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EFFECTS OF MINERAL NITROGEN LEVELS AND FOLIAR NUTRITION ON
GRAIN FILLING AND KERNEL WEIGHT OF “ISKANDAR” RICE

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Abstract. *This study evaluated grain filling, spikelet sterility, and 1000-grain weight of “Iskandar” rice under three mineral nitrogen levels and foliar nutrition treatments in the Andijan region of Uzbekistan during 2023-2025. The experiment comprised 21 variants arranged within N50, N100, and N150 kg ha⁻¹ backgrounds with a constant P120K100 kg ha⁻¹ supply. Fitovak, urea, YieldOn, and their combinations were applied at tillering and stem elongation. At N100P120K100, the three-year mean proportion of filled grains increased from 83.33% in the control to 89.97% under Fitovak + urea + YieldOn, while unfilled grains declined from 16.67% to 10.03%. The corresponding 1000-grain weight rose from 39.03 to 43.03 g. The biological maximum was obtained at N150 with the three-component treatment, which produced 90.47% filled grains and a 1000-grain weight of 44.03 g. Nevertheless, the N100 combination achieved nearly the same filling level with 50 kg ha⁻¹ less nitrogen. Because replication-level variance was unavailable, the results are interpreted descriptively and require confirmatory statistical testing.*

Keywords: *rice, grain filling, spikelet sterility, 1000-grain weight, nitrogen rate, foliar nutrition, biostimulant, Andijan.*

INTRODUCTION

Rice yield is determined not only by the number of reproductive sites but also by the capacity of the crop to fill them. A high sink size does not guarantee productive yield when assimilate supply during grain development is insufficient. Filled-grain percentage, spikelet sterility, and 1000-grain weight therefore provide a more direct assessment of reproductive efficiency than panicle size alone [1, 2].

Nitrogen supports canopy development and photosynthetic capacity, but excessive or poorly timed nitrogen may delay maturity, increase competition among spikelets, and reduce the transfer of non-structural carbohydrates to developing kernels [3, 4, 6, 7]. Potassium contributes to assimilate transport and water relations, while foliar nutrition may temporarily supplement plant demand during critical reproductive transitions. The agronomic objective is thus to synchronize source activity with sink filling rather than simply maximize vegetative growth.

The objective of this study was to quantify the response of grain filling and 1000-grain weight of “Iskandar” rice to three mineral nitrogen levels and foliar applications of Fitovak, urea, YieldOn, and their combinations over three growing seasons.

Literature review. Yoshida [1] and De Datta [2] described grain filling as an integrated outcome of genotype, canopy photosynthesis, assimilate remobilization,



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temperature, water status, and nutrient supply. Zheng et al. [7] showed that nitrogen supplied around panicle development can alter non-structural carbohydrate dynamics and kernel filling. However, nitrogen applied in excess of crop demand may prolong vegetative activity without proportionate gains in grain weight.

Integrated nutrient management studies indicate that the efficiency of applied nitrogen depends on timing, plant density, canopy development, and the balance between indigenous and fertilizer-derived nutrients [5, 8, 9, 11, 12]. Foliar treatments can complement soil fertilization by delivering small nutrient or physiologically active doses at periods of high demand. Mahmoodi et al. [10] reported that foliar fertilization at late tillering and panicle initiation improved physiological and agronomic traits of rice. These findings support evaluation of combined treatments, while also requiring caution because proprietary biostimulants may act differently across environments.

Materials and Methods. Field experiments were conducted from 2023 to 2025 on light sierozem soil in the Andijan region. The 0-30 cm layer contained 1.23% humus, 0.092% total nitrogen, 24.6 mg kg⁻¹ available P₂O₅, and 218 mg kg⁻¹ exchangeable K₂O. The rice cultivar “Iskandar” was grown under three nitrogen rates (50, 100, and 150 kg ha⁻¹) with a constant P120K100 kg ha⁻¹ background.

Each nitrogen background included seven foliar variants: water-treated control, Fitovak, urea, YieldOn, Fitovak + urea, Fitovak + YieldOn, and Fitovak + urea + YieldOn. Applications were made at tillering and stem elongation. Grain-filling assessment included the percentages of filled and unfilled grains, while kernel development was characterized by 1000-grain weight. The present paper deliberately excludes productive stem density, panicle length, and total grains per panicle because those variables were analyzed in an earlier publication.

Three-year arithmetic means were calculated from annual values. Changes relative to control were expressed as percentage-point differences for filled and unfilled grains and as percentages for 1000-grain weight. No least significant difference, p-value, standard error, or confidence interval was calculated because replication-level observations were not available in the source tables.

Results and Discussion. At N50P120K100, the three-year mean proportion of filled grains was 82.13% in the control and 89.20% under Fitovak + urea + YieldOn. This 7.07-percentage-point improvement was accompanied by a decline in unfilled grains from 17.87% to 10.80%. The 1000-grain weight increased from 38.53 to 42.03 g, or by 9.1%. Two-component combinations also performed well, with Fitovak + YieldOn producing 88.90% filled grains and a mean kernel weight of 41.53 g.



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Table 1.

Three-year mean grain-filling indicators of “Iskandar” rice, 2023-2025

No.	Treatment	Filled grains, %	Unfilled grains, %	1000-grain weight, g	Weight increase, %
1	N50P120K100, control	82.13	17.87	38.53	-
2	N50 + Fitovak	83.87	16.13	39.43	2.3
3	N50 + urea	84.37	15.63	40.03	3.9
4	N50 + YieldOn	84.83	15.17	40.33	4.7
5	N50 + Fitovak + urea	88.57	11.43	41.03	6.5
6	N50 + Fitovak + YieldOn	88.90	11.10	41.53	7.8
7	N50 + Fitovak + urea + YieldOn	89.20	10.80	42.03	9.1
8	N100P120K100, control	83.33	16.67	39.03	-
9	N100 + Fitovak	85.27	14.73	40.23	3.1
10	N100 + urea	85.70	14.30	40.83	4.6
11	N100 + YieldOn	86.10	13.90	41.23	5.6
12	N100 + Fitovak + urea	89.47	10.53	42.03	7.7
13	N100 + Fitovak + YieldOn	89.73	10.27	42.53	9.0
14	N100 + Fitovak + urea + YieldOn	89.97	10.03	43.03	10.2
15	N150P120K100, control	83.87	16.13	39.33	-
16	N150 + Fitovak	85.70	14.30	40.53	3.1
17	N150 + urea	86.10	13.90	41.03	4.3
18	N150 + YieldOn	86.47	13.53	41.63	5.8
19	N150 + Fitovak + urea	89.97	10.03	42.83	8.9
20	N150 + Fitovak + YieldOn	90.23	9.77	43.43	10.4
21	N150 + Fitovak + urea + YieldOn	90.47	9.53	44.03	11.9

Table 2.

Response of grain filling to the three-component foliar treatment

N level	Filled grains, %	Change, percentage points	1000-grain weight, g	Weight change, %
N50	82.13 → 89.20	+7.07	38.53 → 42.03	+9.1
N100	83.33 → 89.97	+6.63	39.03 → 43.03	+10.2
N150	83.87 → 90.47	+6.60	39.33 → 44.03	+11.9



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The N100 background provided a favorable balance between filling efficiency and nitrogen input. The control averaged 83.33% filled grains and 39.03 g per 1000 grains, whereas the three-component treatment reached 89.97% and 43.03 g. The gain in filled-grain proportion was 6.63 percentage points and the gain in kernel weight was 10.3%. YieldOn alone produced a slightly higher filled-grain proportion and kernel weight than urea alone, while urea tended to support stronger vegetative responses in the broader experiment. This contrast is consistent with different functional emphases of rapidly available nitrogen and a biostimulant, although the mechanism was not directly measured.

The highest biological values occurred at N150. The three-component variant averaged 90.47% filled grains, 9.53% unfilled grains, and 44.03 g per 1000 grains. Relative to the N150 control, filled grains increased by 6.60 percentage points and kernel weight by 11.9%. Nevertheless, its filled-grain advantage over the N100 three-component treatment was only 0.50 percentage points and its 1000-grain weight advantage was 1.00 g, despite an additional 50 kg ha⁻¹ of mineral nitrogen.

Across years, treatment ranking remained consistent: 2024 values were generally lower and 2025 values higher than those of 2023, but combined foliar treatments maintained their advantage within each nitrogen background. Such consistency supports biological relevance, yet it cannot replace formal inference from replicated plot data. The current results should therefore be treated as a robust descriptive pattern requiring confirmation with variance estimates.

The reduction in unfilled grains together with increased 1000-grain weight suggests that the treatments improved both the proportion and degree of kernel filling. This coordinated response is agronomically important because increasing sink size without sufficient assimilate supply can raise sterility. The N100 three-component treatment appears particularly efficient because it approached the N150 biological maximum with a lower mineral nitrogen input.

CONCLUSIONS:

Mineral nitrogen and foliar nutrition consistently altered the grain-filling profile of “Iskandar” rice over 2023-2025, with combined treatments outperforming the corresponding controls.

At N100P120K100, Fitovak + urea + YieldOn increased the mean proportion of filled grains from 83.33% to 89.97% and reduced unfilled grains from 16.67% to 10.03%.

The same N100 treatment increased 1000-grain weight from 39.03 to 43.03 g, representing a 10.3% improvement over the control.

The biological maximum was recorded at N150 with the three-component treatment: 90.47% filled grains and a 1000-grain weight of 44.03 g.

Because the N100 three-component treatment approached the N150 maximum with 50 kg ha⁻¹ less nitrogen, it is recommended for replicated field validation as a resource-efficient strategy; statistical and economic confirmation remains necessary.

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REFERENCES:

1. Yoshida S. Fundamentals of Rice Crop Science. Los Baños: International Rice Research Institute, 1981. 269 p.
2. De Datta S.K. Principles and Practices of Rice Production. New York: John Wiley & Sons, 1981. 618 p.
3. Dobermann A., Fairhurst T. Rice: Nutrient Disorders and Nutrient Management. Singapore and Los Baños: PPI, PPIC and IRRI, 2000. 191 p.
4. Fageria N.K. The Use of Nutrients in Crop Plants. Boca Raton: CRC Press, 2009. 448 p.
5. Cassman K.G., Gines G.C., Dizon M.A., Samson M.I., Alcantara J.M. Nitrogen-use efficiency in tropical lowland rice systems: contributions from indigenous and applied nitrogen. *Field Crops Research*, 1996, 47: 1-12.
6. Peng X.L., Liu Y.Y., Luo S.G., Fan L.C., Song T.X., Guo Y.W. Effects of site-specific nitrogen management on yield and dry matter accumulation of rice from cold areas of Northeastern China. *Agricultural Sciences in China*, 2007, 6: 715-723.
7. Zheng Y.M., Ding Y.F., Liu Z.H., Wang S.H. Effects of panicle nitrogen fertilization on non-structural carbohydrate and grain filling in indica rice. *Agricultural Sciences in China*, 2010, 9: 1630-1640.
8. Tian G., Gao L., Kong Y., Hu X., Xie K., Zhang R. et al. Improving rice population productivity by reducing nitrogen rate and increasing plant density. *PLoS ONE*, 2017, 12(8): e0182310.
9. Hou W., Khan M.R., Zhang J., Lu J., Ren T., Cong R. et al. Nitrogen rate and plant density interaction enhances radiation interception, yield and nitrogen use efficiency of mechanically transplanted rice. *Agriculture, Ecosystems and Environment*, 2019, 269: 183-192.
10. Mahmoodi B., Moballeghi M., Eftekhari A., Neshai-Mogadam M. Effects of foliar application of liquid fertilizer on agronomical and physiological traits of rice. *Acta Agrobotanica*, 2020, 73(3): 7332.
11. Su Z.F., Du Y.L., Zhou P.N., Sun C.M., Zhang Y.J., Ji C.M., Xu L.X. Effects of nitrogen fertilizer rate and planting density on leaf area and photosynthetic productivity of high-yield rice population. *Chinese Journal of Rice Science*, 2013: 38-41.
12. Wang S.L., Lin W.X., Liang Y.Y., Yu G.J. Effects of nitrogen fertilizer and plant density on culm quality, yield structure and nitrogen use in rice. *Chinese Journal of Rice Science*, 2009: 135-141.

