Effect of Urea Fertilizer Levels and Number of Seedlings per Hill on some Quality Characteristics of Rice Grain

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Abstract

A field experiment was conducted in the Mishkab Rice Research Station Najaf province during the summer a season 2022. The study aims to determine the effect of nitrogen fertilizer and number of seedlings per hill in characteristics of quality and milling characteristics of rice "cultivar Yasemin".

Randomized complete block design (RCBD) in split plot arrangement with three replications, the nitrogen levels (210 ,280 ,350, 420) kg urea. Ha-1 represented the main plots, while the number of seedling per hill (1,2,3,4 and 5) seedling. Hill represented the sub plots, and the results of statistical analysis showed significant differences between the means of treatments for studied factors and it's interaction, The results showed that increasing nitrogen fertilization significantly improved carbohydrate content, with the highest mean value recorded at the highest nitrogen level (1.301 ppm). Higher nitrogen supply also enhanced milling quality traits, as brown rice percentage increased to 75.83%, broken rice percentage decreased to its lowest value of 2.61%, and total extraction percentage reached 72.53%. Regarding seedling number per hill, grain quality traits improved with increasing seedling density up to four seedlings per hill, where carbohydrate content reached 1.342 ppm, brown rice percentage increased to 75.50%, broken rice percentage declined to 2.12%, and total extraction percentage increased to 72.69%. Increasing seedling number beyond four did not result in further significant improvement in the studied traits. It can be concluded that applying the highest nitrogen level combined with four seedlings per hill represents the optimum management practice for improving grain quality and milling performance of Jasmine rice.

Key words: seedling per hill, urea fertilizer, Quality Characteristics.

ISSN 2072-3857

Introduction

Rice is grown over much of the world and provides more calories directly to human beings than any other cereal. Rice production is concentrated in Asia (~90% of total world production), with China and India being the largest single national producers and consumers of rice. Because of its critical role in human nutrition, more rice must be produced annually to provide food for a growing population. World- wide rice yields increased more than threefold between 1960 and 2019.Much of this production is due to greater yield per hectare of land area rather than increasing land area used in rice production. The increase in yield has been facilitated by genetic improvement of rice varieties through breeding for changing production conditions and improved cropping practices. The development of hybrid rice has also allowed large increases in rice productivity to be achieved. The rice plant is har- vested as the rough rice grain, or paddy, which contains approximately 20% husk, 10% bran, and 70% milled rice. The unbroken kernel of rice is the main product of the rice paddy that is consumed by humans.(4).

The number of seedlings in the rice paddies is an important factor that can play a significant role in increasing rice yield due to its impact on branch formation, crop yield, and its components, effective interception, nutrient absorption, and carbon assimilation rate (9). Competition among plants in high plant density increases shading, lodging, and Brown yield at the expense of grain yield and quality (11).

Rice is a crop that requires large amounts of nutrients, especially nitrogen (11). While plants absorb mineral nutrients from the soil, soil nitrogen is often insufficient to meet the plant's needs. Therefore, farmers are forced to add nitrogen fertilizers to achieve yield and quality. However, excessive nitrogen addition can negatively affect plant productivity as the plant may not be able to absorb the excess nitrogen, leading to unnecessary expenses for farmers and nitrogen loss through denitrification, volatilization, leaching, and plant toxicity, contributing to environmental pollution (17) (18) (19).

(12) in a study on the effect of nitrogen and some micronutrients on rice grain quality indicated that nitrogen increase led to an increase in grain protein content. (2). also reported that increased nitrogen had a significant effect on increasing protein content in rice. (8) mentioned that the percentage of protein increased by 7.9% to 8.34% when nitrogen levels were increased from 80 $kg.ha^{-1}$ to 120 $kg.ha^{-1}$.

Rice protein is important because it contains essential amino acids (albumin, globulin, prolamin, glutelin) that make up the majority of amino acids in rice. Glutelin accounts for approximately 80%, while albumin accounts for 1-5%, globulin 4-15%, and prolamin 2-8%. However, the proportion of each protein component is influenced by agricultural practices and genetic composition (11). (7) found that protein content increased significantly with increasing nitrogen levels, with an increase of 8-10.2 $kg.ha^{-1}$ when nitrogen was increased from 0 to 150 $kg.ha^{-1}$.

latitude 31 degrees north and longitude 44 degrees east, at an altitude of 70 meters above sea level, Affiliated to the Department of Agricultural Research

Sea level and its affiliation with the Agricultural Research Department for the purpose of studying the effect of different levels of urea on some milling traits of rice grains (Jasmine variety) and their carbohydrate and protein contents, with the influence of the number of seedlings per hill.

Studying milling traits is important for determining grain quality, and the primary goal of the rice milling process is to obtain rice grains characterized by high quality and minimal losses to achieve a high milling rate (20).

Materials and Methods

A field experiment was conducted during the summer season of 2022 at the Mishkhab Rice Research Station in Al-Najaf Al-Ashraf Governorate, located at

46% nitrogen content is used, and it is applied in two doses: the first dose one month after planting and the second dose one month after the first dose. The planting densities (1, 2, 3, 4, or 5) plants per hill are employed. The secondary plots are occupied and denoted as (D1, D2, D3, and D4) respectively.

The experiment is conducted using a Split Plot design, and the treatments are distributed using a Randomized Complete Block Design (RCBD) with three replications. The main plots included different levels of urea fertilizer (210, 280, 350, and 420 kg.ha^{-1}), denoted as (N1, N2, N3, and N4) respectively. Urea fertilizer with

Table (1): Physical and Chemical Soil Characteristics

soil texture			K	P	N	EC	SO4-	PH
mud	Mud	Sand	(mg.kg-1)	(mg.kg-1)	(mg.kg-1)	(ds.ml-1)	(Meq/L)	7.92
38.3	39.5	22.2						
Greensand clay								

❖ The soil is analyzed in the laboratories of the Department of Agriculture, Al-Qassim Green University

planting in each secondary plot. The experiment included 60 experimental units, with each set of 20 units allocated to one section. Necessary ditches and channels are opened for water drainage.

The Jasmine variety rice seeds are obtained from the Rice Research Station in Al-Mashkab. Planting is carried out on June 16, 2022. The grains are soaked

The experimental field is divided into three replications, with each replicate further divided into four main plots based on nitrogen levels. The dimensions of each main plot are 3m x 4m, with an area of 12m^2. Each main plot is further divided into five secondary plots based on planting densities, with a total of six rows of mill. The weight of the brown rice (brown rice) obtained after removing the hulls (husk) is determined as a percentage using the following equation:

$$\text{Percentage of brown rice} = \frac{\text{Weight of brown rice (g)}}{\text{Weight of paddy (g)}} \text{ x } 100$$

Polishing Process:

The Brown rice obtained from the milling process is placed in a Japanese-made Satake grain testing mill for one and a half minutes to remove

the Broken rice:

Broken rice is obtained by passing the Weight rice resulting from the milling process through sieves of various sizes to separate whole grains from the broken grains (three-quarters of a grain or less). The percentage of broken rice is calculated as follows:

$$Percentage\ of\ broken\ rice = \frac{wight\ of\ broken\ rice}{wight\ of\ brown\ rice} \times 100$$

Bran rice:

The percentage of bran rice resulting from the milling process is calculated as follows:

$$Perecentage\ of\ bran\ rice = \frac{wight\ of\ milling\ (g)}{wight\ of\ brown\ rice\ (g)} \times 100$$

Total milling :

The percentage of total milling yield is calculated as follows:

in flowing water after being placed in hemp bags and agitated periodically to ensure the renewal of water and oxygen for 48 hours. Afterward, the bags are lifted, and the soaked grains are spread on a thin mat for 24 hours. They are stirred several times until the roots and shoots appeared.

The germinated grains are then planted in small dishes containing suitable soil after moistening it appropriately. Subsequently, the germinated grains are sprinkled with a light layer of soil, and the dishes are stacked on top of each other and placed in a shaded area. They are covered with well-soaked hemp bags for 4-5 days. Afterward, the dishes are transferred to a small nursery in the field.

The seedlings are transplanted on July 9, 2022, and are planted manually in rows with a spacing of 30 cm between rows and 15 cm between hills.

The first fertilization is applied on August 7, 2022, and the second fertilization is applied on September 7, 2022.

The studied traits:

Qualitative tests are conducted on the rice grains obtained from the experiment at the Al-Hilla Rice Silo Laboratory and the government-run Rice Mill of the General Company for Grain Trade, Ministry of Trade.

Milling Process:

One hundred grams of grains (paddy) from each treatment are milled using a Japanese-made Satake hull grain testing

1) indicate improved grain filling and starch accumulation within the endosperm. In terms of seedling number per hill, carbohydrate content increased progressively from one to four seedlings, after which no significant increase was observed between four and five seedlings. This response suggests that four seedlings per hill provided an optimal balance between plant density and resource utilization, allowing efficient light interception and nutrient uptake without inducing excessive intra-hill competition. The interaction effect further confirmed this pattern, as the combination of the highest nitrogen level with four or five seedlings per hill produced the maximum carbohydrate content, with no significant difference between the two treatments. These findings indicate that increasing hill density beyond four seedlings does not enhance carbohydrate accumulation, emphasizing the importance of optimizing both nitrogen supply and plant density to improve grain quality in Jasmine rice. This finding is consistent with the results of (1), (13), (15).

Percentage of total milling= $\frac{\text{Weight of Weight rice (g)}}{wight\ of\ whitened\ rice\ for\ manufacturing} \times 100$

Statistical analysis is performed using analysis of variance for each trait, and statistical differences are tested using the least significant difference (LSD) at a 5% significance level to find statistical differences between the means of the treatments (16).

Results and Discussion

Carbohydrate Percentage:

The results presented in Table 2 demonstrate a clear and consistent increase in carbohydrate content of Jasmine rice grains with increasing nitrogen fertilization levels. This trend reflects the fundamental role of nitrogen in enhancing chlorophyll formation, leaf area development, and photosynthetic efficiency, which collectively promote greater synthesis and translocation of assimilates toward the developing grains. The highest carbohydrate values recorded at the N4 level (420 kg urea ha-

Table 2 illustrates the impact of urea levels, seedling numbers per hill, and their interaction on carbohydrate percentage (ppm) in Yasmin rice crop.

Mean	The number of seedlings per hill					Nitrogen levels
	D5	D4	D3	D2	D1	
1.034	1.122	1.118	1.012	0.811	0.692	N1
1.127	1.055	1.042	0.947	0.866	0.767	N2
1.246	1.389	1.378	1.255	1.196	1.117	N3
1.301	1.473	1.463	1.342	1.273	1.119	N4
	1.355	1.342	1.197	1.154	1.101	mean
0.330						LSD 0.05 D
0.543						LSD 0.05 N
0.746						LSD 0.05 D X N

increase is in agreement with the findings of (3), (21)

The results also indicate significant differences based on seedling density, with an increase in the number of seedlings per hill leading to an increase in the percentage of Brown rice, up to 4 seedlings per hill, reaching 75.50%. Further increases in seedling density did not have a significant effect, possibly due to intense competition among plants, suggesting that increased vegetative growth led to enhanced photosynthetic rates, resulting in a higher percentage of Brown rice. Further more, the results reveal a significant interaction between the study factors. (21).

The combinations N4 x D4 yielded the highest percentage of Brown rice at 76%, while the combination N1 x D1 produced the lowest percentage at 70.66%.

Percentage of Brown Rice:

The results presented in Table 3 show significant differences among urea fertilizer levels in the percentage of Brown rice. The highest percentage, 75.83%, is obtained when 420 kg urea ha-1 is applied, while the lowest percentage, 72.66%, is observed at the fertilizer level of 210 kg urea ha-1. The increase in the percentage of Brown rice can be attributed to the fact that the high fertilizer level contributed to the accumulation of materials involved in the photosynthetic process and their export from the source (leaf) to the sink (grains), Higher nitrogen availability enhanced grain development and endosperm formation, resulting in a greater proportion of intact kernels following the dehusking process. This

Table 3 illustrates the impact of urea levels, seedling numbers per hill, and their interaction on the percentage of Brown rice (%) in Yasmin rice crop.

mean	The number of seedlings per hill					Nitrogen levels
	D5	D4	D3	D2	D1	
72.66	73.10	73.33	72.66	71.66	70.66	N1
73.20	74.33	74.00	73.33	72.33	71.00	N2
74.00	75.20	75.66	74.50	73.00	72.33	N3
75.83	76.00	76.00	75.33	74.33	73.00	N4
	75.167	75.500	74.66	73.23	71.83	mean
0.592						LSD 0.05 D
0.941						LSD 0.05 N
1.323						LSD 0.05 DXN

Percentage of Broken Rice:

The results indicate significant differences among urea fertilizer levels in the percentage of broken rice. The level of 420 kg urea ha-1 resulted in the lowest percentage, reaching 2.61%, while the level of 210 kg urea ha-1 produced the highest percentage, reaching 3.89%. This can be attributed to the abundance of nitrogen, which led to the formation of homogeneous, translucent grains free of gaps between starch granules, making the grains more resistant to friction inside the milling chamber and thus reducing the percentage of broken rice, indicating a direct improvement in grain strength and resistance to mechanical stress during milling. Higher nitrogen levels enhanced carbohydrate accumulation and endosperm density, which contributed to stronger and more cohesive grain structure, thereby reducing susceptibility to breakage. These findings are consistent with those of (3), (21).

The results also show significant differences based on seedling density, with a density of 4 seedlings per hill resulting in the lowest percentage of broken rice, at 2.12%, while a density of 1 seedling per hill yielded the highest percentage, at 3.54%. Increasing densities beyond 4 seedlings per hill did not lead to significant differences. This is likely due to the efficient carbohydrate metabolism in rice grains and the high percentage of Brown rice (Table 3), which resulted in the formation of grains resistant to breakage These findings are consistent with (21).

Furthermore, the interaction results show that the combination N4xD4 had the lowest percentage of broken rice at 2.38%, while the combination N1xD1 had the highest percentage at 3.89%.

Table 4 illustrates the impact of urea levels, seedling numbers per hill, and their interaction on the percentage of broken rice (%) in Yasmin rice crop.

Mean	The number of seedlings per hill					Nitrogen levels
	D5	D4	D3	D2	D1	
3.73	3.27	3.46	3.53	3.84	3.89	N1
3.26	2.98	3.12	3.32	3.54	3.60	N2
3.77	2.77	2.81	2.89	2.97	3.12	N3
2.61	2.24	2.38	2.72	2.91	2.97	N4
	2.20	2.12	3.31	3.84	3.54	mean
0.385						LSD 0.05 D
0.643						LSD 0.05 N
0.877						LSD 0.05 D x N

The results also show significant differences based on seedling density,

with a density of 4 seedlings per hill resulting in the highest percentage of bran rice, reaching 6.95%, while a density of 1 seedling per hill yielded the lowest percentage, at 4.46%. Increasing densities beyond 4 seedlings per hill did not lead to significant differences. This can be attributed to the increased seedling density and its impact on increased protein representation, as the bran layers contain a portion of oil and protein, as noted by (5). This led to an increase in the percentage of bran rice with higher seedling densities. These findings align with the results of (21).

Furthermore, the interaction results indicate that the combination N4 x D4 had the highest percentage of bran rice at 6.95%, while the combination N1x D1 had the lowest percentage at 4.46%.

Percentage of Bran Rice:

The results from Table 5 indicate significant differences among nitrogen fertilizer levels in the percentage of bran rice. The percentage of bran rice increased with higher levels of urea fertilizer. The level of 420 kg urea ha-1 produced the highest percentage, reaching 6.58%, while the level of 210 kg urea ha-1 resulted in the lowest percentage, at 5.35%. reflecting enhanced grain development and increased thickness of the outer grain layers. This can be attributed to the role of nitrogen in the products of photosynthesis, enhancing the efficiency of the sink in representing the products of photosynthetic growth. Consequently, it leads to an increase in dry matter accumulation, positively impacting the bran layer. These findings align with the results of (5), (21).

Table 5 illustrates the impact of urea levels, seedling numbers per hill, and their interaction on the percentage of bran rice (%) in Yasmin rice crop.

mean	The number of seedlings per hill					Nitrogen levels
	D5	D4	D3	D2	D1	
5.35	5.88	5.85	5.49	4.79	4.46	N1
5.71	5.91	5.94	5.53	5.33	4.63	N2
6.39	6.54	6.29	5.72	5.53	5.93	N3
6.58	7.01	6.95	6.82	6.74	6.21	N4
	6.47	6.34	6.16	6.00	5.56	mean
0.560						LSD 0.05 D
0.737						LSD 0.05 N
1.171						LSD 0.05 D x N

Total Milling Percentage:

The results from Table 6 indicate significant differences amon g urea fertilizer levels in the total milling percentage. Increasing urea fertilizer levels contributed to an increase in the total milling percentage. The level of 420 kg urea ha-1 resulted in the highest percentage, reaching 72.53%, while the level of 210 kg urea ha-1 produced the lowest percentage, at 71.08%. The increase in the total milling percentage at the 420 kg urea ha-1 level can be attributed to the positive effect of this level on the efficiency of transferring the products of photosynthesis from the source to the sink and reducing the percentage of broken rice (Table 4), among other factors that contributed to producing and processing high-quality grains. These findings align with the results of (6), (11).

The results also indicate significant differences based on seedling density, with a density of 4 seedlings per hill resulting in the highest percentage, reaching 72.69%. The density of 5 seedlings per hill did not significantly differ from the 4-seedling density. However, a density of 1 seedling per hill yielded the lowest percentage, at 70.88%. This improvement in grain properties through increasing the percentage of Brown rice (Table 3), the percentage of broken rice (Table 4), and the percentage of bran rice (Table 5) contributed to enhancing the total milling percentage of the grains.

Furthermore, the interaction results show that the combination N4xD4 had the highest total milling percentage at 73.19%, while the combination N1xD1 had the lowest percentage at 69.21%.

In conclusion, the study suggests that increasing urea fertilizer levels had significant positive effects, leading to improvements in most of the studied traits. Regarding seedling density, increases beyond 3 seedlings per hill are not economically beneficial, with the best results achieved at a density of 3 seedlings per hill.bran layers and obtain polished rice.

Table 6 illustrates the impact of urea levels, the number of seedlings per hill, and their interaction on the total extraction percentage (%) of Jasmine rice crop.

mean	The number of seedlings per hill					Nitrogen levels
	D5	D4	D3	D2	D1	
71.08	72.23	71.33	70.55	70.08	69.21	N1
71.53	72.35	72.56	71.41	71.20	70.34	N2
71.95	73.08	72.98	71.87	71.58	70.95	N3
72.53	73.28	73.19	72.30	72.00	71.11	N4
	72.79	72.69	71.53	71.29	70.88	mean
0.734						LSD 0.05 D
0.934						LSD 0.05 N
1.520						LSD 0.05 D x N

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ISSN 2072-3857