AGPE THE ROYAL GONDWANA RESEARCH JOURNAL
OF HISTORY, SCIENCE, ECONOMIC, POLITICAL AND SOCIAL SCIENCE
ISSN (E): 2583-1348 | A Peer reviewed | Open Accsess & Indexed
Volume 05 | Issue 01 | January 2024 | *www.agpegondwanajournal.co.in* | Page No. 11-20

INFLUENCE ON DIFFERENT RATES OF NITROGEN AND POTASSIU FERTILIZERS APPLICATION ON YIELD AND YIELD CONTRIBUTING CHARACTERS OF RICE (*Oryza sativa* L.)

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Abstract:

To evaluate the effect of different rates of nitrogen and potassium fertilizers on yield and yield contributing characters of rice and to compare the effect of N and K balanced fertilization on the growth and yield of rice production. The pot and field experiments were conducted at Yezin Agricultural University farm, Zeyarthiri Township, Nay Pyi Taw in the dry and wet season of 2022-23. Using T1 (control),T2(86 kg N ha-1+ 92 kg K ha-1),T3(86 kg N ha-1+ 46 kg K ha-1),T4(46 kg N ha-1+ 92 kg K ha-1), T5 (46 kg N ha-1+ 92 kg K ha-1),T6(129 kg N ha-1+92 kg K ha-1),T7(129 kg N ha-1+46 kg K ha-1) in seven treatments with three replications included in the experiment using a randomized complete block design (RCBD). According to the experimental results, different applications of N and K had significant effects on plant height, number of tillers, number of panicles, panicle length, number of spikelets and grain yield and revealed significant differences in grain yield in response to N and K applications. These findings found that combined different applications of N and K gave the highest grain yield from T6 (45.2 g plant-1) in dry season (pot experiment) and (6.2 t ha-1) in wet season (field experiment)), which statistically from all other N and K differed application treatments. Based on the results, the combined effect of N and K fertilizer treatments gave a higher grain yield, an increased yield percentage, and better growth performance. Therefore, the combined use of N and K fertilizer treatments gave higher grain yield, yield increase percentage and better growth performance.

Key Words - Different Applications, Nitrogen, Potassium, Yield, Rice

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I. Introduction

About half of the world's population depends on rice (Oryza sativa L.) as a staple crop; therefore, production of this crop needs to be greatly increased to meet demand from a growing global population. The demand for rice is predicted to rise from 439 million tons (mt) in 2010 to 496 mt by 2020, 553 mt by 2035, and 623 mt by 2050 (Shrestha, Karki & Hossain, 2022). For this reason, boosting rice production is essential to guaranteeing global food security. One of the biggest nations in Southeast Asia, Myanmar is known for producing rice as its primary agricultural crop. Rice production in Myanmar accounts for approximately 43% of total agricultural production in the country, making it the seventh largest producer of rice in the world. Of the 67.6 million hectares of land, 12.8 million are used for cultivation (Naing, Nistratov, & Klushin, 2022).

The primary input and one of the most crucial elements in the production of rice is fertilizer. Rice production costs can be decreased and yield increased with proper fertilizer management. It is necessary to meet the nutrient needs of plants and help rice plants function at a high level. Large amounts of nitrogen (N), phosphorus (P), and potassium (K) are applied to rice fields as fertilizers; a shortage of any one of these nutrients reduces yield. Soil productivity may be impacted by uneven fertilizer application of N, P, and K (Masni & Wasli, 2019). In plants, nitrogen is a vital component of growth and development, photosynthesis, yield, quality, and biomass production in rice. By accelerating tillering, leaf area development, grain formation, grain filling, and protein synthesis, nitrogen encourages quick plant growth and raises grain yield and quality. On the other hand, too much N fertilizer causes the photosynthetic capacity to drop. N has an important role in the creation of rice quality (Shrestha, Karki & Hossain, 2022). Additionally, the total number of spikelets and the number of stems and panicles per square meter increased with nitrogen fertilization, which had an impact on grain productivity. Potassium is the most abundant nutrient in plants including rice plant. Potassium is an essential factor in optimizing root development, enhancing plant vigor, reducing lodging, encouraging cell division, supplying osmotic pull, helping to neutralize organic acid, and boosting seed resistance to pests and diseases, helps in maintaining metabolism and yield (Shrestha, Kandel, Subedi & Shah, 2020). A lack of K in the fertilizer hinders crop yield increases. However, because of its higher cost and slower rate of yield increase, farmers tend to overlook K fertilizer in agricultural production.

To achieve high yields, farmers frequently overapply N fertilizer in agricultural production. However, such over-fertilization does not always result in increased yields and may reduce the N use efficiency (NUE) of the crop (Ye & Zhang et al., 2021). In a similar vein, N application combined with K resulted in higher NUE biomass production, NUE of grain production, and N uptake than N application alone. Potassium plays an important role in ensuring efficient utilization of nitrogen (Singh and Singh 2000). It is well known that nitrogen and potassium have a unique relationship in crops, and that this relationship can either work antagonistically or cooperatively to increase crop productivity. Nitrogen (N) and potassium (K) are two important elements that affect crop yield. N and K interaction enhances rice yield in terms of canopy performance and nutrient acquisition and utilization (Xu et al., 2023). Combined application of K and N had a remarkable positive reciprocal effect on crops,and was an important approach in improving K use efficiency (Bahmanyar & Mashaee, 2010).

II. MATERIALS AND METHODS

The pot and field experiments were carried out from December to May 2022-2023 (dry season) and from June to November (wet season), 2022-23. The two experiments were conducted at the Department of Soil and Water Science, Yezin Agricultural University farm. The two experiments were laid out by a Randomized Complete Block Design having seven treatments with three replications. T_1 (control),T_2(86 kg N ha^{-1}+ 92 kg K ha^{-1}),T_3(86 kg N ha^{-1}+ 46 kg K ha^{-1}),T_4(46 kg N ha^{-1}+ 92 kg K ha^{-1}), T_5 (46 kg N ha^{-1}+ 92 kg K ha^{-1}),T_6(129 kg N ha^{-1}+92 kg K ha^{-1}),T_7(129 kg N ha^{-1}+46 kg K ha^{-1}).The first pot experiments, the size of pot used in this experiment was 29 cm diameter and 26 cm in height. Each pot was filled with tested soil at the rate of 10 kg. All pots were filled with a water and maintained water level 5 cm above the soil surface. The second field experiment, individual plot size was 5 m × 4 m. Double bunds were constructed 1m apart between the plots and 1.5 m between the blocks. The tested rice variety was Sin Thu Kha rice variety with a 135-day duration. Twenty-one-day old seedlings were transplanted in a space of field 20 cm × 20 cm. P fertilizer was applied at 22 kg P ha^{-1} at basal in all treatments. Before conducting the experiment, the soil sample was randomly collected to investigate some physicochemical properties. The results are shown in Table 1. As a regular practice, the two experiments were irrigated whenever necessary. For cultural practices, irrigation, weed control, and pest and disease management practices were done when it was necessary. Growth parameters such as plant height, number of tillers hill^{-1} and SPAD value were recorded for pot experiment of one plant per each pot and field experiment from randomly selected 5 plant sample from each plot in 2 - weeks interval starting from 14 days after transplanting (DAT) until heading stages. At harvest, the grain yields were computed from a central 1 m^2 size harvested area from each plot. Five hills were selected as samples to assess the yield component parameters.

Table. Physicochemical properties of the experimental soil before planting

Parameters	Analytical result	Description
Soil Texture	Loamy sand	-
Soil pH	5.4	Moderately acid
Total N (%)	0.07	very low
Available N (mg kg^{-1})	80	Medium
Available P (mg kg^{-1})	2.4	low
Available K (mg kg^{-1})	39	low
Organic matter (%)	1.43 %	low
Electrical Conductivity (dSm^{-1})	0.04	Non saline

III. STATISTICAL ANALYSIS

The results were statistically analyzed by using statistix software (8th version). All treatment was carried out three replications with Completely Randomized Design (CRD). Mean comparison was carried out Least Significant Difference (LSD) at 5% level.

IV. RESULTS AND DISCUSSION

Plant height (cm)

Plant height in all treatments increased progressively from 14 DAT to 84 DAT under both pot and field experiments (Figure 1 a and b). It was found that only control treatment (T_1) gave the lowest plant height at all growth stages, combined application of N and K fertilizer application (T_6) possessed a significant difference in plant height among the other treatments similarly. Chaturvedi (2005) stated that the application of nitrogen fertilizers increased in plant height significantly. Because potassium contributes to nitrogen use efficiency, highest plant height resulted from highest application of potassium combination with highest nitrogen rate (Gething 1993; Tatar et al. 2010).

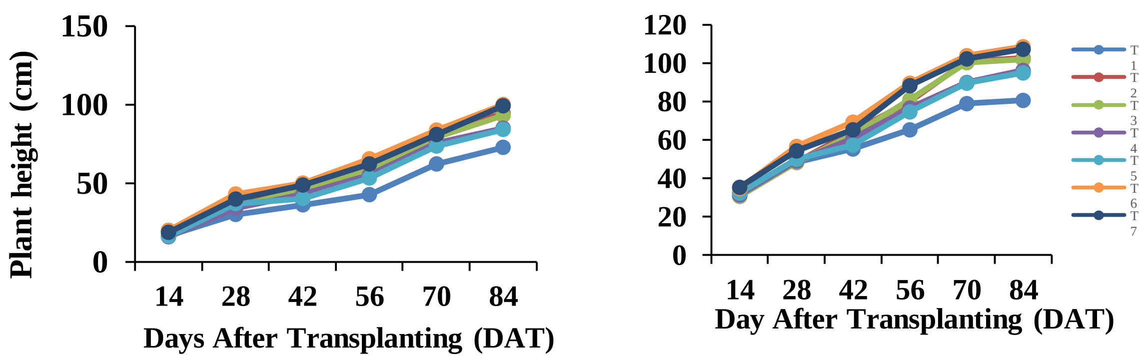


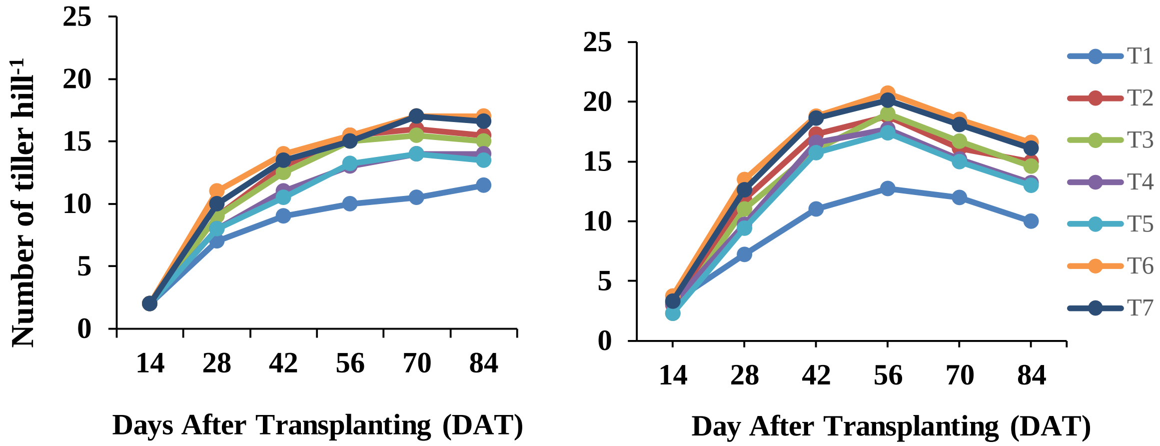
Figure.1 Plant height (cm) of as affected by different

Figure.1 Plant height (cm) as affected by different rates of nitrogen and potassium fertilization in (a) dry season and (b) wet season.

Number of tillers hill^{-1}

The number of tillers hill^{-1} counted at different growth stages from 14 DAT to 84 DAT are presented in Figure 2 (a and b). In the dry season (pot experiment), the tiller number ranged from 11.5 to 17.0 and the maximum value was observed in T_6 (17.0) followed by T_7, T_2, T_3, T_4 and T_5 respectively, and the minimum value in control. In the wet season, the number of tillers ranged from 10 to16.6. The highest number of tillers was produced by T_6 and the lowest number by control treatment. Numbers of tillers were increased within increasing amount of N and K which could be attributed to the influence of N on leaf development, tiller production and increasing leaf photosynthetic activity (Ntanson and Koutroubas 2002). However, within the same amount of nitrogen fertilizer, potassium application significantly increased the number of tillers hill^{-1}.

Figure.2 Number of tillers hill^{-1} as affected by different rates of nitrogen, potassium fertilization in (a) dry season and (b) wet season.



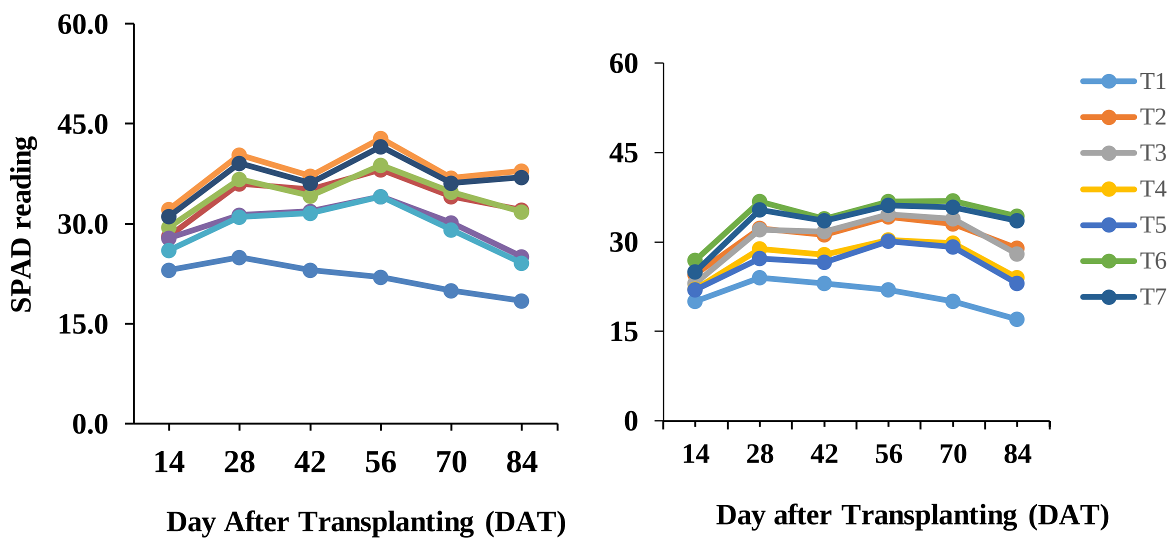


Figure.3 SPAD value as affected by different rates of nitrogen and potassium fertilization in (a) dry season and (b) wet season.

SPAD value

SPAD value was highly significantly different among the different applications of nitrogen fertilizer. It was highly significantly different applications of nitrogen fertilizer in14DAT, 28 DAT, 42 DAT, 56 DAT, 70 DAT,84 DAT at 1 % level of significant is shown Figure 3 (a and b). In the dry season (pot experiment), the SPAD value ranged from 18.0 to 38.0 and the highest value was observed in T_6 (38.0) followed by T_7, T_2, T_3, T_4 and T_5 respectively, and the lowest value in control. In the wet season (field experiment), SPAD value ranged from 17 to 34.3. The highest number of SPAD value was produced by T_6 and the lowest number by control treatment. Consistent with other reports, the relationship between SPAD and N differed significantly depending on the growth stage (Takebe & Yoneyama, 1989).

Yield and Yield Component Characters

Number of panicles hill^{-1}

The mean number of panicles hill^{-1} affected by different nitrogen and potassium fertilizations is given in (Table 3 and 4). There was a highly significant difference in the number of panicles hill^{-1} between the treatments. The treatment with the highest nitrogen rate, T_6(13.8), had the greatest number of panicles hill^{-1}. This treatment's results were statistically like those of treatments T_7, T_2, and T_3, T_5, and T_4, with values of 13.0, 11.5,11.3,10.8, and 10.5, respectively. The lowest number of panicles hill^{-1} was resulted from control in dry seasons (pot experiment). The number of panicles hill^{-1} ranged from 7.7 to 12.5 among different treatments. The highest number of panicles was recorded in T_6 and control got the lowest number of panicles hill^{-1}in wet season (field experiment). Ghoneim, Gewaily and Osman (2018) also mentioned that the high rate of N showed maximum counts of panicles per hill while the control showed minimum counts of panicles per hill^{-1}.

Number of spikelets panicle^{-1}

The findings showed that the application of varying amounts of potassium and nitrogen at the 1% level caused a considerable variation in the number of spikelets panicle^{-1} are showed in (Table 3 and 4). In two experiments, the highest number of spikelets panicle^{-1} was produced by T_6 (148.6) in dry season (pot experiment), (156.7) in wet season (field experiment). The reason why T_6 showed the maximum was related to combined applications of N and K. Abd El-Hadi et al. (2013) and Ding et al. (2015) concluded that nitrogen fertilizer significantly increases number of spikelets in rice and the utilization of applied nitrogen fertilizer was improved by potassium fertilization.

Panicle length (cm)

The average panicle length significantly varied depending on the nitrogen and potassium fertilization rates used in (Table 3 and 4). Different nitrogen and potassium fertilization rates had an impact on the panicle length, which resulted in a 5% difference that was statistically significant. The maximum panicle length was observed from T_6 (21.9cm) which was statistically like that of T_7 (21.1 cm), T_3 (21.0 cm) T_2 (20.9cm), T_4 (19.8 cm) and then followed by T_5 (19.1 cm) in dry season (pot experiment). The lowest panicle length was resulted from T_1 (18.7 cm). Similarly, the maximum panicle length (23.4 cm) was obtained by T_6, which was not statistically significant different from T_2, T_7, T_3, T_4 and T_5 with the values of (22.1cm, 21.2 cm, 20.2 cm and 19.6 cm) respectively, in the wet season (field experiment). The shortest panicle length was recorded from control. Bahmaniar and Ranjbar (2007) stated that nitrogen application can increase panicle length, and the number of panicles per square meter which are correlated with grain yield.

1000 grain weight (g)

In this experiment, the addition of nitrogen and potassium fertilizers had no appreciable impact on the Sin Thu Kha rice variety 1000 grain weight (Table 4.1). The maximum 1000 grain weight was found in T_6 and the minimum grain weight was observe in control which was not significantly different among each other. Since 1000 grain weight is a genetical character fixed by an individual variety, it was not significantly affected by fertilizer treatments (Wilson et al. 1996; Bahmanyar and Mashaee 2010).

Filled grain (%)

The filled grain % was significantly influenced by nitrogen and potassium fertilizer application is presented Table 3 and 4. Depending on the different fertilizer treatment, the filled grain (%) varied from 65.8% to 85.9% in the dry season (pot experiment) and from 65.4 to 87.6 % in the wet season (field experiment). The highest filled grain % was obtained from T_6 in both seasons dry season (pot experiment) and wet season (field experiment). It was discovered that fertilizer with a nitrogen and potassium balance led to most of the highest full grain present results. Potassium fertilizer increased the number of filled grains, and the improved grain filling under potassium application was due to increased photosynthetic activity, as potassium stimulates some biochemical processes (Mathews 2005).

Grain yields

The results of nitrogen and potassium balanced fertilization at a 1% level on grain yield are shown in Table (3 and 4). The T_6 treatment provided the highest grain yield (45.2 g plant^{-1}). The control treatment produced the smallest amount of grain output (18.9 g plant^{-1}) in dry season (pot experiment). The highest grain yield that recorded from T_6 (6.64 t ha^{-1}). The smallest grain yield was found in control (3.1t ha^{-1}) in wet season (field experiment). Furthermore, at all rates of nitrogen application, the treatments receiving potassium had produced higher grain yield than corresponding treatments receiving no potassium. The application of nitrogen and potassium fertilizers increased grain yield in comparison with no application of both fertilizers (Farrokh et al. 2012). Therefore, it was discovered that all the better grain yields came from fertilization treatments that balanced nitrogen and potassium levels.

Table 3. Mean effect of yield and yield components of rice as affected by different rate of nitrogen and potassium fertilization in dry season, 2022-23.

Treatments	Panicle length(cm)	Number of panicle hill^{-1}	Number of spikelet panicle^{-1}	Filled Grain %	1000 grain weight(g)	Grain yield (g plant^{-1})
T_1	18.7 c	9.3 c	94.3 e	65.8 e	19.10	18.9 e
T_2	20.9 ab	11.5 b	136.7 b	82.2 b	20.3	42.8 a
T_3	21.0 a	11.3 b	128.9 c	78.6 c	19.8	33.4 bc
T_4	19.8 bc	10.5 b	125.5 cd	74.9 d	19.8	31.5 cd
T_5	19.1 c	10.8 b	120.1 d	74.2 d	18.4	28.9 d
T_6	21.9 a	13.8 a	148.6 a	85.9 a	21.4	45.2 a
T_7	21.1 a	13.0 a	134.2 bc	81.6 b	19.5	36.4 b
$LSD_{0.05}$	1.20	1.02	16.45	1.64	1.91	4.42
Pr>F	*	**	**	**	ns	**
CV%	9.98	5.99	6.25	1.44	6.5	8.78

In each column, * Significant difference at 5% level, ** Significant difference at 1% level, ^{ns} non-significant difference.

Table .4 Yield and yield components of Sin Thu Kha rice variety as affected by different rates of nitrogen, potassium fertilization during wet season, 2023.

Treatments	Panicle length(cm)	Number of panicles hill^{-1}	Number of spikelets panicle^{-1}	Filled grain %	1000 grain weight(g)	Grain yield (t ha^{-1})
T_1	17.7 e	7.7 e	94.6 f	65.4 f	19.5	3.1 f
T_2	22.3 b	10.8 b	152.6 b	84.5 b	20.3	5.9 b
T_3	21.2 c	9.5 c	141.8 d	74.1 d	20	5.3 d
T_4	20.2 d	8.9 d	136.7 e	71.8 e	19.5	5.1 d
T_5	19.6 d	8.6 d	134.4 e	70.2 e	19.4	4.5 e
T_6	23.4 a	12.5 a	156.7 a	87.6 a	20.7	6.2 a
T_7	22.1 bc	10.9 b	147.1 c	79.8 c	20.2	5.6 c
$LSD_{0.05}$	0.73	0.53	4.0	2.1	0.98	0.55
Pr>f	**	**	**	**	ns	**
CV%	2.43	3.04	1.63	1.55	3.24	10.86

In each column, * Significant difference at 5% level, ** Significant difference at 1% level, ^{ns} non-significant difference.

Conclusion

The pot and field experiments assessed the balancing on the application of nitrogen and potassium as well as optimum fertilizer rates to achieve higher grain yield and nutrient use efficiency. According to the experimental results, different applications of nitrogen and potassium fertilizer was increased plant height, number of tillers hill^{-1}, SPAD value, panicle length, number of panicles hill^{-1}, number of spikelets panicle^{-1}, and grain yield for both experiments since the plants were provided enough available N and K for plant. At different rates of nitrogen and potassium fertilizers, the maximum grain yields were produced by the rate of T_6(129 kg N ha^{-1}+92 kg K ha^{-1}) followed by T_2(86 kg N ha^{-1}+92 kg K ha^{-1}) in both experiments. However, the maximum grain yield and greater magnitude of increase in yield were observed in combined application of N with K fertilizers. Therefore, the combined use of N and K fertilizer treatments gave higher grain yield, yield increase percentage and better growth performance.

Acknowledgement

We are grateful to Dr. Kyaw Ngwe (Professor and Head, Department Soil and Water Science, Yezin Agricultural University) and Daw Theingi Win (Assistant Lecturer, Department of Soil and Water Science,) and U Lu Zaw Myo (Lecturer, Department of Agronomy) for the valuable knowledge and continuous supporting until completion of this research.

References

1. Abd El-Hadi, A. H., A. Y. Negm and M. Marchand. 2013. Impact of potassium on nitrogen utilization by the rice crop under saline conditions, International Potash Institute, 35: 9-12.
2. Bahmaniar, M. A. and G. A. Ranjbar. 2007. Response of rice cultivar to rates of nitrogen and potassium application in field and pot conditions, Pakistan Journal of Biological Sciences, 10 (9): 1430-1437.
3. Bahmanyar, M. A. and S. S. Mashaee. 2010. Influences of nitrogen and potassium top dressing on yield and yield components as well as their accumulation in rice (Oryza sativa), African Journal of Biotechnology, 9 (18): 2648-2653.
4. Bahmanyar, M. A., & Mashaee, S. S. (2010). Influences of nitrogen and potassium top dressing on yield and yield components as well as their accumulation in rice (*Oryzasativa* L.). African Journal of biotechnology, 9(18), 2648-2653.
5. Brar, M. S. and P. Imas. 2014. Potassium and nitrogen use efficiency: Role of potassium in improving nitrogen use efficiency, IPI (International Potash Institute), 18.
6. Chaturvedi, I. 2005. Effect of nitrogen fertilizers on growth, yield and quality of hybrid rice (Oryza sativa L.). Central European Agriculture. 6 (4): 611-618.
7. Farrokh, A. R., M. Kavoosi, T. Razavipour and M. Rezaei. 2012. The study of effects of different nitrogen and potassium levels on yield and mineral elements storage in straw and grain of rice ratoon (Hashemi cultivar), International Information System for the Agricultural Science and Technology (AGRIS), 2 (95): 11-21.

8. Gething, P. A. 1993. The potassium-nitrogen partnership. IPI research topics, No:13 (2nd Revised Edition), International Potash Institute, Basel, Switzerland.
9. Masni, Z., & Wasli, M. E. (2019). Yield performance and nutrient uptake of red rice variety (MRM16) at different NPK fertilizer rates. International Journal of Agronomy, 2019.
10. Mathews, D. V. 2005. Response of rice to soil fertility constraints and bio-fertilizers in coastal alluvial soil of Karnataka, thesis, University of Agricultural Sciences, Dharwad.
11. Myint, S. W., Naing, Z. Y., Nistratov, A. V., & Klushin, V. N. (2022, July). Activated carbon based on rice husks of Myanmar enterprises as a remover of organic solvent vaporsfrom the air. In IOP Conference Series: Earth and Environmental Science (Vol. 1061, No. 012033). IOP Publishing.
12. Ntanos, D. A. and S. D. Koutroubas. 2002. Dry matter and N accumulation and translocation for indica and japonica rice under Mediterranean conditions, Field Crops Research, 74: 93-101.
13. Shrestha, J., Karki, T. B., & Hossain, M. A. (2022). Application of nitrogenous fertilizer in rice production: A review. Journal of Nepal Agricultural Research Council,8, 16-26.
14. Shrestha, J., Shah, K. K., & Timsina, K. P. (2020). Effects of different fertilizers on growth andproductivity of rice (Oryza sativa L.): A review. International Journal of Global Science Research, 7(1), 1291- 1301.
15. Takebe, M., & Yoneyama, T. (1989). Measurement of leaf color scores and its implication to nitrogen nutrition of rice plants. Japan Agricultural Research Quarterly, 23(1), 86-93.
16. Xu, W., Li, J., Feng, J., Shao, Z., Huang, Y., Hou, W., & Gao, Q. (2023). Nitrogen and potassium interactions optimized asynchronous spikelet filling and increased grain yield of japonica rice. *PeerJ*, *11*, e14

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