da and above were observed to be above the application average. Furthermore, although there was a difference in yield between the 350 kg/da and 400 kg/da doses, they were not statistically different as they were in the same grouping.

Yield per pot is a fundamental parameter in yield, and Budaklı et al. (2005) observed that grain yield increased in parallel with the nitrogen dose applied and reported a 1.5-fold increase at the highest dose applied compared to the control dose. In our study, it was also observed that the yield per pot increased as the fertilizer dose increased. In conclusion, it can be stated that there is a positive correlation between grain yield and the applied nitrogen dose.

Temür (2016), in his master's thesis, found pot yield to be 19.19-29.31 g/pot in an experiment where he applied silicon doses to 4 different rice varieties.

Yield per Plant (g/plant)

The average values and statistical groupings for yield per plant in the rice plant are given in Table 1.

In the measurements made, the yield per plant varied between 0.60 and 2.14 g/plant. The highest yield per

plant was measured as 2.14 g/plant at a dose of 400 kg/da, while the lowest yield per plant was measured at a dose of 0 (control) (0.60 g/plant).

As the amount of fertilizer applied increased, the yield per plant also increased. Therefore, it can be said that there is a positive relationship between the fertilizer dose and the yield per plant. This parameter is important in terms of reflecting the tillering potential at the single plant level and the yield potential of the applications.

Şavşatlı et al. (2006) investigated the effect of different planting methods on yield and yield components in some rice varieties, and found that the highest panicle yield per plant was 3.99 g for the Baldo variety using the transplanting method, while the lowest panicle yield per plant was 2.06 g for the Veneria variety using the broadcast seeding method.

Rice Yield (%)

The study presents the average values and statistical groupings for rice yield in rice plants in Table 1.

Measurements showed that rice yield ranged between 64.78% and 71.15%. The lowest rice yield was obtained from the 0 (control) dose, while the highest rice yield was obtained from the 100 kg/da dose. The average rice yield was found to be 69.15%, while the 100 kg/da, 150 kg/da, 200 kg/da, 300 kg/da, and 350 kg/da doses were observed to be above the average. Fluctuations in rice yield were observed as the applied dose increased (). This value indicates the rice ratio during rice processing and is of critical importance in economic evaluation.

Şavşatlı and Gülümser (2006) reported broken rice yields of 70.65-75.84% in rice varieties where they applied transplanting and broadcasting methods under Samsun conditions; Sürek et al. (2016) reported total rice yields of 70.6-74.1% under Thrace conditions; Kahraman et al. (2021) found broken rice yields of 74.27% and 67.87% for the Karacadağ and Osmancık-97 varieties, respectively, with conventional farming practices; with organic farming practices, they found yields of 71.43% and 73.73%, respectively.

Unbroken Rice Yield (%)

The average values and statistical groupings for the unbroken yield of rice plants in the study are given in Table 1.

Measurements showed that the unbroken yield ranged between 53.86% and 60.78%. The lowest unbroken yield was obtained at a dose of 350 kg/da,

while the highest unbroken yield was obtained at a dose of 250 kg/da. The average unbroken yield was found to be 56.98%, and it was observed that the 100 kg/da, 150 kg/da, 200 kg/da, 250 kg/da, and 400 kg/da doses were above average. This parameter plays a decisive role in terms of rice quality and market value. A high unbroken rice yield indicates a high-quality product.

Şavşatlı and Gülümser (2006) found the breakage-free yield in rice varieties to be between 52.81% and 64.39%. Yılmaz and Sonkaya (2018) calculated the unbroken yield as 51.20-60.81% in their study as a result of applying zinc doses to 4 different rice varieties. Akay et al. (2017) found the average unbroken yield in some rice varieties in the Bafra Plain to be 60.32%. The highest shatter-free yield was obtained from the Gala variety at 66.04%, while the lowest shatter-free yields were found in the Aromatik-1 and Çakmak varieties at 52.71% and 52.52%, respectively.

Conclusion

In rice plants, the effect of 9 different sheep wool fertilizer doses (0, 50, 100, 150, 200, 250, 300, 350, 400 kg/da) on yield and yield components; parameters such as panicle number, grains per panicle, grain weight per panicle, thousand-grain weight, yield per panicle, yield per plant, rice yield, and unbroken yield were examined. The results of the study showed that the effect of organomineral fertilization on all parameters examined was statistically significant ($p < 0.01$).

According to the data obtained at the end of the study, the highest values for most parameters, such as the number of panicles per pot, grain weight per panicle, yield per pot, and yield per plant, were obtained from the application of 400 kg/da sheep wool fertilizer. However, sheep wool fertilizer was found to cause an increase in the number of grains per cluster, thousand-grain weight, rice yield, and broken grain yield, but with fluctuating changes.

Although our study covers only one year of data, it is thought that sheep wool fertilizer could be an alternative fertilization method in terms of organic farming and sustainability in the future.

In order to obtain more reliable and useful results, it is thought that testing different doses of sheep wool fertilizer in different environments or ecological areas, establishing different versions of the experiment, and extending the duration of the

experiment could be more beneficial in terms of achieving healthier results.

Conflict of Interest

There is no conflict of interest among the authors.

Author Contrubiton Statement

The authors have equal contributions.

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