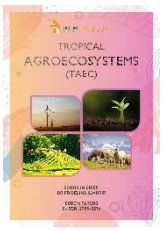
ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2735-0274 (Online)
CODEN: TARGDB

Tropical Agroecosystems (TAEC)

DOI: http://doi.org/10.26480/taec.02.2023.49.57



RESEARCH ARTICLE

RESPONSE OF DIFFERENT FERTILIZER MANAGEMENT PRACTICES ON GROWTH AND YIELD OF SPRING RICE VARIETIES AT CHEBETAR, GORKHA, NEPAL

Sadikshya Dawadi[a], Shiva Chandra Dhakal[b], Anish Paudel[c]

[a] Department of Agriculture, Agriculture and Forestry University, Rampur, Chitwan, Nepal
[b] Department of Agricultural Economics and Agribusiness Management, Agriculture and Forestry University, Rampur, Chitwan, Nepal
[c] Department of Agronomy, Agriculture and Forestry University, Rampur, Chitwan, Nepal
**Corresponding Author Email: sadikshya.dawadi@gmail.com*

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ARTICLE DETAILS

Article History:

Received 23 August 2023
Revised 26 September 2023
Accepted 30 October 2023
Available online 06 November 2023

ABSTRACT

A field experiment was conducted in Chebetar, Gorkha, Nepal from February 2021 to July 2021 in two factorial RCBD with three replications to elucidate the response of different fertilizer management practices on the growth and yield of spring rice varieties. The first factor used in the experiment was spring rice varieties (Hardinath-1, Hardinath-3 and Chaite-5). The second factor was different fertilizer management practices, i.e., Government recommended dose (120:40:40 kg NPK ha^{-1}), Farmers' practice (62.4:18.4:0 kg NPK ha^{-1}), Nutrient Expert (NE) software dose (109:28:46 kg NPK ha^{-1}) and 125% of government recommendations (150:50:50 kg NPK ha^{-1}). Traits like plant height, number of tillers per square meter, number of effective tillers per square meter, panicle length, grains per panicle, thousand grain weight, grain yield, straw yield, and harvest index were observed. Hardinath-1 outperformed other varieties in effective tillers per square meter, number of grains per panicle, grain yield, and harvest index. Hardinath-3 had higher plant height, thousand-grain weight, and straw yield, while Chaite-5 had higher panicle length. Regarding fertilizer levels, plant height and number of grains per panicle were higher for NE software dose, whereas effective tiller per square meter, thousand-grain weight and grain yield were higher for 125% of Government recommendations. From economic analysis, Gross return, Net return, and B/C ratio were obtained higher in Hardinath-1 and 125% of the Government recommended dose. Thus, Hardinath-1 along with 125% of Government recommended dose was found beneficial in the context of Chebetar, Gorkha, Nepal.

KEYWORDS

Rice; Nutrient Expert Software; Fertilizers; Yield

1. INTRODUCTION

Rice (*Oryza sativa*) is the principal food crop in the world, grown on 158 million hectares with a total production of more than 700 million tons (CGIAR, 2020). It is the world's most significant strategic crop for food and nutrition security (CDD, 2017). It is a staple food crop of Nepal (Joshi and Upadhaya, 2020). It is grown on 1.46 million hectares (ha) producing 5.15 million tons with a productivity of 3.5 t/ha (PMAMP, 2020). In Gorkha district, rice is cultivated on 12,347 ha, producing 42,474 metric tons (mt) with a productivity of 3.44 mt/ha; Main season rice accounts for 11,735 ha area, producing 39,685 mt. with a productivity of 3.38 mt/ha, while spring rice accounts for 612 ha area, producing 2,789 mt. with a productivity of 4.56 mt/ha (MoALD, 2020). The 15th Five-Year Plan aims for rice productivity to be 4.5mt/ha but only 3.76mt/ha in FY 2076/77 (NPC, 2020). The gap between the potential yield and the actual yield at the farm level is 54 % per unit of land. This indicates a prospect for productivity increment through genetic and agronomic means (MOAD, 2015). In Gorkha district, the total number of a farming family in the district are 56,671. Still, the number of households that need more food to feed families all year round is 36,952 (PMAMP, 2020).

Farmers are skeptical about the superior performance of improved varieties. Their preference to grow long-duration varieties hinders harvesting and threshing of spring season rice due to the onset of monsoon. Late harvesting of spring rice also shortens the turnaround period. So, using local cultivars indiscriminately is one of the major causes of low rice yield (Khan, et al., 2015). Moreover, farmers need to be more knowledgeable about the nutrient status of their land. According to despite having the recommended dose of 100:30:30 kg NPK per hectare, farmers were using a dose equivalent to 46:26:10 kg NPK per hectare (Bhandari et al., 2016; Adhikari et al., 2020). In contrast, many farmers use excessive fertilizers for their crop production to meet the demand of the increasing population (Hossain, et al., 2018). This indiscriminate use of chemical fertilizers negatively affects crop productivity, soil fertility and soil structure (Savci, 2012).

Site-specific nutrient management (SSNM) enables nutrition management to be tailored to the field and location-specific conditions (IRRI, 2007). Site-specific fertilizer recommendations can be made from computer-based tools like Nutrient Expert (IPNI, 2017). However, studies have yet to be done on developing a site and variety-specific fertilizer recommendations (FAO, 2006). Besides, there is no recommendation on the dose of chemical fertilizer for spring season rice. According to location-specific and variety-specific fertilizer recommendations and management are critical (Sapkota et al., 2017). Thus, this study is of immense importance to improve growth and yield through proper varietal choice and appropriate nutrient doses of spring rice varieties.

2. MATERIAL AND METHODS

The experiment was conducted at Chebetar-10, Gorkha, Nepal. The site is under the Project Implementation Unit (PIU), Rice zone of the Prime

Quick Response Code	Access this article online	
	Website: www.taec.com.my	DOI: 10.26480/taec.02.2023.49.57

Cite The Article: Sadikshya Dawadi, Shiva Chandra Dhakal, Anish Paudel (2023). Response of Different Fertilizer Management Practices on Growth and Yield of Spring Rice Varieties at Chebetar, Gorkha, Nepal. *Tropical Agroecosystems, 4(2): 49-57*.

Minister Agriculture Modernization Project (PMAMP). Geographically, the study site is located at at 27⁰99′ N latitude and 84⁰63′ E longitude at an elevation of 389 masl. The research was carried out from February 2021 to July 2021. The experimental site has a sub-tropical climate zone. Therefore, the climate of the study area is favorable for rice production. During the study period (February to July 2021), the maximum temperature was recorded in April (32⁰C), while the lowest temperature was recorded in February (11⁰C). Likewise, precipitation was highest during July, i.e., up to 845mm and lowest during March (2.1mm). Similarly, relative humidity was also high during July (89%) and lowest during April (19%), as represented by Figure 1.

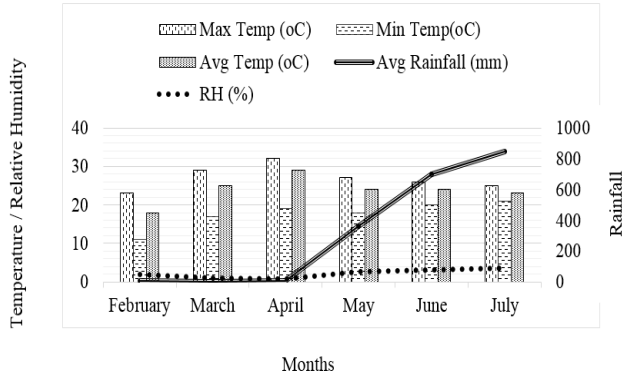

Figure 1: Weather data of experimental location for rice growing season at Gorkha, Nepal, 2021 (Source: World weather online, 2021)

The physicochemical properties of soil are presented in Table 1.

Table 1: Physiochemical properties of experimental soil at Chebetar, Gorkha, 2021

Soil Properties	Result	Category
Soil texture	Sandy loam	
Soil pH	6.2	Acidic
Total Nitrogen (%)	0.08	Low (<0.1)
Available Phosphorus (kg ha^{-1})	45.8	Medium (30-55)
Available Potassium (kg ha^{-1})	84.7	Low (< 110)
Organic Matter content (%)	1.66	Low (< 2.5)

The experiment was conducted in two factor RCBD design with three replications, wherein the first factor was spring rice varieties (Hardinath-1, Hardinath-3, and Chaite-5), and the second factor was different fertilizer management practices, i.e., Government recommended dose (120:40:40 NPK, kg ha^{-1}), Farmers' practice (62.4:18.4:0 NPK, kg ha^{-1}), Nutrient Expert software dose (109:28:46 NPK, kg ha^{-1}) and 125% of Government recommendation (150:50:50 NPK, kg ha^{-1}). The total treatments were 12 (3*4), so the total experimental units were 36. Each plot size was 3m*3m (9m^2), accommodating 225 plants. Twenty-seven days old seedlings were transplanted at the rate of three seedlings per hill at a spacing of 20cm*20cm. Plot to plot spacing of 0.5m and replication to replication spacing of 1m was maintained. The total experimental area was 42.5m*12m (l*b), i.e., 510 sq. m.

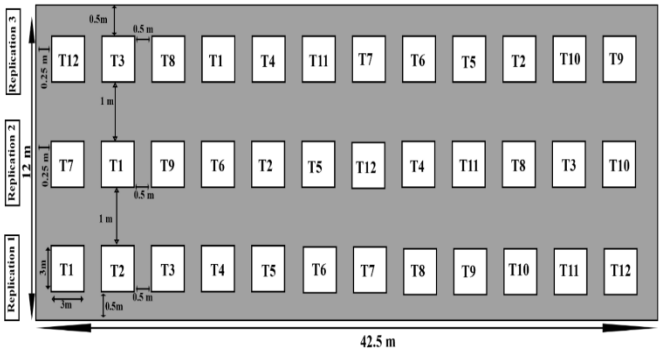

Figure 2: Layout of the experimental plot

In each plot, the total dose of phosphorus and potash and 50% nitrogen per treatment were applied as basal dose. The remaining dose of nitrogen was top-dressed during tillering and panicle initiation. Pre-emergence herbicide (Pretilachlor) and Fipronil 0.3% GR were applied for plant protection. Light irrigation was provided immediately after transplanting, and sufficient irrigation was provided during tillering and panicle initiation. Nutrient expert software based on computer decision was used to decide the amount of fertilizers to be applied under nutrient expert dose. The farmer's practice dose was applied based on the application of fertilizers by the existing local farmers and they were relying only on urea and diammonium phosphate in their field. Various biometrical observations, yield and yield attributing characters were recorded. Economic analysis was done on the existing price in the market. MS- Excel was used for data entry and tabulation, and R-studio software was used for data analysis.

3. Result and Discussion

3.1 Biometrical observation

3.1.1 Plant height

Varieties significantly influenced plant height at all the growth stages except 75 DAT. At 30 DAT, the plant height of Hardinath-3 (33.15 cm) was statistically higher than other treatments, while the smallest plant height was found in Chaite-5 (29.30 cm), which was statistically at par with Hardinath-1 (30.69 cm). Likewise, at 45 DAT, the plant height of Hardinath-3 (51.43cm) was found to be significantly higher than Hardinath-1 (47.76 cm) but was statistically at par with Chaite-5 (49.04 cm). Furthermore, at 60 DAT, plant height was found to be significantly higher in Hardinath-3 (79.53 cm) followed by Chaite-5 (75.04 cm), while statistically lowest plant height was observed in Hardinath-1 (71.18 cm). Moreover, at 75 DAT, Hardinath-3 was superior in plant height to the rest of the genotypes. Although various nutrient management practices did not significantly influence plant height, it was found to be maximum on Nutrient Expert's recommended dose at all growth stages except 30 DAT. In contrast, minimum plant height was recorded on government-recommended doses at all growth stages except 45 DAT (Table 2).

Table 2: Plant height (cm) as influenced by different fertilizer management practices of spring rice varieties at Chebetar, Gorkha, 2021

	Plant height (cm)			
Treatments	**30DAT**	**45DAT**	**60DAT**	**75DAT**
Varieties				
Hardinath-1	30.69^{b}	47.76^{b}	71.18^{c}	87.71
Hardinath-3	33.15^{a}	51.43^{a}	79.53^{a}	93.71
Chaite-5	29.30^{b}	49.04^{ab}	75.04^{b}	90.46
LSD (=0.05)	2.191	2.64	3.76	ns
Sem (±)	0.747	0.9	1.28	1.73
F probability	<0.01	<0.05	<0.001	0.07
Fertilizer doses				
Government recommended	29.91	48.86	73.99	88.91
Farmers' practice	32.53	49.91	74.19	89.18
Nutrient Expert recommended	31.66	50.60	77.59	92.50
125% of Government recommended	30.06	48.27	75.24	91.91
LSD (=0.05)	ns	ns	ns	ns
SEm (±)	0.862	1.04	1.48	2.002
F probability	0.12	0.40	0.32	0.48
CV, %	8.34	6.31	5.90	6.62
Grand mean	31.04	49.41	75.25	90.62

Note: The common letter(s) within the column in superscript indicate non-significant difference based on Duncan multiple range test (DMRT) at 0.05 level of significance. LSD: Least Significant Difference, SEm: Standard Error of mean, CV: Coefficient of Variance, DAT: Days After Transplanting, ns: Non-significant; GRD: (120:40:40 NPK, kg ha^{-1}), FP: (62.4:18.4:0 NPK, kg ha^{-1}), NE: (109:28:46 NPK, kg ha^{-1}), 125% GRD: (150:50:50 NPK, kg ha^{-1})

Hardinath-3 was observed to have maximum plant height, which was in line with the findings of (Niraula et al., 2020). According to plant height is a varietal attribute and a genetic feature of the cultivar; hence plant height differed amongst cultivars (Chamely et al., 2015). The NE treatment produced the largest plant height, according to (Gupta et al., 2016).

3.1.2 Number of tillers per square meter

Varieties did not significantly influence the number of tiller m-2 in all the growth stages except 60 DAT. At 60 DAT, the tiller m^{-2} was significantly higher in Hardinath-1 (163.25 m^{-2}). Conversely, a statistically lower number of tiller m^{-2} was found in Hardinath-3 (133.30 m^{-2}), which was statistically at par with Chaite-5 (137.37 m^{-2}). Likewise, the number of tiller m^{-2} was found to be significantly influenced by fertilizer management practices at all the growth stages except 30 DAT and 45 DAT. At 60 DAT, the number of tiller m^{-2} was higher on 125% of the Government recommended dose (163.50 m^{-2}) and lowest on Government recommended dose (119.67 m^{-2}). Furthermore, at 75 DAT, the number of tiller m^{-2} was highest on 125% of Government recommended dose (146.47 m^{-2}) and least on Farmers' practice (116.05 m^{-2}) (Table 3).

Table 3: Tiller number m^{-2} as influenced by different fertilizer management practices of spring rice varieties at Chebetar, Gorkha, 2021

	Tiller number m^{-2} at different days of transplanting			
Treatment	**30DAT**	**45DAT**	**60DAT**	**75DAT**
Varieties				
Hardinath-1	41.58	99.58	163.25^{a}	131.20
Hardinath-3	35.91	83.41	133.30 ^{b}	123.17
Chaite-5	35.91	99.75	137.37^{b}	143.67
LSD (=0.05)	ns	ns	16.17	ns
Sem (±)	2.45	6.99	5.51	6.34
F probability	0.19	0.18	<0.01	0.09
Fertilizer doses				
Government recommended	33.67	80.77	119.67^{b}	124.78^{ab}
Farmers' practice	40.56	94.11	147.28^{a}	116.05^{b}
Nutrient Expert recommended	38.33	97.44	148.11^{a}	143.22^{a}
125% of Government recommended	38.67	104.67	163.50^{a}	146.47^{a}
LSD (=0.05)	ns	ns	18.67	21.48
Sem (±)	2.83	8.07	6.36	7.32
F probability	0.38	0.23	<0.001	<0.05
CV, %	22.46	25.68	13.20	16.56
Grand mean	37.80	94.25	144.63	132.68

The interactive effect of nutrient management practices of spring rice varieties on tiller number per square meter at 60 DAT is shown in Table 4. The tillers for Hardinath-1 were significantly higher on farmers' practice (182.67 m^{-2}), Nutrient Expert software recommended dose (159 m^{-2}), and 125 % of Government recommended dose (166 m^{-2}) than 100 % Government recommended dose (145.33 m^{-2}) whereas for Hardinath-3 it was significantly higher on 125 % of Government recommended dose (165 m^{-2}) than other nutrient management practices. But for Chaite-5, Nutrient Expert software recommended dose and 125% of Government recommended dose were statistically similar to each other but significantly higher than other treatments in terms of tillers per square meter.

Table 4: Tiller number m^{-2} at 60 days after transplanting as influenced by interaction of different fertilizer management practices of spring rice varieties at Chebetar, Gorkha, 2021

Fertilizer doses	**Varieties**		
	Hardinath-1	**Hardinath-3**	**Chaite-5**
Government recommended	145.33^{bc}	122.67^{cd}	91^{d}
Farmers' practice	182.67^{a}	122.5^{cd}	136.67^{bc}
Nutrient Expert recommended	159^{ab}	123^{cd}	162.33^{ab}
125% of Government recommended	166^{ab}	165^{ab}	159.5^{ab}
SEm (±)	11.03		
CV,%	13.20		
LSD (=0.05)	50.27		

The number of tillers m^{-2} were increased with the increasing amount of fertilizer levels which is consistent with the finding of (Ntanos and Koutroubas, 2002).

3.2 Yield and yield attributing characters of rice

3.2.1 Panicle length

Panicle length was recorded significantly higher on Chaite-5 (23.24 cm) than Hardinath-3 (22.39 cm), which was statistically at par with Hardinath-1 (22.62 cm). However, the variation in panicle length was not significantly affected by various fertilizer management practices. Nevertheless, panicle length was longest at 125% of Government recommended dose (23.10 cm) followed by Government recommended dose (22.80 cm), Farmers' practice (22.67cm) and Nutrient Expert software recommended dose (22.43 cm) (Table 5).

3.2.2 Number of effective tillers per square meter

The analyzed data presented in Table 5 showed that the number of effective tiller m-$^{-2}$ in all the treatments was found significant at a 1 % level of significance. Effective tiller number m-2 was significantly higher on Hardinath-1 (297.12 m^{-2}) and Chaite-5 (287.33 m^{-2}) than Hardinath-3

(240.5 m^{-2}). Moreover, the number of effective tiller m-2 was statistically higher in 125% of Government recommended dose (296.83 m^{-2}), Government recommended dose (287.44 m^{-2}) and Nutrient Expert software recommended dose (281.88 m^{-2}) than in Farmers' practice (233. 77 m^{-2}).

Furthermore, effective tiller m^{-2} was significantly influenced by the interaction of different fertilizer management practices and spring rice varieties. Effective tiller m^{-2} for Hardinath-1 was significantly higher in 125% of Government recommended dose (343.5 m^{-2}) than other nutrient management practices, but it was statistically at par with Government recommended dose (297 m^{-2}). For Hardinath-3, the effective tiller m^{-2} was significantly higher in Government recommended dose than all other nutrient doses (260.33 m^{-2}). Furthermore, for Chaite-5, the effective tiller m^{-2} was significantly higher in the Nutrient Expert software recommended dose (333.67 m^{-2}) than in Farmers' practice (210.33 m^{-2}), but it was statistically similar to Government (305 m^{-2}) and 125% of Government recommended dose (300.33 m^{-2}) (Table 6).

3.2.3 Number of grains per panicle

Hardinath-1 (123.74) was superior in terms of the number of grains per panicle, which was statistically similar to Chaite-5 (119.23), while a statistically lower number of grains per panicle was observed in Hardinath-3 (81.06). However, fertilizer management practices did not significantly influence the differences in the number of grains per panicle. Nevertheless, it was found to be highest on Nutrient Expert software recommended dose (115.8) and lowest on Farmers' practice (97.19), as shown in Table 5.

3.2.4 Sterility percent

Statistically, sterility percent was higher in Hardinath-3 (49.84%), followed by Chaite-5 (40.76%) and lower in Hardinath-1 (28.61%). However, the sterility percentage variation was insignificant among various fertilizer management practices. Nevertheless, the maximum number of sterile grains was observed on Government recommended dose (41.60%), followed by 125% of Government recommended dose (39.85%), Nutrient Expert software recommended dose (39%) and Farmers' practice (38.48%) respectively (Table 5).

Table 5: Effective tiller number m^{-2}, Panicle length (cm), Grain per panicle and Sterility percentage of rice as influenced by different fertilizer management practices of spring rice varieties at Chebetar, Gorkha, 2021

Treatment	Effective tillers (no. m^{-2})	Panicle length (cm)	Number of grains per panicle	Sterility (%)
Varieties				
Hardinath-1	297.12^{a}	22.62^{ab}	123.74^{a}	28.61^{c}
Hardinath-3	240.5^{b}	22.39^{b}	81.06^{b}	49.84^{a}
Chaite-5	287.33^{a}	23.24^{a}	119.23^{a}	40.76^{b}
LSD (=0.05)	25.13	0.75	22.15	5.2
SEm (±)	8.57	0.26	7.55	1.77
F probability	<0.001	<0.1	<0.001	<0.001
Fertilizer doses				
Government recommended	287.44^{a}	22.80	110.61	41.60
Farmers' practice	233.77^{b}	22.67	97.19	38.48
Nutrient Expert recommended	281.88^{a}	22.43	115.8	39
125% of Government recommended	296.83^{a}	23.10	108.43	39.85
LSD (=0.05)	29.02	ns	ns	ns
SEm (±)	9.89	0.29	8.72	2.05
F probability	<0.001	0.502	0.502	0.72
CV, %	10.79	3.91	24.23	15.46
Grand mean	274.98	22.75	108.01	39.73

Table 6: Effective tiller number m^{-2} of rice as influenced by interaction of different fertilizer management practices of spring rice varieties at Chebetar, Gorkha, 2021

Fertilizer doses	Varieties		
	Hardinath-1	Hardinath-3	Chaite-5
Government recommended	297^{abc}	260.33^{cdef}	305^{abc}
Farmers' practice	262^{cde}	229^{ef}	210.33^{f}
Nutrient Expert recommended	286^{bcd}	226^{ef}	333.67^{ab}
125% of Government recommended	343.5^{a}	246.67^{def}	300.33^{abc}
SEm (±)	17.14		
CV,%	10.79		
LSD (=0.05)	50.27		

Effective tiller m^{-2} was found to be maximum for Hardinath-1, which was significantly different from Hardinath-3 but was at par with Chaite-5. The variance in the genetic makeup of the variety is the cause of the variability in the number of effective tiller m^{-2} (Roy, et al., 2014). According to all evaluated rice genotypes were found to be highly significant ($p < 0.01$) for plant height, panicle length, number of tillers/ plant, and grain yield (Shrestha et al., 2021). However, conclude that the interaction between rice varieties and nitrogen rates for panicle length was insignificant (Gewaily et al., 2018). Likewise, grain $panicle^{-1}$ was significantly higher for Hardinath-1 than Hardinath-3 but was found statistically at par with Chaite-5. A group researcher finds a highly significant difference in grain panicle-1 among different rice genotypes during their research (Raisheed et al., 2002). Moreover, the filled grain per panicle was found to be highest in Nutrient Expert, which corroborates with the experiment of (Gupta et al., 2016).

Table 7 depicts that Hardinath-1 had maximum sterile grains in 125% of Government recommended doses which was statistically at par with

Government recommended doses and Farmers' practice, while minimum sterile grains were found in Nutrient Expert software's recommended dose. Likewise, for Hardinath-3, statistically higher sterile grains were found in Government recommended dose, followed by 125% of the Government recommended dose, Farmers' practice, and Nutrient Expert software recommended dose, respectively. Moreover, for Chaite-5, the sterility percentage of grains was found to be maximum on Nutrient Expert software recommended dose followed by Government recommended dose, 125% of Government recommended dose and Farmers' practice, respectively.

Table 7: Sterility percentage of rice as influenced by interaction of different fertilizer management practices of spring rice varieties at Chebetar, Gorkha, 2021

Fertilizer doses	Varieties		
	Hardinath-1	Hardinath-3	Chaite-5
Government recommended	28.27^{de}	55.44^{a}	41.09^{bc}
Farmers' practice	29.53^{de}	50.81^{ab}	35.11^{cde}
Nutrient Expert recommended	26.64^{e}	40.83^{bc}	49.53^{ab}
125% of Government recommended	29.99^{de}	52.27^{a}	37.30^{cd}
SEm (±)	3.54		
CV,%	15.46		
LSD (=0.05)	10.40		

3.3 Thousand grain weight (TGW)

Hardinath-3 was found superior in terms of thousand-grain weight (22.36g), which was statistically similar to Hardinath-1(21.88 g), while significantly lower thousand-grain weight was recorded in Chaite-5 (17.56 g), as depicted in Figure 3. However, the differences in thousand-grain weight were not significantly influenced by various nutrient management practices. Nevertheless, the maximum thousand-grain weight was observed in 125% of Government recommended dose (20.98 g), whereas the minimum in Nutrient Expert software recommended the dose (20.18 g), as shown in Figure 4.

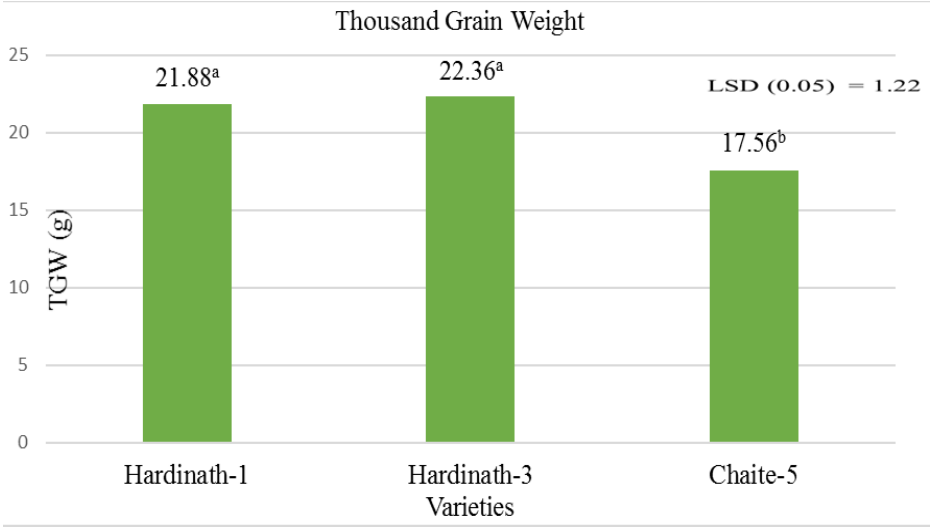

Figure 3: Thousand Grain Weight (g) as influenced by spring rice varieties at Chebetar, Gorkha, 2021

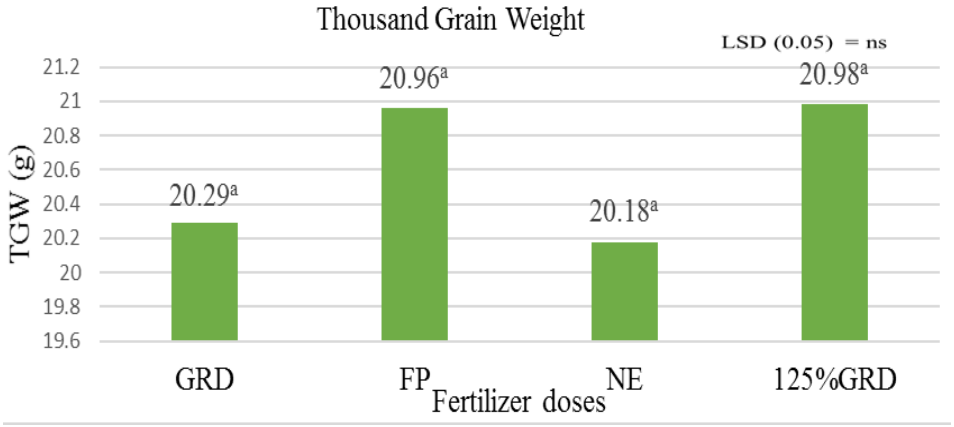

Figure 4: Thousand Grain Weight (g) of rice as influenced by different fertilizer management practices of spring rice varieties at Chebetar, Gorkha, 2021

3.4 Grain yield

The analyzed data (Figure 5) revealed that grain yield was significantly higher in Hardinath-1 (3929.28 kg ha^{-1}), and significantly lower grain yield was recorded in Hardinath-3 (3011.32 kg ha^{-1}), which was statistically at par with Chaite-5 (3237.59 kg ha^{-1}). Likewise, significantly higher grain yield was found in 125% of the Government recommended dose (3889.02 kg ha^{-1}) than all other treatments, which were observed to be statistically similar with each other, i.e., grain yield on Nutrient expert recommendation dose was 3345.93 kg ha^{-1} followed by Government recommended dose (3334.16 kg ha^{-1}) and Farmers' practice (2901.82 kg ha^{-1}) respectively (Figure 6).

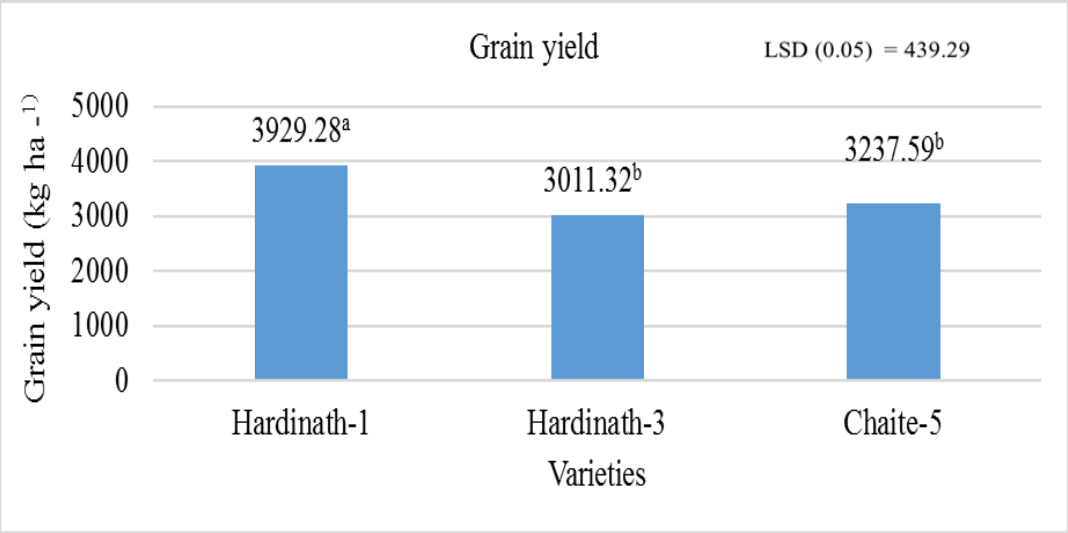

Figure 5: Grain Yield (kg ha^{-1}) as influenced by spring rice varieties at Chebetar, Gorkha, 2021

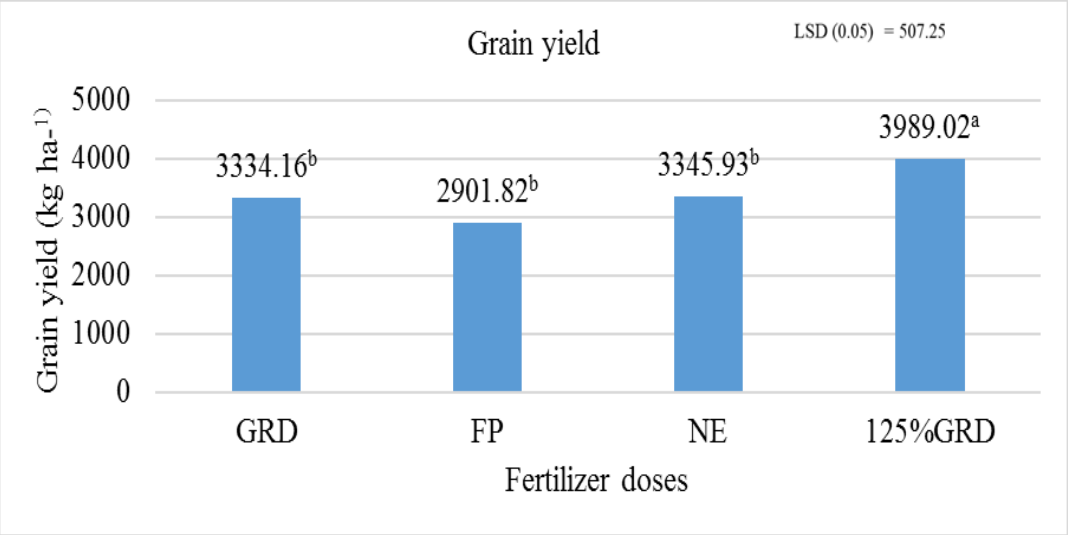

Figure 6: Grain Yield (kg ha^{-1}) of rice as influenced by different fertilizer management practices of spring rice at Chebetar, Gorkha, 2021

Besides, the interaction of various fertilizer management practices and spring rice varieties showed a significant interactive effect on grain yield, presented in Table 8. Grain yield was significantly superior to Government recommended dose (4507.26 kg ha^{-1}), the Nutrient expert-recommended dose (4254.23 kg ha^{-1}), and 125% of the Government recommended dose (3828.17 kg ha^{-1}) than Farmers' practice (3127.43 kg ha^{-1}).

Table 8: Grain Yield (kg ha^{-1}) of rice as influenced by interaction of different fertilizer management practices of spring rice varieties at Chebetar, Gorkha, 2021

Fertilizer doses	Varieties		
	Hardinath-1	Hardinath-3	Chaite-5
GRD	4507.26^{a}	2491.43^{d}	3003.77^{cd}
Farmers' practice	3127.43^{bcd}	2799.62^{d}	2778.39^{d}
Nutrient Expert Software	4254.23^{a}	2768.25^{d}	3015.29^{cd}
125% of GRD	3828.17^{abc}	3985.98^{ab}	4152.90^{a}
SEm (±)	299.56		
CV,%	15.29		
LSD (=0.05)	878.58		

Grain yield was significantly higher in 125% of government-recommended doses than in other treatments. The increase in grain yield might be due to nitrogen application enhancing the dry matter production, improving rice growth rate, promoting elongation of internodes and activity of growth hormones like gibberellins (Gewaily et al., 2018). There were significant differences among various rice genotypes in grain yield produced. The highest grain yield was recorded in Hardinath-1. The highest grain yield might be due to its most filled grains panicle-1 (Roy et al., 2014).

3.5 Straw yield

Spring rice varieties significantly influenced variation in straw yield. It was significantly higher for Hardinath-3 (4029.1 kg ha^{-1}) than all other treatments (Figure 7). However, differences in straw yield were not significantly affected by various fertilizer doses. But, it was higher in farmers' practice (3431.39 kg ha^{-1}) followed by Nutrient expert recommendation dose (3352.58 kg ha^{-1}), Government recommend dose (3319.64 kg ha^{-1}) and 125% of Government recommended dose (3110.14 kg ha^{-1}) (Figure 8).

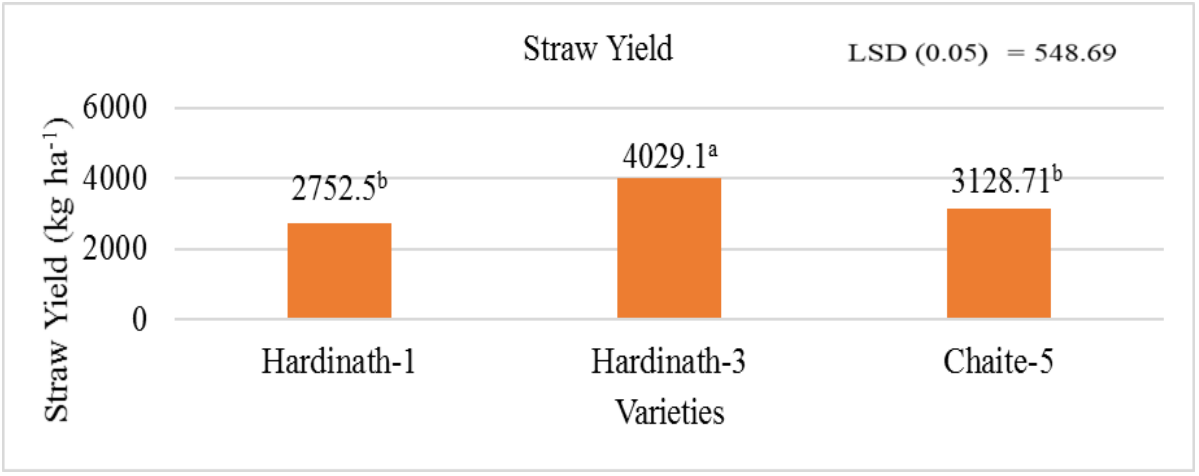

Figure 7: Straw Yield (kg ha^{-1}) as influenced by spring rice varieties at Chebetar, Gorkha, 2021

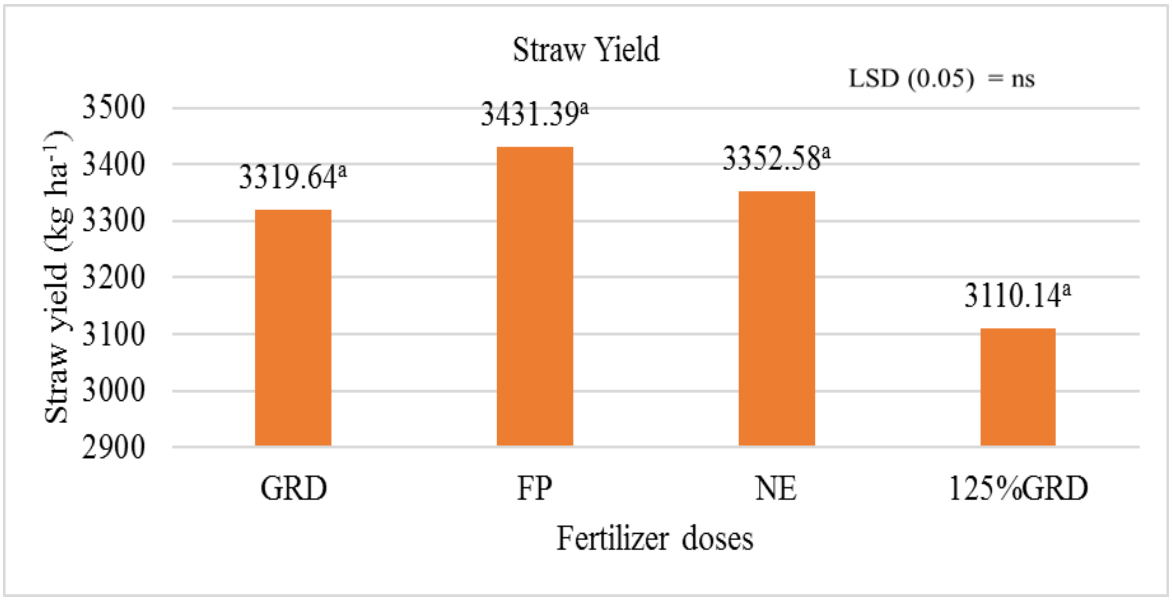

Figure 8: Straw Yield (kg ha^{-1}) of rice as influenced by different fertilizer management practices of spring rice at Chebetar, Gorkha, 2021

The straw yield was highest in Hardinath-3, consistent with the finding of Niraula et al. (2020).

3.6 Harvest index (HI)

Different spring rice varieties exerted a significant influence on the harvest index. It was significantly higher for Hardinath-1 (0.61) and significantly lowest for Hardinath-3 (0.42). (Figure 9) However, different nutrient management practices did not significantly affect variation in Harvest Index. The highest harvest index was found in Farmers' practice 0.54, while it was lowest in Government recommended dose (0.49), as shown in Figure 10.

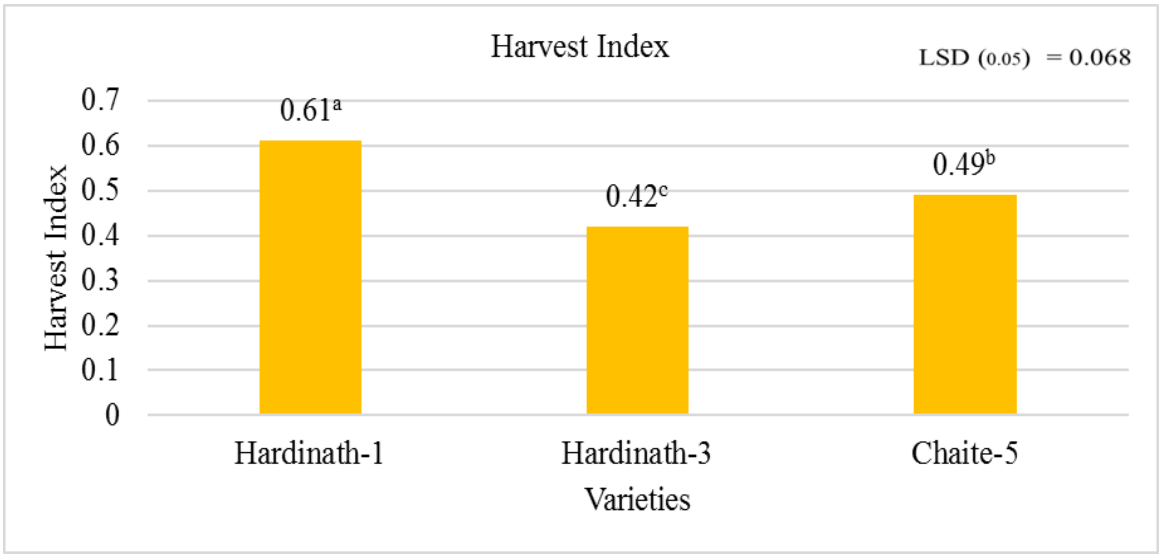

Figure 9: Harvest Index as influenced by spring rice varieties at Chebetar, Gorkha, 2021

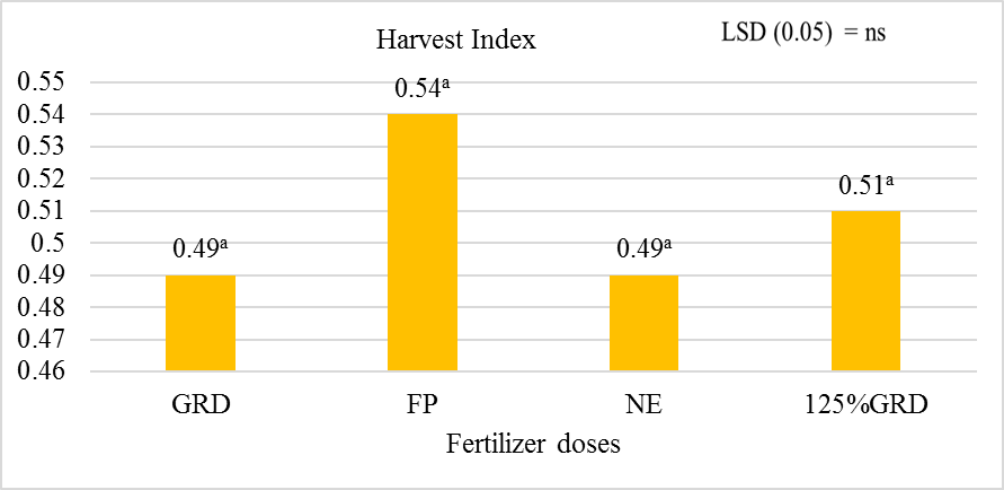

Figure 10: Harvest Index of rice as influenced by different fertilizer management practices of spring rice at Chebetar, Gorkha, 2021

Likewise, the Grain yield and harvest index of Hardinath-1 were superior to other treatments, which corroborates with the findings of Puri et al. (2021).

4. Economic Analysis

Table 9 depicts that cost of cultivation did not vary significantly in the case of variety because of the exact cost of cultivation among all the varieties due to similar agronomic practices and the cost of seeds. Moreover, as there are different doses of fertilizers in different nutrient management practices, there was a significant difference in the cost of cultivation due to the difference in the cost of Urea, DAP, and MOP in different treatments. The maximum cost was incurred in 125% of the Government recommended dose (NRs. 83607), while the minimum cost was observed in Farmers' practice (NRs. 70880). Likewise, the Gross return was recorded significantly higher in Hardinath-1 (NRs. 123004.5) than in the rest of the treatments. Furthermore, 125% of Government recommended doses (NRs. 127716.7) had significantly higher gross returns than all other treatments. Moreover, the Net return was observed to be statistically higher in Hardinath-1 (NRs. 43827.47) than in other varieties. However, the Net return was not significantly influenced by fertilizer management practices. Numerically, the highest net return was obtained from 125% of Government recommended dose (NRs. 44109.74). Besides, the B/C ratio was obtained significantly higher in Hardinath-1 (1.55) and Hardinath-3 (1.47) than in Chaite-5 (1.37). In the case of nutrient levels, 125% of Government recommended doses recorded a maximum B/C ratio (1.53), and the statistically lowest B/C ratio was observed in Government recommended doses (1.41).

Table 9: Economics as influenced by of rice as influenced by interaction of different fertilizer management practices of spring rice varieties at Chebetar, Gorkha, 2021

Treatments	Cost of cultivation	Gross Return	Net Return	Benefit: Cost
Varieties				
Hardinath-1	67300	123004.5^{a}	43827.47^{a}	1.55^{a}
Hardinath-3	67300	111545.0^{b}	32368.00^{b}	1.47^{a}
Chaite-5	67300	109098.2^{b}	29921.17^{b}	1.37^{b}
LSD (=0.05)	ns	11222.9	11222.9	0.1004634
SEm (±)		3826.55	3826.55	0.03425395
F probability		<0.05	<0.05	<0.01
Fertilizer doses				
Government recommended	80321^{c}	113230.8^{b}	32909.76^{a}	1.41^{b}
Farmers' practice	70880^{d}	103427.9^{b}	32547.92^{a}	1.45^{ab}
Nutrient Expert recommended	81900^{b}	113821.4^{b}	31921.43^{a}	1.47^{ab}
125% of Government recommended	83607^{a}	127716.7^{a}	44109.74^{a}	1.53^{a}
LSD (=0.05)		12959.09	12959.09	0.1160051
SEm (±)		4418.53	4418.53	0.03955306
F probability		<0.01	0.18	0.24
CV, %		11.57	37.47	8.08
Grand Mean	79177	114549.2	35372.21	1.47

5. Conclusion

Plant height and straw yield were higher for Hardinath-3 and other growth parameters, and yield attributes and yield were higher for the Hardinath-1 variety. Likewise, 125 % of Government recommended dose is required for Hardinath-3 and Chaite-5, while Hardinath-1 is superior in all other nutrient management practices except in farmers' doses. Moreover, few growth parameters and yield attributes were better for Nutrient Expert. In contrast, most of the yield attributes along with yield were superior while increasing the government recommendation by 25%. Thus, the newer high-yielding varieties need higher nutrients for good yield. Hence, site-specific nutrient management should be considered before recommending the fertilizer dose to attain better growth and yield performance of each released rice variety. Regarding economic analysis from the study, Gross return, net return and B/C ratio were obtained higher in Hardinath-1 and 125% of the Government recommended dose. Thus, Hardinath-1 with 125% of government recommendations, can be used to boost the growth and yield of rice in Gorkha, Nepal.

Acknowledgements

I want to express my profound gratitude to Agriculture and Forestry University, Rampur, Chitwan, for allowing me to participate in an internship program under PMAMP. Furthermore, I want to express my deepest acknowledgement, sincere gratitude and indebtedness to all the concerned people of the PMAMP for their significant contribution and support in my study.

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