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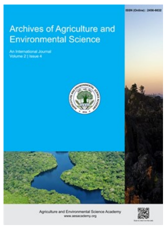

ORIGINAL RESEARCH ARTICLE

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# Efficacy of different doses of NPK on growth and yield of rice bean (*Vigna umbellata*) in Khadbari, Sankhuwasabha, Nepal

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**ABSTRACT**

An essential cultural technique for ensuring correct development and maximizing output is administering fertilizer sources for the crops. The experiment was carried out from February 2022 to May 2022 at Khadbari-3, Maruwa, Sankhuwasabha, to determine the efficacy of various dosages of NPK on the growth performance of the rice bean variety (Sunehri). The trial used a Randomized Complete Block Design (RCBD) with seven treatments replicated three times. The treatments were listed and named as T1 (0:0:0 kg NPK/ha); T2 (20:30:10 kg NPK/ha) (Recommended dose); T3 (10:20:15 kg NPK/ha); T4 (40:80:40 kg NPK/ha); T5 (20:20:20 kg NPK/ha); T6 (80:100:60 kg NPK/ha); and T7 (20:0:30 kg NPK/ha), respectively. The experimental results revealed that the highest yield/plant (39g) was obtained from the plot treated with T4 (40:80:40 kg NPK/ha), followed by 24.93 g and 24.13 g from the plot receiving T2 (20:30:10 kg NPK/ha) and T6 (80:100:60 kg NPK/ha), respectively. The lowest yield of 14.07 g was obtained from the control plot, followed by 15.27 g and 21.20 g from the plot receiving T7 (20:0:30 kg NPK/ha) and T3 (10:20:15 kg NPK/ha), respectively. Vegetative parameters such as plant height, branch numbers, and leaves numbers were recorded as a maximum of 19.72 cm, 6.88, and 18.97 in plots treated with T5 (20:20:20 kg NPK/ha), T7 (20:0:30 kg NPK/ha), and T1 (0:0:0 kg NPK/ha), consecutively, and corresponding minimum values were found 18.12 cm, 5.36 and 15.63 in T3 (10:20:15 kg NPK/ha), T1 (0:0:0 kg NPK/ha), and T7 (20:0:30 kg NPK/ha), respectively. Conclusively, the study's findings suggest that the rice bean crop responds to fertilizers and applying T4 (40:80:40 kg NPK/ha) enhances crop production considerably.

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## INTRODUCTION

The rice bean is an Indochina native likely domesticated in Thailand and the surrounding area. It was introduced to Egypt, the Indian Ocean islands and the East African coast. It is currently grown in Fiji, tropical Asia, the Indian Ocean Islands, Australia, tropical Africa, and South America (Asha *et al.*, 2019). The genera Vigna subgenus ceratotropics has 21 species that are found throughout Asia. This subgenus has six cultivated species, the most important of which are the azuki bean (*Vigna angularis*), rice bean (*Vigna umbellata*), mung bean (*Vigna radiata*), and black bean (*Vigna mungo*) (Chiphang *et al.*, 2022; Dhillon and Tanwar, 2018). The rice bean (*Vigna umbellata*) is a rarely utilized regarded as a marginal fodder and food crop in Nepal and northern India. In Nepal's central hills, rice bean is planted among rice berms and terrace edges (Khadka and Khanal, 2013). It is produced mainly for its beans, although it is also used as a fodder, vegetable (green pods), and conventional healers

(Bhagyawant *et al.*, 2019; Manivannan *et al.*, 2009). Although it is predominantly farmed for humans, it is also utilized as green manure and fodder (Stagnari *et al.*, 2017). Farmers mainly cultivate landraces because there hasn't been much research or development support for this crop. It is a fast-growing summer season, and a short-lived perennial legume is typically grown annually. It can be upright, semi-erect, or interweaving, while it does not always require support. It is usually 30-100 cm tall but can grow to be 200 cm tall (Swathi *et al.*, 2021). It has a massive root hair with a tap root that may reach depths of 100 to 150 cm. The stems are beautifully hairy and branching. The leaves are trifoliate, with complete leaflets about 6 to 9 cm long. The blooms are papilionaceous and brilliant yellow and appear on 5-10 cm long axillary racemes. It is a self-pollinating plant. The fruits are cylindrical pods 7.5 to 12.5 cm long with 6-10 oval, 8-10 mm seeds with a flattened hilum. It can grow on a wide range of soil but performs well in sandy loam soil (Sánchez-Navarro *et al.*, 2019). The optimum pH range for this is 6.0-6.5; however, it can tolerate acidic soil. It performs best up to a height of 1500 m from sea level with an average rainfall of 1000-1500 mm/annum. The optimum temperature for this is 20-35°celcius. The rice bean is a good source of minerals, vitamins, proteins, and carbohydrates. Methionine and tryptophan, two limiting amino acids, are abundant in rice bean protein (de Carvalho and Vieira, 1996).

Likewise, Rice beans have a better nutrient benefit than numerous other beans in the Vigna family. Nonetheless, despite its nutritious superiority, it has been classified as underused. People are ignorant of its nutritive advantages for these and other factors (Dahipahle *et al.*, 2017; Wu *et al.*, 2021). The effects of the fertilizer on the number of pod clusters/plants, the seed yield/plots, plant height, the number of seeds/pods, and the total number of mature pods harvested all substantially impacted growth and yield. The fertilizer has a good impact on seed output and the qualities that contribute to it (Moniruzzaman *et al.*, 2008). According to Ali *et al.* (2015), all fertilizer treatments result in appreciable improvements in bean output. Treatment four, however, performed better, obtaining 60 kg $K_2O$, 90 kg N, 90 kg $P_2O_5$, and 90 kg N annually in an efficient manner. Furthermore, Duarah *et al.* (2011) discovered that rice bean output increases when phosphorus doses increase and react better to application. Datt *et al.* (2013) claimed that the effects of organic fertilizer on plant height, number of pod clusters per plant, number of seeds per pod, seed yield per plot, and the overall number of mature pods collected all had a significant impact on growth and yield.

Despite being a crop with several uses, the rice bean is a neglected and underutilized legume produced in certain areas by poor and marginal farmers (Dhillon and Tanwar, 2018). It never developed into a significant crop despite being a nutrient-rich food, fodder, and a strong source of genes for biotic and abiotic stress tolerance, including drought, soil acidity, and storage insect (Pattanayak *et al.*, 2019). Additionally, there is a lack of documentation and publications on growing rice beans, which keeps farmers who want to grow them from focusing on farming (Khadka and Khanal, 2013). Due to these and other factors, the farmers are unaware of its nutritional advantages (Wu *et al.*, 2021). For the rice bean to restore its position, marketing and promotion initiatives, as well as plant breeding, more and more research must be done. Additionally, rice bean cultivars that satisfy farmers' preferences for growth patterns, fertilizer responses, maturity periods, uniform seeds, high yields, and insect resistance are necessary (Katoch, 2013). Thence, the study aims to find out the most effective dose of NPK fertilizers to improve rice beans' yield and growth performance.

## MATERIALS AND METHODS

### Description of the experimental site

The research was conducted in the research field of Khandbari - 3, Maruwa, Sankhuwasabha. The area is located at 27°24’25.0” N latitude and 87°12’03.9” E longitude & an elevation of about 1100 Masl (Figure 1). Most of the area falls in the hilly region of Nepal. It faces mild to warm, cool temperatures (7-21 °C) in winter and (22-32 °C) in Summer.

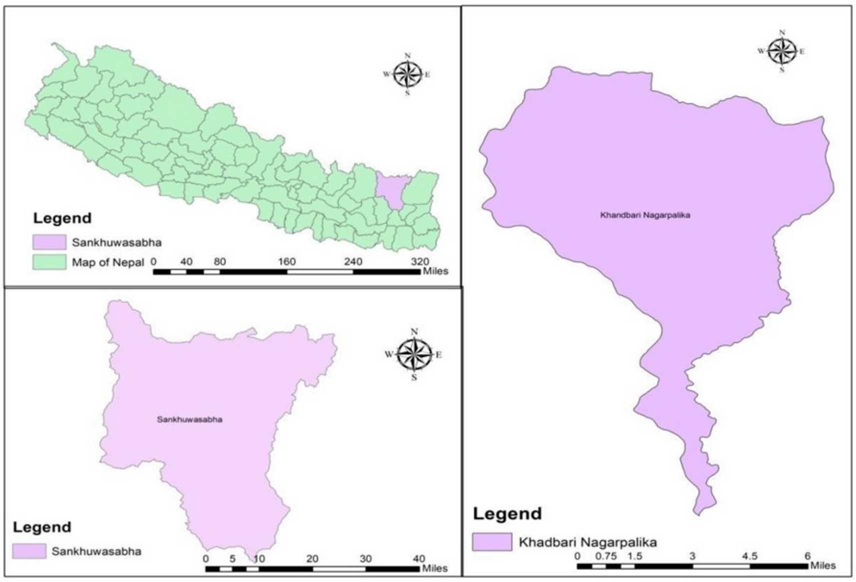


**Figure 1.** *Map of research site.*

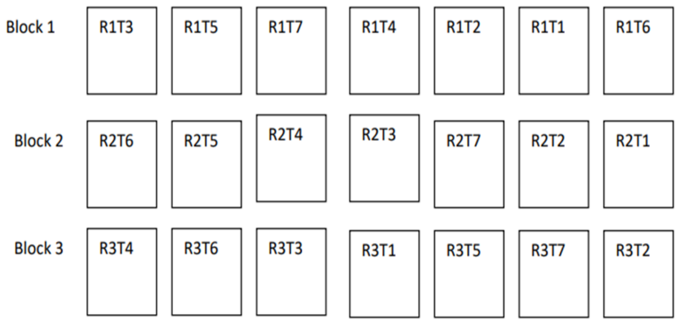


**Figure 2.** *Layout of the research field.*

## Soil analysis

The plot was prepared thoroughly, and a soil sample was taken for a lab test. The soil had a clayey loam texture and a pH of 5.7. The NPK availability of soil was found at 104, 73.6, and 883.3 kg/ha, respectively.

## Variety selection

'Sunehri' variety of rice beans was selected for the study. Its maturity duration is about 120-150 days, though the duration of this variety increases with altitude.

## Experimental detail and field layout

The field was selected, and the layout and experiment were conducted from 27th February 2022 to 17th May 2022. The area was designed as a Randomized Complete Block Design (RCBD) with seven treatments and three replications, with treatments allotted by lottery inside the block (Figure 2). The gap between replication and treatment was kept at 0.4 m. The length and breadth of each plot were 2 m and 1.5 m, respectively. In each plot, the seed was sown at a spacing of (40 X 30) cm. There were four rows in a plot, and in each row, there were six plants. The total number of plants per plot was twenty-four, out of which sixteen were border plants. In addition, five non-border plants were arbitrarily chosen out of each field for data collection.

## Treatment details

The seven different treatments were used in the research, which is presented in Table 1.

**Table 1.** Treatment details of the research.

| S.N. | Treatments | Doses of NPK (Kg/ha) |
|---|---|---|
| 1. | T1 | 0:0:0 |
| 2. | T2 | 20:30:10 (RD) |
| 3. | T3 | 10:20:15 |
| 4. | T4 | 40:80:40 |
| 5. | T5 | 20:20:20 |
| 6. | T6 | 80:100:60 |
| 7. | T7 | 20:0:30 |

RD: Recommended dose

## Fertilizer application

Compost manure was applied at the same dose in all fields, i.e., @10 ton/ha a week before plantation, while different amounts of NPK was applied to different plot based on the rate shown in (Table 1). The entire dosage of P and K, as well as half of the N dose, were utilized in the final field preparation, with the remaining half of N top-dressed after one month of planting.

## Intercultural operation

All the cultural operations were practised uniformly and timely in all treatments as recommended. The plants were irrigated manually with a watering can for a week or according to the moisture requirements. The first wedding of the field was done on the 29th day, i.e., a day before top dressing, while the second wedding was done after the 50th day of the plantation. As some of the plants were infested from damping off during the second week of the plantation, the field was drenched with Saaf (Carbendazim 12+ Mancozeb 63WP) @ of 2g/l of water. Also, some plants were infested with aphids, and the field was sprayed with Neem solution (Azadirachtin 0.03) @ 5ml/l of water two times at weekly intervals from the 20th to the 30th day of the plantation. All the critical operations were performed at the proper time as recommended.

## Parameters studied

Six parameters were taken to study the number of average pod weight/plant (gm), leaves/plant, number of branches/plants, the average number of pods/plants, plant height(cm), and average pod length (cm) (Table 2).

## Data collection

The data of vegetative parameters were recorded after the 20th day of plantation and continued till the last harvest at ten days intervals. Data of reproductive parameters were started recorded from the 58th day of the plantation when fruiting was observed in about fifty percent of the plants and was recorded three times at an interval of ten days. The pod length and plant height were measured with a geometrical scale, while pod weight was measured with a digital hand-weighing machine.

## Statistical analysis of data

The data retrieved from the field were entered, tabulated, and processed in Microsoft Excel (2019 version), and ANOVA of the treatments was done through Gen-Stat (18$^{th}$ Edition). Duncan's Multiple Range Test (DMRT) adjudged the treatment mean differences.

**Table 2.** Parameters recorded for growth and yield attributing characters of rice bean.

| S.N. | Growth and yield attributes |
|---|---|
| 1. | Plant height |
| 2. | Number of branches |
| 3. | Number of leaves |
| 4. | Number of pods |
| 5. | Pod yield |
| 6. | Pod length |

## RESULTS AND DISCUSSION

### Effect of different doses of NPK on vegetative parameters

**Plant height:** It was found that there was no significant variation ($p<0.05$) among different doses of fertilizer in plant height. The maximum height (19.72 cm) of the plant was observed in the plot applied with 20:20:20 kg NPK/ha followed by a control plot and plot receiving 20:30:10 kg NPK/ha whose mean height was 19.63 cm and 19.52 cm, respectively, which were statistically at par with each other. Minimum plant height (18.12 cm) was recorded in a plot receiving 10:20:15 kg NPK/ha followed by a plot treated with 80:100: 60 and 40:80:40 kg NPK/ha with mean heights of 18.89 cm and 19.09 cm, respectively, which are statistically at par. The above experiment shows that the plant height of rice bean range between 18-20 cm, which is similar to that of the findings obtained by Anand *et al.* (2020), where the height of the plant range between 17-21 cm. In contrast, the results seem to have massive variation from the findings of Kundu *et al.* (2015). This may be due to the difference in the purpose of cultivation as Kundu *et al.* (2015) cultivated rice bean for fodder (biomass) purposes.

**Number of branches:** The average number of branches did not change significantly ($p<0.05$) across treatments. The plot administered with 20:0:30 kg NPK/ha had the most branches per plant (6.88), trailed by 6.38 and 6.33 average number of branches in the plots treated with 10:20:15 and 40:80:40 kg NPK/ha, respectively, which are approximately equivalent. The minimum number of branches (5.36) was observed in the control plot, followed by 5.90 and 5.91 branches in the plot, receiving 80:100:60 and 20:30:10 kg NPK/ha, respectively. From the experiment, we concluded that the number of branches ranges between 5-7, similar to the result obtained by Anand *et al.* (2020), where branches range between 5-8. In contrast, the result obtained by Devi *et al.* (2021) seems to be slightly different, which could be due to the difference in the source of fertilizer applied.

**Number of leaves:** The aggregate number of leaves was not statistically different ($p<0.05$) across treatments. The plot administered with 10:20:15 kg NPK/ha had the most leaves (18.97), preceded by 17.97 and 17.73 averaged number of leaves in the plots treated with 40:80:40 and 20:20:20 kg NPK/ha, correspondingly (Table 3). The plot that got 20:0:30 kg NPK/ha had the fewest leaves (15.63), accompanied by 15.68 and 17.27 leaves in the control plot and plot supplied with 80:100:60 kg NPK/ha, accordingly. The result aligns with the result obtained in the investigation performed by Ponmurugan *et al.* (2016), who reported that nitrogen and potassium are the major factors for determining the number of leaves in Vigna.

### Effect of different doses of NPK on yield and yield attributing parameters

**Pod yield:** In terms of pod yield per plant, there was a substantial difference ($p<0.01$) across treatments (Table 4). The highest pod weight was observed from the plot receiving 40:80:40 kg NPK/ha (39.00g). The second highest yield was obtained from the plot receiving 20:30:10 kg NPK/ha (24.93g) and 80:100:60 kg NPK/ha (24.13g), which were statistically at par with each other. The lowest yield was obtained from the control plot (14.07g), followed by a plot receiving 20:0:30 kg NPK/ha (15.27g) which were statistically at par. The result corresponds with the findings of Kar and Ram (2015), who reported the highest pod yield with the implication of 60 kg/ha potassium, whereas the result shows a huge gap with Morab *et al.* (2021). This has occurred due to genotypic differences between the varieties or because of different source of nitrogen applied.

**Table 3.** Effect of different doses of NPK on vegetative parameters.

| Treatment (Kg NPK/ha) | Average number of leaves | Average number of branches | Average plant height (cm) |
|---|---|---|---|
| 20:20:20 | 17.73 | 5.933 | 19.72 |
| 20:30:10 | 17.58 | 5.917 | 19.52 |
| 20:0:30 | 15.63 | 6.883 | 19.25 |
| 40:80:40 | 17.97 | 6.333 | 19.09 |
| 80:100:60 | 17.27 | 5.90 | 18.89 |
| 10:20:15 | 18.97 | 6.38 | 18.12 |
| 0:0:0 | 15.68 | 5.36 | 19.63 |
| Mean | 17.26 | 6.1 | 19.18 |
| SEM | 1.84 | 0.932 | 1.435 |
| CV (%) | 18.5 | 18.7 | 13 |
| F-Test | Ns | Ns | Ns |

Values are the mean of three replications; CV: Coefficient of variation; **: significant at 1% level of significance; values with the same letters in a column are not significantly different at 1% level of significance by DMRT; Ns: Non-significant

**Table 4.** Effect of different doses of NPK on Yield attributing parameters.

| Treatment Kg NPK/ha | Average number of pod/plants | Average pod length (cm) | Average Yield/ plant (g) |
|---|---|---|---|
| 40:80:40 | 6.33[a] | 12.52[a] | 39.00[a] |
| 20:30:10 | 4.60[b] | 11.84[ab] | 24.93[b] |
| 80:100:60 | 4.80[b] | 11.32[bc] | 24.13[b] |
| 20:20:20 | 4.20[bc] | 11.76[b] | 22.00[c] |
| 10:20:15 | 3.73[cd] | 11.69[b] | 21.20[c] |
| 20:0:30 | 3.10[d] | 11.36[bc] | 15.27[d] |
| 0:0:0 | 3.13[d] | 10.73[c] | 14.07[d] |
| Mean | 4.276 | 11.603 | 22.94 |
| SEM | 0.2055 | 0.229 | 0.68 |
| CV (%) | 8.3 | 3.4 | 5.1 |
| F-Test | ** | ** | ** |

Values are the mean of three replications; CV: Coefficient of variation; **: significant at 1% level of significance; values with the same letters in a column are not significantly different at 1% level of significance by DMRT.

**Number of pods:** There were important variations ($p<0.01$) in the average number of pods/plants across treatments. The plot with the largest number of pods (6.33) acquired 40:80:40 kg NPK/ha. The plot obtaining 80:100:60 kg NPK/ha had the second-greatest number of pods (4.8), trailed by (4.6) in the plot obtaining 20:30:10 kg NPK/ha, which were quantitatively equal (Table 4). The control plot and the plot obtaining 20:0:30 kg NPK/ha (3.13), which were numerically equal, had the fewest pods (3.13). The number of pods obtained in this research differs from the result obtained in the study conducted by Morab *et al.* (2021) and Kundu *et al.* (2015). This may be due to the difference in the methodology of the experiment, i.e., Morab *et al.* (2021) utilized the seeds after bio-priming and Kundu *et al.* (2015) showed to have a different purpose of cultivation.

**Pod length:** The averaged pod length varies considerably ($p<0.01$) between treatments. The plot administered with 40:80:40 kg NPK/ha had the maximum pod length (12.52 cm), preceded by 11.84 cm and 11.76 cm in plots inoculated with 20:30:10 and 20:20:20 kg NPK/ha, correspondingly, which were significantly equal. On the other hand, the control plot had the shortest pod length, trailed by plots obtaining 80:100:60, 20:0:30, and 10:20:15 kg NPK/ha, with pod lengths of 10.73cm, 11.32 cm, 11.36 cm, and 11.69 cm, consecutively. A similar result was reported in the findings of Morab *et al.* (2021), who reported that the pod length ranges from 8-11 cm. Thus, this investigation aligns with his findings.

There were considerable changes in yield and yield attributing factors amongst distinct different NPK dosages. Among seven treatments, the performance of 40:80:40 kg, NPK/ha was found best in which average pod yield per plant was located at 39.00 g, followed by 24.93 g and 24.13 g from plot treated with 20:30:10 and 80:100:60 kg NPK/ha respectively. The plot obtaining 40:80:40 kg NPK/ha had the highest approximate number of pods/plants and averaged pod length. The control plot, on the other hand, yielded similar minimal values. This result follows research done by Katoch (2013), in which 20:60:20 had performed best in the seed yield of rice beans. These results also support the finding of Hossain *et al.* (2021), who obtained the maximum seed yield of mung bean from a plot treated with 20:50:35 kg NPK/ha. This study confirms the findings of Bhupenchandra *et al.* (2019), who discovered the highest pod yield/plants, pod production/ha., the number of pods/plants, pod length, crude protein content, and tryptophan content on plots treated with 40:40:40 kg NPK/ha. The maximum average number of branches, plant height, and the number of leaves were found from plots receiving 20:20:20, 20:0:30, and 10:20:15 kg NPK/ha, and the corresponding minimum values were found from plots treated with 10:20:15, 0:0:0, and 20:0:30 kg NPK/ha. Although average values of the parameters were found to be different among treatments, statistically, these values were not significantly different, i.e., these values are at par with each other, which might be due to previous field conditions, extraneous soil factors, soil fertility gradient, soil moisture content, soil heterogeneity, soil texture, environmental factor, etc. Swathi *et al.* (2021) reported that the application of 20 kg K/ha plus 15 kg Fe/ha produces an optimum level of plant parameters encompassing plant height, nodules per plant, plant dry weight, branches per plant, pods per plant, and seeds per pod. During an investigation on rice beans, Susilowati *et al.* (2016) reported that the combination of 5 Mg organic fertilizer, 50% of recommended fertilizer, plus MVA induces the productivity and quality of the rice bean crop. Furthermore, Ponmurugan *et al.* (2016) also documented that using plant growth-promoting microbes, particularly actinomycetes, increases the growth performance and production ability in Vigna by boosting nitrogen availability and metabolism. Similarly, the result obtained in this research corresponds with the findings of Behera *et al.* (2017), who reported that applying a successive dose of nitrogen up to 40 kg/ha produces the maximum yield attributing characters, including the clusters per plant and pods per plant.

## Conclusion

This study on the effect of different fertilizer doses on the growth and yield of rice beans revealed that the different rates of NPK fertilizer significantly improved the yield and yield-attributing parameters over control among all treatments. Still, a non-significant difference was observed in vegetative parameters. Among the treatments, that T4 (40:80:40 kg NPK/ha) performed best in yield and yield attributing parameters. Therefore, it can conclude that for obtaining a better yield in rice beans, 40:80:40 kg NPK/ha can be the adequate dose. However, a single field experiment may not be sufficient for proper recommendation. So, multiple experiments should be done in locations with varying climatic conditions to draw appropriate conclusions.

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## Conflict of interest

The authors state that there is no conflict of interest in the publishing of this research.

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