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Investigating the Effect of Different Amounts and Sources of Nitrogen on Quantitative and Qualitative Characteristics of Rice

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ABSTRACT

The present study was conducted in the agricultural year of 2022-2023 in the climatic conditions of Khorramabad city. The experiment was conducted as a basic design of randomized complete blocks with 3 replications. The treatments include N1: nano-nitrogen fertilizer, according to the soil test result and fertilizer recommendation, N2: nano-nitrogen fertilizer, according to the twice fertilizer recommendation, N3: nano-nitrogen fertilizer, half the fertilizer recommendation, N4: fertilizer Normal nitrogen chemical fertilizer with a concentration (90 Kg ha^{-1}) and according to Cody's recommendation, N5: Normal nitrogen chemical fertilizer with a concentration (180 Kg ha^{-1}) double the recommended N6 fertilizer: Normal nitrogen chemical fertilizer with a concentration (45 Kg ha^{-1}) half of the recommendation Fertilizer, N7: combination of nitrogen fertilizer (half of nano nitrogen + half of normal nitrogen chemical fertilizer), control: no fertilizer. The results showed that the highest seed yield in N3, was 5767 Kg ha^{-1}, and the lowest yield was 3383 Kg ha^{-1} in the control. The highest biological yield was obtained in N5 amount of 18632 Kg ha^{-1} and the lowest amount was obtained in the control of 10957 Kg ha^{-1}. On the other hand, the increase in nitrogen fertilizer plays an important role in the growth of rice. Increasing the supply of nitrogen through fertilizer has improved the process of photosynthesis, and the absorption of nutrients, and as a result, increased the quantity and quality of yield. In general, the combination or use of nitrogen fertilizers and nitrogen nano-fertilizers in rice cultivation has led to improved growth, increased production, and improved product quality.

Keywords*:* Plant height, Rice, Nitrogen, Nano fertilizer, Growth, Grain yield.

INTRODUCTION

Rice is the most important food product after wheat in the world, and it is the most important grain that constitutes more than half of the world's food. Rice is a grain that provides more than 80% of daily calories for the consumer and is the main food for more than half of the world's population. Rice provides 20% of the world's energy, while the share of wheat is 19% and corn is 5%. Nitrogen is one of the important food elements for agricultural plants, which if not consumed in sufficient amounts, causes limitations in plant growth (Nezhad *et al*., 2014; Lotfi *et al*., 2021; Fathi, 2022). It has been reported that higher or lower nitrogen consumption has a negative effect on the growth and production of agricultural plants (Taheri *et al*., 2021; Ghadirnezhad Shiade *et al*., 2024). The increase in agricultural food production worldwide during the last four decades has been accompanied by a seven-fold increase in the use of nitrogen fertilizers (Hafeez *et al*., 2023). Therefore, the challenge of the coming years will be to meet the needs of the expanding population through the development of agricultural production while maintaining the quality of the environment (Mirzaei Heydari *et al*., 2023; Kadhim Joni Alsaedi, 2023; Ghadirnezhad Shiade *et al*., 2023; Mirzaei-Heydari *et al*., 2013). The application of nanotechnology in agriculture has been increasing in recent years and is a valuable tool for achieving the goal of sustainable food production worldwide (Khairy *et al*., 2022). Nanotechnology, which is of great interest in the agricultural revolution, is due to the high reactivity, bioavailability, and surface effects of nanoparticles (Al-Juthery *et al*., 2018). Nano fertilizers have been studied to increase the efficiency of nutrients and improve plant nutrition compared to traditional fertilizers (Saad *et al*., 2022). A nanofertilizer is any nanoparticle product that is used to improve nutrient efficiency (El-Saadony *et al*., 2021). According to various climatic and soil factors such as soil properties, nutrient status, and their reaction, rice shows a positive and significant response to fertilizer application and increases dry matter production (Heydari *et al*., 2009; Heydari *et al*., 2011; Mirzaei Heydari and Babaei, 2022). It has been reported that the use of nitrogen fertilizer improves seed yield through the effect on photosynthesis, and increases dry matter production, transfer, absorption, and seed filling (Eyni *et al*., 2023). The researchers investigated the effect of the amount of nitrogen consumed on the amount of soil residues, soil organic carbon, soil organic nitrogen, and the speed of soil nitrogen mineralization. They stated that an increase in the amount of nitrogen consumed caused more biomass production and as a result, an increase in the volume of residues returned to the soil, and with an increase in nitrogen levels, the rate of decomposition and mineralization of residues increased (Divito *et al*., 2011; Beigzadeh *et al*., 2019). For this reason, considering the importance of achieving sustainable agricultural goals to optimize nitrogen consumption and also improve quantitative and qualitative characteristics, it is necessary to investigate the effect of nitrogen fertilizer sources on these factors.

MATERIAL AND METHODS

This research was carried out in the agricultural year of 2022-2023 in a research farm in Khorramabad at latitude 48 degrees 18 minutes north longitude 33 degrees 30 minutes east and an altitude of 1171 meters above sea level. This region has a semi-arid and cool climate with mild summers. Based on the results of the soil test from zero to 30 cm depth, soil texture is loam-clay, acidity 7.6, electrical conductivity 0.39 deciSiemens/meter, organic matter 0.57%, total nitrogen 0.03%, phosphorus 4. 10 mg/kg and potassium was 280 mg/kg. The experiment was conducted as a basic design of randomized complete blocks with 3 replications. The treatments include N1: nano-nitrogen fertilizer, according to the soil test result and fertilizer recommendation, N2: nano-nitrogen fertilizer, according to the soil test result and twice the fertilizer recommendation, N3: nano-nitrogen fertilizer, according to the soil test result and half the fertilizer recommendation, N4: fertilizer Normal nitrogen chemical fertilizer with a concentration (90 Kg ha^{-1}) and according to Cody's recommendation, N5: Normal nitrogen chemical fertilizer with a concentration (180 Kg ha^{-1}) double the recommendation of N6 fertilizer: Normal nitrogen chemical fertilizer with a concentration (45 Kg ha^{-1}) half of the recommendation Fertilizer, N7: combination of nitrogen fertilizer (half of nano nitrogen + half of normal nitrogen chemical fertilizer), control: no fertilizer (control agent). Nano nitrogen was obtained from reputable agricultural stores.

Nitrogen fertilizer was prepared from a urea source with 46% nitrogen. Land preparation was done in June. To perform the plowing operation, before preparing the land, the experimental plots were irrigated. Based on the recommendation of the fertilizer, potassium and phosphorus fertilizer in the amount of 100 kilograms per hectare was distributed on the soil surface and mixed with the agricultural soil to the desired depth with the last disc operation. Transplanting was done according to the custom of the region with a distance of 20x20 cm and the distance between the blocks was considered to be 2 meters.

Variance analysis of the data with SAS v.3 software and also to compare the mean of the desired traits, the LSD test was used at the five percent probability level. In this experiment, the effect of random year was considered.

RESULT AND DISSECTION

Plant height

The results showed that the effect of nitrogen sources on plant height was significant at the level of 1% (Table 1). The average comparison results showed that the maximum height of the plant in N3 treatment was 128 cm and the lowest height was 104.9 cm in the control treatment. Also, a significant difference was observed between other levels of nitrogen sources (Figure 1). Nano-nitrogen increases the efficiency of fertilizer application and reduces

the pollution and risks of chemical fertilizers. Also, nanonitrogen may increase plant metabolism due to its distinct physicochemical properties, which ultimately increase plant growth. The report of other researchers confirms the results of this study (Rathnayaka *et al*., 2018).

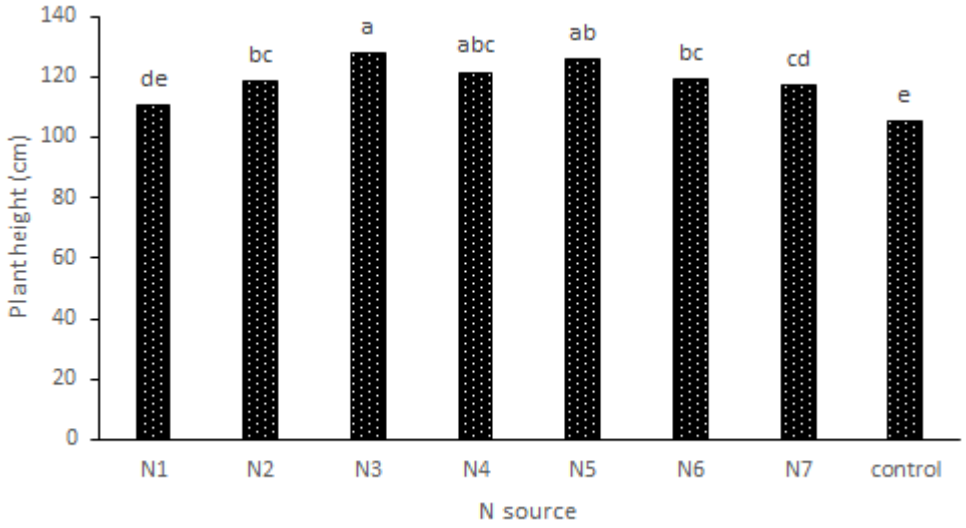

Figure 1. Simple effects of nitrogen sources on rice height

Table 1. Results of variance analysis of nitrogen fertilizer sources on quantitative and qualitative traits of rice

S.O.V	DF	M.S						
		height	cluster length	seeds per cluster	1000-seed wright	seed yield	biological yield	nitrogen seed
block	2	38.20	9.05	20.75	21.10	1898637	8507722	0.02
N source	7	171.98**	10.04*	115.99*	21.94*	1974576*	19324518*	0.12*
Error	14	20.41	2.93	29.80	7.40	665838	5296629	0.04
Total	23	68.09	5.63	55.24	13.01	1171350	9845212	0.07
C.V	-	3.8	7.02	6	10.2	16.52	15.31	13.1

** ,*and ns are significant at 5% and 1% level and non-significant, respectively

Cluster length

The results showed that the effect of nitrogen sources on cluster length was significant at the five percent level (Table 1). The average comparison results showed that the maximum cluster length in N5 treatment was 26.84 cm and the lowest was 20.43 cm in the control treatment. Also, a significant difference was observed between other levels of nitrogen sources (Figure 2). Nitrogen is one of the important elements required for plant growth and plays an important role in influencing various plant components, including spike length. The improvement in spike length may be due to the vital role of nitrogen in maintaining the structural stability of the cell membrane and its use in protein synthesis, membrane function, and cell elongation (Welch *et al*., 2008). The researchers reported that the maximum amount of cluster length related to the treatment of urea fertilizer with sulfur coating and the level of two per thousand nanoparticles was obtained (Kayan Hosseini *et al*., 2019). The results of this research are consistent with our results.

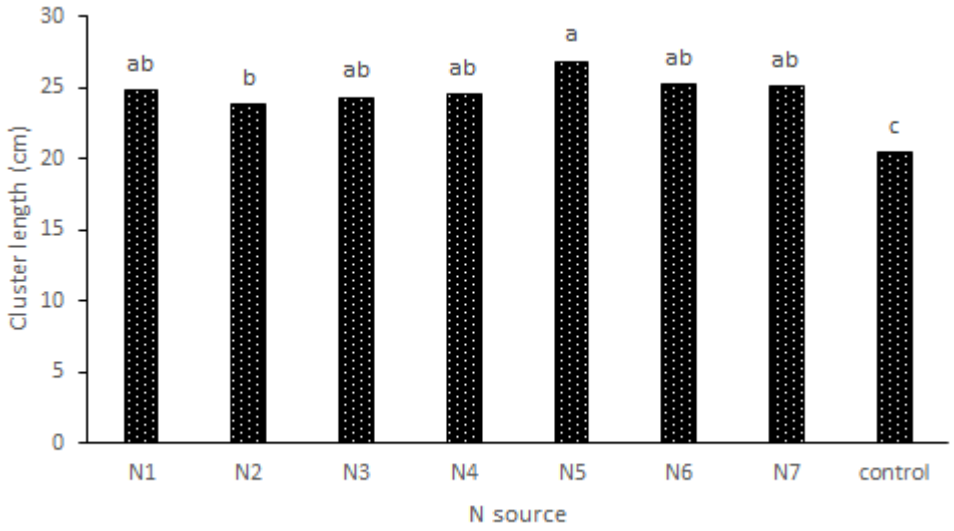

Figure 2. Simple effects of nitrogen sources on cluster length

Number of seeds per cluster

The results showed that the effect of nitrogen sources on the number of seeds per cluster was significant at the five percent level (Table 1). The results of the average comparison showed that N3 was obtained at the rate of 38.98 and the lowest rate was obtained at the rate of 79.79 in the control treatment. Also, a significant difference was observed between other levels of nitrogen sources (Figure 3). Nitrogen, as a main element in the structure of amino acids, proteins, and hormones, stimulates the growth and development of plant cells and organs. An increase in nitrogen can lead to the development of the rice cluster and ultimately

increase the number of grains (Ghadirnezhad Shiade *et al*., 2024; Alwan Kattan *et al*., 2022; Zamani *et al*., 2023). In addition, nitrogen plays a role in regulating the processes of cell division and grain size. Increasing the amount of nitrogen may stimulate cell division and, as a result, increase the size and number of seeds (Fathi and Zeidali, 2022 Zeidali *et al*., 2022).

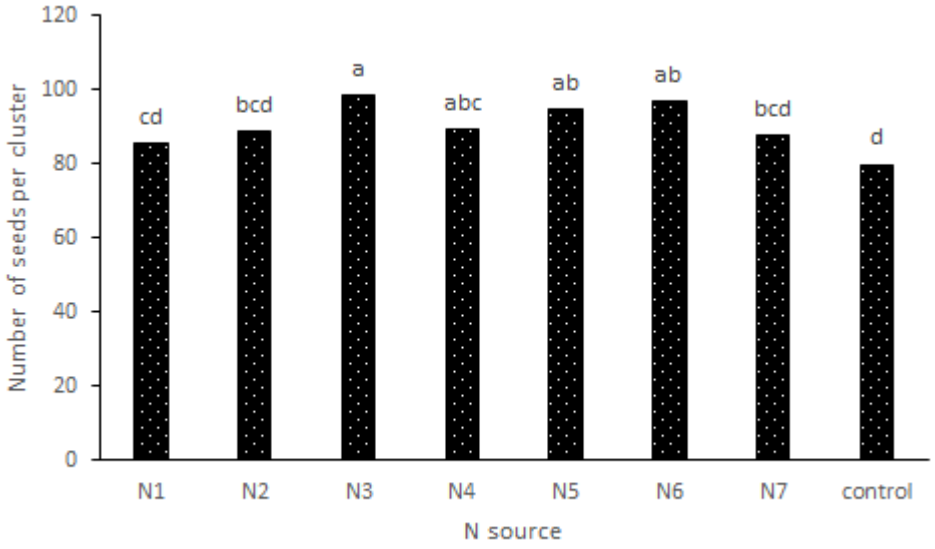

Figure 3.Simple effects of nitrogen sources on the number of seeds per cluster

Weight of a thousand grains

The results showed that the effect of nitrogen sources on the weight of one thousand seeds was significant at the five percent level (Table 1). The average comparison results showed that the highest weight of 1000 seeds in N3 treatment was 29.22 grams and the lowest weight was 21.27 grams in the control treatment. Also, a significant difference was observed between other levels of nitrogen sources (Figure 4). Nitrogen is one of the main elements in the construction of chlorophyll. With optimal access to nitrogen fertilizer, the amount of chlorophyll and absorption of nutrients by the plant is improved, and as a result, the weight of a thousand seeds increases. An increase in nitrogen consumption makes the plant use the created environmental conditions more and the durability of the leaf surface increases, and thus the weight of a thousand seeds of the plant increases and finally the yield increases (Taheri *et al*., 2021).

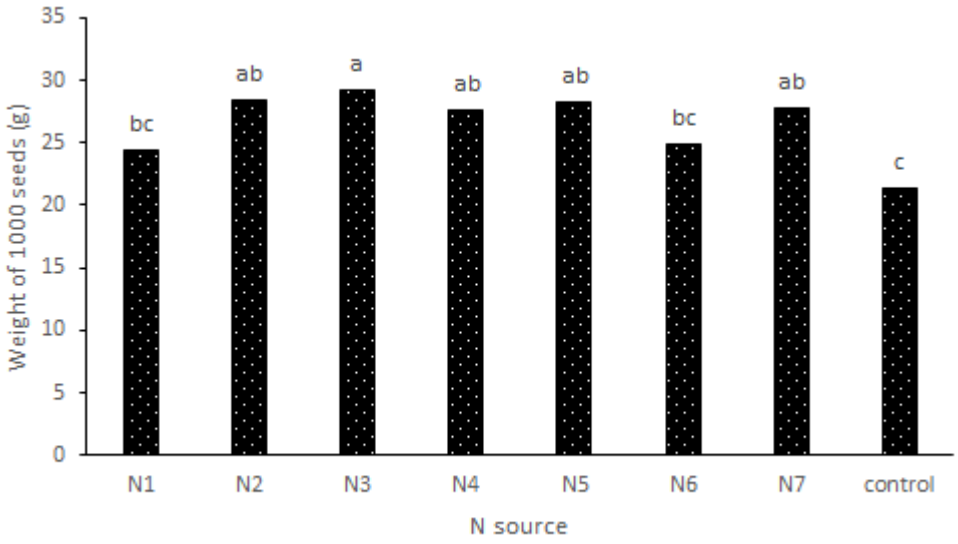

Figure 4. Simple effects of nitrogen source on 1000 seed weight

Seed yield

The results showed that the effect of nitrogen sources on grain yield was significant at the five percent level (Table 1). The average comparison results showed that the highest seed yield was obtained in the N3 treatment at the rate of 5767 Kg ha^{-1} and the lowest yield was obtained in the control treatment at the rate of 3383 Kg ha^{-1}. Also, a significant difference was observed between other levels of nitrogen sources (Figure 5). Probably, the availability of nutrients for rice growth through nitrogen fertilizer has increased the growth and development of the plant during the growing season, which has ultimately led to an increase in grain yield. Researchers reported that the use of nitrogen fertilizer had the greatest effect on grain yield (Mirzaei *et al*., 2018; Fathi *et al*., 2016). In a research, researchers showed that the increase in nitrogen consumption increases the amount of protein and protoplasm, so the increase in photosynthetic activity and its overall effect will cause more growth of the plant, in which more flowers will be formed. The results of these researchers showed that the seed yield of 200 Kg $ha^{-1}$of nitrogen was 4806 Kg ha^{-1} more than the case of not using fertilizer and 100 Kg ha^{-1} (Keyhanian *et al*., 2012).

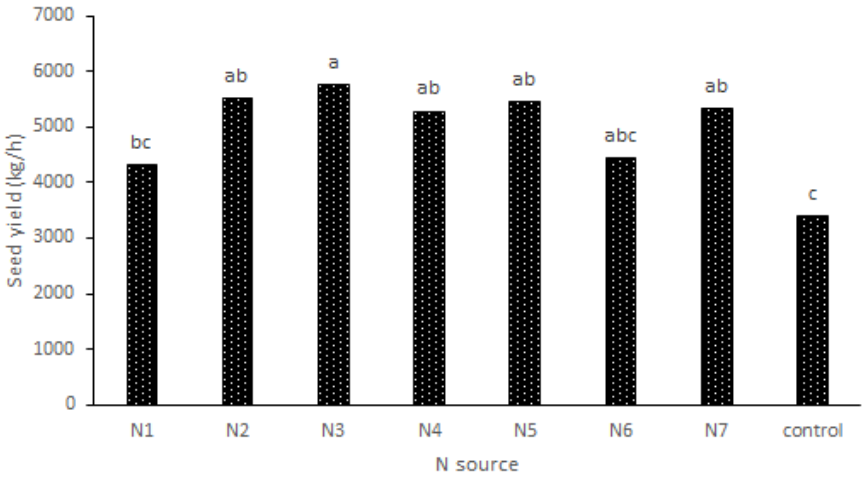

Figure 5. Simple effects of nitrogen sources on grain yield

Biological yield

The results showed that the effect of nitrogen sources on biological performance was significant at the five percent level (Table 1). The average comparison results showed that the highest biological yield was obtained in N5 treatment at the rate of 18632 Kg ha^{-1} and the lowest rate was obtained at the control treatment at the rate of 10957 Kg ha^{-1}. Also, a significant difference was observed between other levels of nitrogen sources (Figure 6). Nitrogen is one of the most important food elements that plays an important role in the growth and development and production of plant dry matter. When enough nitrogen is available to the plant, the rate of photosynthesis increases and enables the plant to grow faster and produce more biomass, which is effective in increasing plant biomass (Ashraf *et al*., 2005; Kardoni *et al*., 2020).

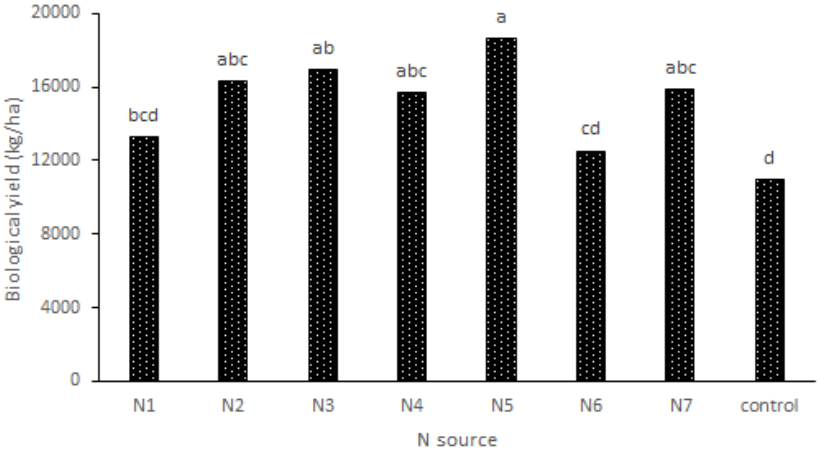

Figure 6. Simple effects of nitrogen sources on biological performance

Seed nitrogen

The results showed that the effect of nitrogen sources on seed nitrogen was significant at the one percent level (Table 1). The average comparison results showed that the highest seed nitrogen was obtained in the N3 treatment at the rate of 1.82% and the lowest amount was obtained at the control treatment at the rate of 1.2%. Also, a significant difference was observed between other levels of nitrogen sources (Figure 7). Nutrient elements, including nitrogen, are factors affecting the activity of photosynthetic enzymes and, as a result, the accumulation of dry matter in plants (Mirzaei Heydari and Mishkhaszadeh, 2022; Fathi, 2022; WATHEQ JABBAR *et al*., 2021). It has been reported that the concentration of nitrogen in plant organs is affected by the amount of dry matter and the amount and type of nitrogen used per unit area (Taheri *et al*., 2021).

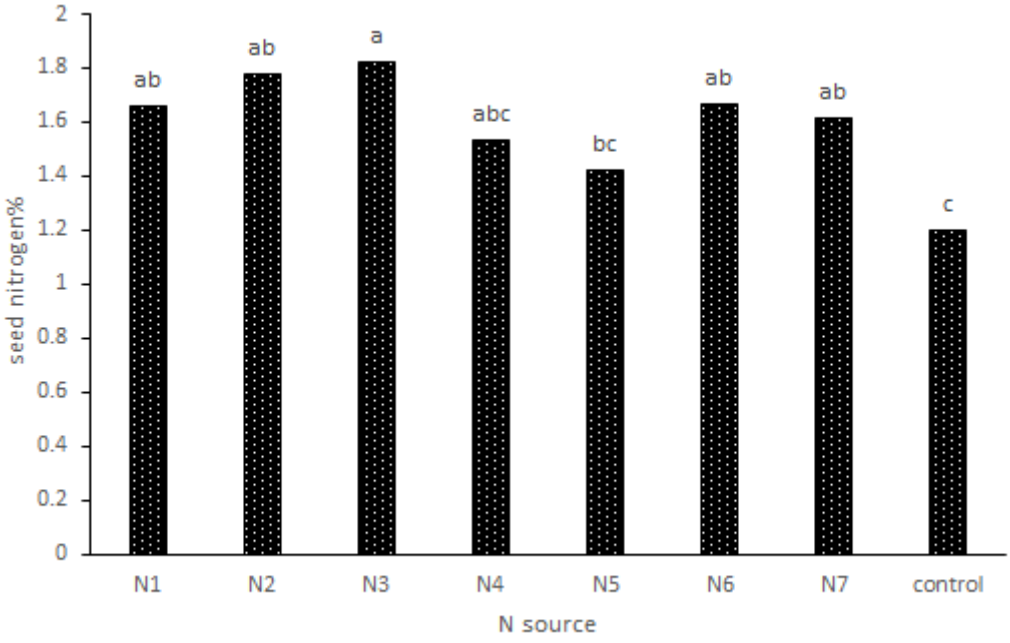

Figure 7. Simple effect of nitrogen sources on seed nitrogen

CONCLUSION

Nano-fertilizer has helped to improve nutrient exchange and absorption of nutrients and improved plant growth. On the other hand, the increase of nitrogen fertilizer plays an important role in the growth of rice. Increasing the supply of nitrogen through fertilizer has improved the process of photosynthesis, the absorption of nutrients, and as a result, increasing the quantity and quality of yield. In general, the combination or use of each of nitrogen

fertilizers and nitrogen nano-fertilizers in rice cultivation has led to improved growth, increased production, and improved product quality.

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