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RESEARCH ARTICLE

A STUDY OF TWELVE SPRING RICE GENOTYPES WITH FARMERS' PARTICIPATION IN KAILARI VILLAGE, KAILALI, NEPAL

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ABSTRACT

Spring rice (*Oryza sativa* L.) plays a crucial role as Nepal's primary staple cereal crop. It has a high potential as an alternative during low rice production in the main season, ensuring food self-sufficiency. A field study was conducted on spring rice at a farmer field school, Kailari Rural Municipality-09, Kailali district, Nepal to identify the best-performing and the most preferred genotypes by the farmers through the participatory approach. The experiment was laid out in randomized complete block design (RCBD) with twelve spring rice genotypes including a local check variety. Each treatment was replicated thrice. Statistically significant differences in yield and yield-attributing traits were observed among the genotypes under observation. Average plant height was recorded as the highest in Hardinath-3 (101.75 cm) followed by IR17L1387 (99.78 cm), Jhumka (98.74 cm), and IR17A3019 (96.55 cm) with the lowest in IR16A3838 (84.79 cm). Similarly, the total number of tillers and effective tillers were found to be the greatest in IR18A1451 and IR17A3019 respectively at harvest. The sterility percentage was lowest in IR17A3012 followed by IR17A3019 whereas highest in Hardinath-4. Similarly, the Hardinath-1 variety matured earlier than, IR16A3838 and IR17A3019. Hardinath-4 variety followed by Jhumka was a late maturing variety. Maximum grain yield was found in IR17A3012 (6.06 $t\ ha^{-1}$) which was followed by IR17A3019 (5.97 $t\ ha^{-1}$) and superior to the local check variety (Jhumka). Thus, the farmers' preference score was found to be maximum (0.09) in the IR17A3019 genotype which signifies that this genotype has certain preferable traits such as early and uniform maturity, low disease and pest attack, a high number of effective tillers, panicle length, and sterility percentage.

KEYWORDS

Farmer field school, Participatory varietal selection (PVS), Preference analysis, Sterility, Varietal evaluation

1. INTRODUCTION

Rice, a vital staple cereal crop and primary food source for over half of the world's population, contributes more than 20 % of the total calories consumed by the entire world population (Fukagawa and Ziska, 2019). As a semi-aquatic, bisexual, and self-pollinated crop belonging to the Poaceae family, rice plays a crucial role in providing sustenance. In Nepal, Rice ranked first in the area (1,477,378 ha) and production (5,130,625 mt) with 3.47 t/ha productivity in Nepal contributing 13.60 % in AGDP (Ministry of Agriculture and Livestock Development [MoALD], 2023b). Rice has a high yield potential of 5.20 t/ha in Kailali district (MoALD, 2023b). About 7 % of the rice area in Nepal falls under the spring (Chaite) season and 92 % is under the main (Barkhe) season (Jaishi et al., 2020). The transplanting month of spring rice falls within the Nepali month "Chaitra" and hence, is known as Chaite rice. Spring rice covers an area of 5.48 %, 24.85 %, and 69.67 % in mountains, hills, and terai respectively (Regmi et al., 2023).

In Kailali district, spring rice covers 1,080 ha with a production of 5,616 mt and a productivity of 5.20 t/ha (MoALD, 2023b). Despite its higher productivity compared to the main season, spring rice is not cultivated extensively. Government recommendations include varieties like Chaite-2, Chaite-6, Hardinath-1, and Chaite-5 for terai regions, known for their short duration and suitability for making beaten rice (Chiura) (MoALD, 2023a). Spring rice's effectiveness lies in its lower production loss rates, adaptability to various conditions, and resistance to diseases and pests. This crop contributes to agro-biodiversity and promotes sustainable agro-ecological systems. However, challenges such as the non-availability of preferred genotypes and farmers' lack of confidence in spring rice's yield performance hinder its widespread cultivation in Kailari Rural Municipality.

The study aims to address these challenges through Participatory Varietal Selection (PVS), allowing farmers to actively engage in evaluating and selecting genotypes based on their preferences and desired traits. By doing so, farmers will gain the confidence to cultivate spring rice on a larger scale, thereby increasing overall productivity. This shift towards spring rice cultivation holds multiple benefits, including economic advantages, improved nutritional security, and enhanced agro-biodiversity prospects (Kumar et al., 2022). PVS is proven to be an effective approach in harnessing the yield potential of varieties and increasing the genetic diversity in crops (Bradshaw, 2004; Joshi and Witcombe, 1996; Joshi et al., 1997; Maurya et al., 1988). By prioritizing farmers' interests, the research seeks to enhance the development of high-potential spring rice genotypes in Kailari Rural Municipality, contributing to food security, improved nutrition, and economic well-being.

Farmers' involvement in varietal selection is crucial, as their preferences often extend beyond official breeding programs' considerations. While plant breeders focus on traits like yield, flowering duration, and stress resistance, farmers value additional traits such as straw yield, suitable plant height, thresh ability, earliness, grain quality, and disease resistance (Ceccarelli and Grando, 2007). PVS allows farmers to actively participate in the evaluation, testing, and selection process, ensuring that developed genotypes align with local needs and conditions. This study recognizes the

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importance of incorporating farmers' perspectives into rice genotypic development and aims to bridge the gap between scientific breeding efforts and the practical needs of farmers. Through collaborative efforts and participatory approaches, the research seeks to create a more sustainable and farmer-centric agricultural system in Kailari Rural Municipality, Kailali district of Nepal.

2. MATERIALS AND METHODS

2.1 Soil and Climate of the Experimental Site

The field study took place at a farmer field school in Kailari Rural Municipality-09, Gadariya, Kailali district, Sudurpaschim Province, Nepal. The site is located at approximately 28.65°N latitude and 80.76°E longitude, with an altitude of 109 meters above sea level. The soil at the experimental site is characterized as clay loam with slightly acidic conditions (pH<6.5) and a medium organic matter content (2.5% - 5%).

Table 1: Soil properties at the experimental site, Kailali

Properties	Content
Chemical Properties	
1. Soil pH	6.18
2. Soil organic matter (%)	3.15
3. Nitrogen (%)	0.16
4. Phosphorus (kg/ha)	130.35
5. Potash (kg/ha)	463.20
Texture	Clay loam

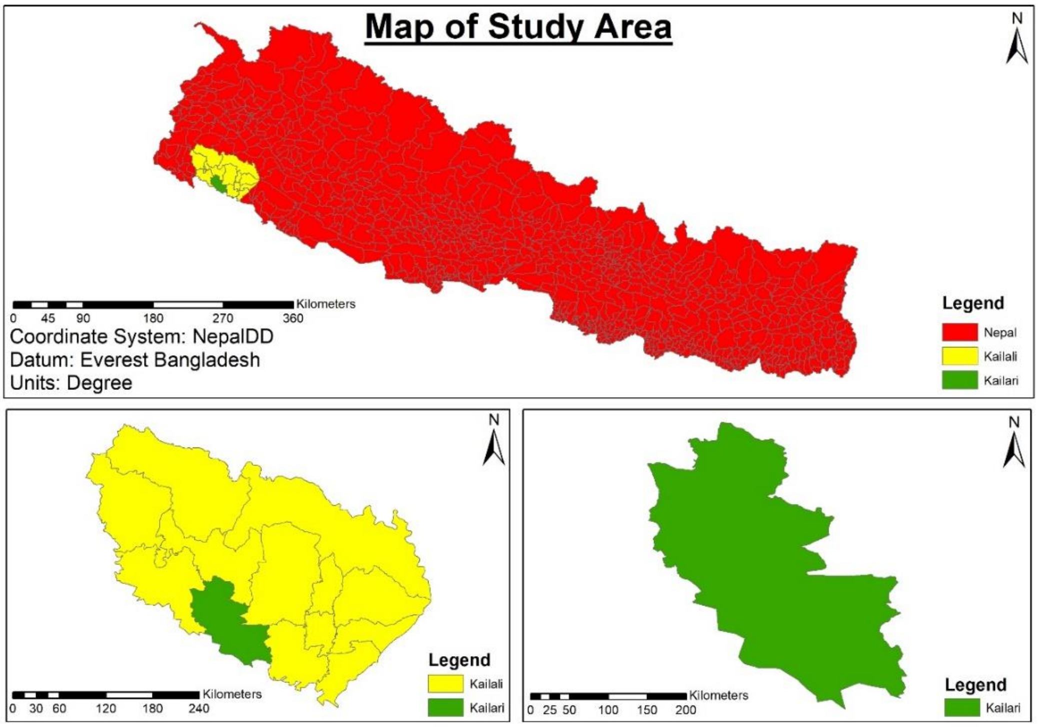


Figure 1: Map of Nepal showing Kailari Rural Municipality of Kailali district

This region experiences a subtropical climate with hot summers and mild winters. The annual precipitation ranges from 1500 to 2000 mm. Throughout the research period, Kailari RM had a subtropical climate, with maximum temperatures reaching up to 36.59 °C and minimum temperatures at 16.24 °C. Precipitation varied from 0 mm to 37.35 mm/day during the cultivation of spring rice. Maximum relative humidity (54.72%) was recorded in February, while the minimum was observed in April (26.66%). Figure 2 illustrates the weekly mean temperature, average precipitation, and average relative humidity during the spring rice cultivation period in Kailali district.

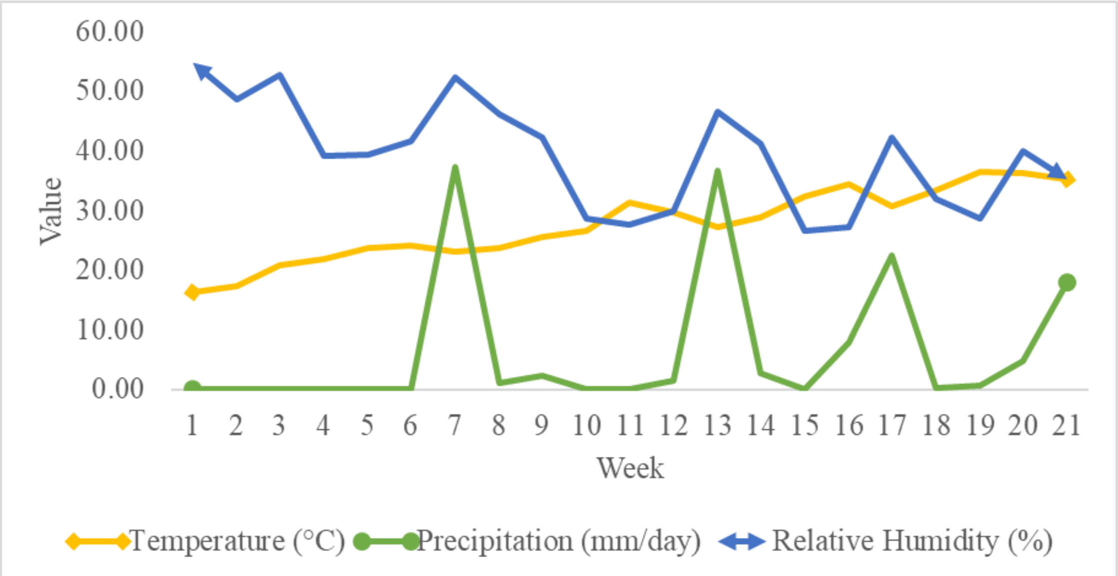


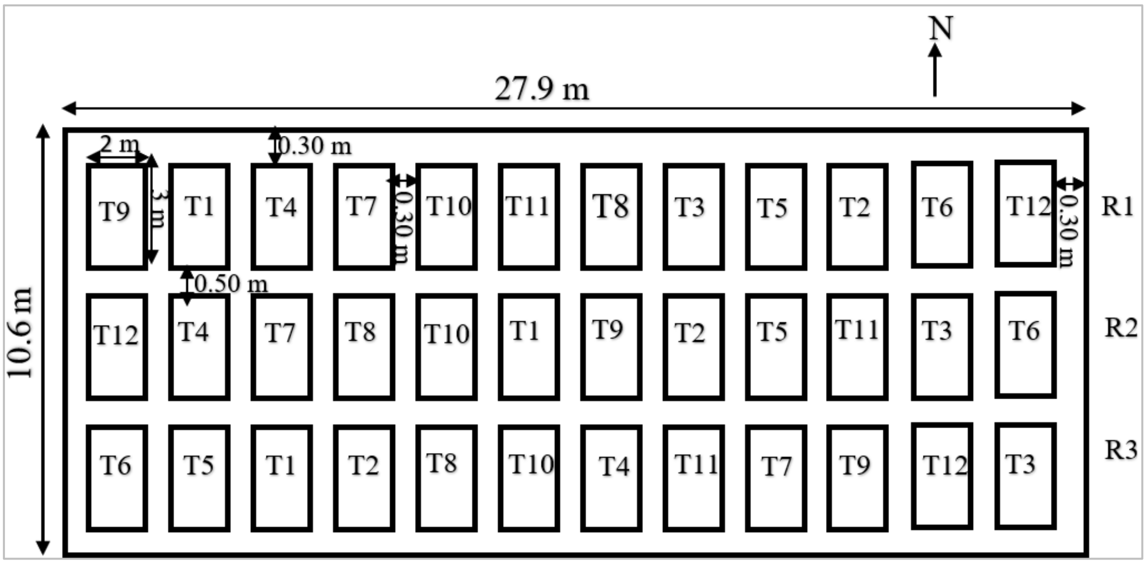
Figure 2: Weekly mean temperature (°C), precipitation (mm/day), and average relative humidity (%) during the growing season of spring rice at Kailari-09, Kailali (Source: *NASA Power | Data Access Viewer*, 2023)

2.2 Design of Experiment

The experimental trial was laid out in a randomized complete block design (RCBD) with twelve treatments, each replicated thrice. The treatments consisted of twelve spring rice genotypes listed in Table 2. The experimental field layout, illustrated in Figure 3, comprised 36 plots, each measuring 3 m x 2 m, with a total plot size of 27.9 m x 10.6 m, including a 0.3 m outer border. The distance between plots was 0.3 m, and between replications, it was 0.5 m. The local variety Jhumka, well-adapted and preferred by farmers for main-season rice, was used as a check variety to assess its performance in the spring season. Jhumka exhibited traits such as a high number of grains per panicle and resistance to diseases and pests, making it a local favorite. Hardinath-1 and Chaite-5 were varieties recommended by the Government of Nepal for the spring season, while Hardinath-3 and Hardinath-4 were recommended for the main season. Genotypes IR16L1831, IR17L1387, IR18A1451, IR17A2949, IR17A3012, IR17A3019, and IR16A3838 were sourced from the International Rice Research Institute (IRRI).

Table 2: Genotypes Used for The Study.

Treatments	Genotypes
T1	Jhumka (Local Check)
T2	Hardinath-1
T3	Hardinath-3
T4	Hardinath-4
T5	Chaite-5
T6	IR16L1831
T7	IR17L1387
T8	IR18A1451
T9	IR17A2949
T10	IR17A3012
T11	IR17A3019
T12	IR16A3838



Where, R1=Replication 1, R2=Replication 2, R3= Replication 3

Figure 3: The layout of the experimental field at a farmer field school, Kailali

2.3 Cultivation Practices

The cultivation process included plowing and leveling the field to create a fine seedbed for rice. Seeds were pre-germinated and sown in a wet seedbed on February 9, 2023, with a seed rate of 50 kg/ha. Thorough plowing, puddling, and field layout were conducted using a power tiller, with fencing to protect the experimental field. Fertilizer application followed government recommendations (120:40:40 NPK kg/ha), with phosphorus and potassium applied at transplantation and nitrogen split into two stages (MoALD, 2022). Urea, Diamine Phosphate (DAP), and Muriate of Potash (MOP) were used as fertilizer sources. Transplantation of 36-day-old seedlings occurred on March 17, 2023, with proper irrigation, manual hand weeding, and five irrigation stages. Harvesting took place when 85% of the grains matured, employing manual sickle cutting. Inner 1m^2 crop harvesting was done separately for yield calculation, and each plot underwent individual harvesting. After two days of sun drying, manual threshing, and cleaning were performed.

2.4 Data Collection and Observation

2.4.1 Growth Parameters

The following growth parameters were observed from the sample plants regularly and recorded.

2.4.1.1 Plant Height

The plant height of ten sampled plants was measured from the soil surface to the tip of the leaf at 30 days and 60 days after transplanting (DAT). The plant height at the time of harvest was measured from the soil surface to the tip of the panicle with the help of measuring tape.

2.4.1.2 Length of Panicle

The length of the panicle was measured from the base to the tip of the panicle using a measuring scale from ten sample plants.

2.4.1.3 Phenological Parameters

The phenological parameters were observed regularly. Daily observation was made during the flowering and maturity time of spring rice genotypes. Days to 50 % flowering were obtained when 50 % of the hills in a row of each plot seemed flowering. Similarly, Days to grain maturity were recorded when 85 % of the hills in a row of each plot seemed matured. The phenological parameters observed were as follows:

2.4.1.4 Days to 50 % Flowering

Days required for 50 % flowering of rice plants in a plot were recorded after visual observation.

2.4.1.5 Days to 85 % Grain Maturity

The number of days required for 85 % grain maturity was recorded in a plot through visual observation. It was observed as the date in which the color of the grain changed from green to golden, hardy grain and leaves and stem became yellowish from green due to the loss in chlorophyll.

2.4.2 Yield Parameters

The following yield parameters were observed and recorded.

2.4.2.1 Tillers Per Hill

The total number of tillers and effective tillers were counted and recorded at the time of harvest from ten sample plants. Total tillers include both effective and non-effective tillers. Noneffective tillers were the tillers which do not contain panicles. Panicle-bearing tillers also called productive tillers were considered effective tillers.

2.4.2.2 Grains Per Panicle

Ten panicles were selected randomly and were hand-threshed. The number of grains per panicle was counted and recorded.

2.4.2.3 Sterility Percentage

The total filled and unfilled grains per panicle were recorded from ten randomly selected panicles. Total grains in a panicle were obtained by adding total filled and unfilled grains in a panicle. The sterility was calculated in percentage using the given formula.

$$\text{Sterility \%} = \frac{\text{Total unfilled grains in a panicle}}{\text{Total grains in a panicle}} \times 100\ \%$$

2.4.2.4 Thousand Grain Weight

Thousand grains were counted from the threshed grain of each plot by selecting the grain of uniform size and shape. Then, those grains were weighted using electronic balance to obtain a thousand-grain weight in grams.

2.4.2.5 Grain and Straw Yield

Grain yield was obtained by harvesting 1m^2 area from the inner rows of each plot, measured in grams. The harvested crop was dried, threshed, and cleaned manually. The moisture percentage was recorded using a digital moisture meter. The grain weight was taken using an electronic balance after recording the moisture. The final grain yield was obtained by adjusting the yield at 13 % moisture using the formula suggested by (Mulvaney and Devkota, 2020).

$$\text{Grain yield} = \frac{\text{Harvest yield} \times (1 - \text{Harvest moisture})}{1 - \text{Standard moisture}}$$

Where, standard moisture was taken as 13 %.

Straw yield was weighted through electronic balance for calculating harvest index where total biomass yield was required. The biomass yield was calculated by adding grain yield and the straw yield in hectare.

2.4.2.6 Harvest Index

The Harvest index was calculated through grain yield and biomass yield using the following formula.

$$\text{Harvest index (HI)} = \frac{\text{Grain yield}}{\text{Biomass yield}}$$

2.4.3 Pest Occurrence

General observation on the occurrence of disease and pests was made during regular observation at the farmer field school. The genotypes that were highly and easily attacked by disease and pest and genotypes less prone to disease and pest were observed regularly to select better genotypes with minimum infestation.

2.5 Data, Tools, and Techniques

The collected data were systematically arranged for analysis. Statistical analysis, including data entry, processing, and refinement, was conducted using Microsoft Office Excel 2016. The analysis of variance (ANOVA) for yield and yield attributes was performed, and means were compared at a 5% significance level using Duncan's Multiple Range Test (DMRT) in R-Studio. Preference analysis was done by the CGIAR model at the time of rice harvest. Casting of votes was done one week before the harvest (85 % grain maturity). For this, farmers of farmer field school were asked to cast votes for two most preferred (Positive votes) and two least preferred (Negative votes) genotypes in the ballots. The farmers were provided with two maize seeds and two soybean seeds each. They were asked to cast maize seed for the two most preferred genotypes and soybean seed for the least preferred genotypes (Maize seed was counted as a positive vote and soybean seed as a negative vote). 26 farmers participated in casting votes. After completion of voting, the data were tallied by counting the seeds, and the farmers were asked the reason behind choosing the variety that received the most votes (Paris et al., 2011). Preference scores for each variety were calculated as follows:

$$\text{Preference Score} = \frac{\text{Total number of positive votes} - \text{Total number of negative votes}}{\text{Total number of positive and negative votes}}$$

(Paris et al., 2011)

3. RESULTS AND DISCUSSION

3.1 Plant Height

The study on rice genotypes revealed highly statistically significant differences in plant height at different growth stages. At 30 days after transplanting (DAT), genotype IR17L1387 exhibited the highest plant height (40.33 cm) followed closely by IR16A3838 (39.47 cm) and IR17A3019 (37.67 cm), indicating strong early growth, while IR18A1451 displayed the lowest height (31.27 cm). By, 60 DAT, Hardinath-3 excelled with a remarkable plant height of 85.50 cm. In contrast, IR18A1451 displayed a relatively lower plant height (63.37 cm) and Jhumka (59.47 cm) had the lowest plant height compared to other genotypes. At harvest, Hardinath-3 consistently had the highest height (101.75 cm) followed by IR17L1387 (99.78 cm) and local Variety Jhumka (98.74 cm) where plant height of IR17A3019 and Jhumka were statistically at par. Genotypes such as IR18A1451 and IR16A3838 exhibited comparatively lower heights, indicating potential limitations in yield. The grand mean of plant height across all genotypes reflected an average height of 36.01 cm at 30 DAT, 71.91 cm at 60 DAT, and 92.71 cm at maturity. Farmers preferred moderate plant height to resist lodging and ease harvest, aligning with preferences reported (Skazhennik et al., 2019; Kanfany et al., 2016). The highly significant p-values highlight substantial genotype variation, emphasizing the importance of selecting suitable genotypes for local conditions in Kailari Rural Municipality.

Table 3: Study of Plant Height (cm) at Different Time Durations, Number of Tillers Per Hill, and Number of Effective Tillers Per Hill of Twelve Spring Rice Genotypes

Genotypes	Plant height 30 DAT (cm)	Plant height 60 DAT (cm)	Plant height at Maturity (cm)	Number of tillers per hill	Number of effective tillers per hill
Jhumka	34.20^{d}	59.47^{g}	98.74^{b}	18.40^{cd}	13.99^{abc}
Hardinath-1	35.47^{cd}	70.07^{d}	85.81^{gh}	17.33^{d}	12.67^{de}
Hardinath-3	35.13^{cd}	85.50^{a}	101.75^{a}	20.17^{c}	13.04^{cd}
Hardinath-4	35.27$_{cd}$	75.40^{bc}	90.37^{f}	19.10^{cd}	10.66^{g}
Chaite-5	37.07^{bcd}	75.93^{b}	92.01^{de}	17.27^{d}	11.93^{ef}
IR16L1831	35.07^{cd}	66.60^{e}	92.92^{d}	23.33^{b}	12.65^{de}
IR17L1387	40.33^{a}	78.03^{b}	99.78^{b}	20.00^{c}	13.50^{bcd}
IR18A1451	31.27^{e}	63.37^{f}	86.93^{g}	26.27^{a}	14.45^{ab}
IR17A2949	36.27^{cd}	69.87^{d}	92.00^{de}	14.73^{e}	11.43^{fg}
IR17A3012	34.93^{cd}	73.03^{c}	90.91^{ef}	17.70^{d}	14.09^{abc}
IR17A3019	37.67^{abc}	76.67^{b}	96.55^{c}	17.70^{d}	15.04^{a}
IR16A3838	39.47^{ab}	69.03^{de}	84.79^{h}	18.53^{cd}	13.89^{bc}
SEm (±)	0.93	0.89	0.45	0.65	0.33
F-test	***	***	***	***	***
CV (%)	4.50	2.14	0.85	5.87	4.36
Grand Mean	36.01	71.91	92.71	19.21	13.11

Note: Means followed by the same letter in a column are not significantly different by DMRT at a 5 % level of significance. *** significant at 0.1 % level of significance, SEm (±) = standard error of mean, CV= coefficient of variation and DAT= days after transplanting

3.2 Total Number of Tillers and Effective Tillers Per Hill

Statistically significant differences were observed in the total number of tillers among spring rice genotypes. Genotype IR18A1451 exhibited the highest number of tillers (26.27), followed by IR16L1831 (23.33), with an average mean of 19.21 tillers per hill. During harvest, genotypes IR17A3019, IR17A3012, Chaite-5, and Hardinath-1 were statistically at par, while the minimum number of tillers was found in genotype IR17A2949 (14.73). The check variety had 18.40 tillers per hill.

Similarly, statistically significant differences were observed in the number of effective tillers per hill. Genotype IR17A3019 displayed the maximum number of effective tillers per hill (15.04), followed by IR18A1451 (14.45), with an average mean of 13.11 per hill. The effective tillers per hill of the local check variety and IR17A3012 were statistically at par, as were Hardinath-1 and IR16L1831. The minimum number of effective tillers per hill was observed in Hardinath-4 (10.66), followed by genotype IR17A2949 (11.43).

These variations in effective tiller counts emphasize the distinct growth behaviors of different genotypes, with potential implications for yield in the local context. Farmers generally preferred genotypes with a higher number of effective tillers, as it correlates with a higher number of panicles per hill. The participatory varietal selection trial conducted in Kailari Rural Municipality underscored the significant impact of rice genotype choice on tiller parameters.

3.3 Days yo 50 % Flowering and 85 % Grain Maturity

The analysis of variance (ANOVA) revealed statistically significant differences in the 50% flowering days among spring rice genotypes, with an average of 106.78 days. Hardinath-1 displayed the earliest 50% flowering at 96.67 days, followed by IR16A3838 and IR17A3019. Genotypes IR17A3012, IR18A1451, Hardinath-3, Chaite-5, and IR17A2949 had statistically similar flowering days. In contrast, Hardinath-4 showed delayed 50% flowering at 116.33 days, followed by the local check variety (Jhumka) and IR16L1831, with Jhumka and IR16L1831 being statistically similar. These variations in flowering times have implications for planting and harvesting activities.

Statistically significant differences in days to grain maturity were observed. Hardinath-1 matured earliest (121.67 days), statistically at par with IR16A3838. IR17A3019, IR17A3012, IR18A1451, and Hardinath-3 were statistically at par. Hardinath-4 exhibited a significantly longer maturity time (137.33 days), followed by the local check variety (Jhumka), IR16L1831, and IR17L1387. The observed variations underscore the importance of optimizing harvest timing and managing cropping cycles. Farmers generally preferred early maturing crops for quicker harvest and reduced risks. Early maturing rice varieties allow for quicker harvest, which reduces the risk of crop loss due to pests, diseases, or adverse weather conditions and avoids potential crop losses (Jin et al., 2020).

The analysis provides valuable insights into the temporal characteristics of spring rice genotypes, aiding farmers in making informed decisions about variety selection in the context of Kailari Rural Municipality.

3.4 Length of Panicle

Panicle length, a crucial trait influencing grain production and crop yield, exhibited statistically significant differences among spring rice genotypes. Chaite-5 displayed the longest panicle (25.70 cm), statistically at par with IR17A3019, IR17L1387, IR16L1831, and IR18A1451, indicating their potential for higher grain production per panicle and enhanced crop yields. In contrast, Hardinath-1 had the shortest panicle (22.97 cm), statistically at par with Hardinath-3, Hardinath-4, IR17A2949, and Jhumka (local check). IR16A3838 and IR17A3012 displayed intermediate panicle lengths. The length of the rice panicle is one of the most important traits in yield-related research because it determines the number of grains the panicle can hold and, consequently, rice yield (Huang et al., 2013). This data on panicle length provides valuable insights for farmers in selecting suitable rice genotypes for optimal yield in Kailari Rural Municipality

3.5 Grains Per Panicle

ANOVA revealed statistically significant differences among spring rice genotypes for the number of grains per panicle. Jhumka (239.89) and Hardinath-4 (231.70) exhibited the highest, statistically similar, numbers of grains per panicle, indicating their potential for maximizing crop yield. IR17A2949, Chaite-5, IR16A3838, and IR17A3019 also demonstrated above-average performance in this aspect. In contrast, IR18A1451 (133.44) had the lowest number of grains per panicle, followed by IR16L1831 and IR17L1387. The number of grains per panicle has a positive direct effect on grain yield (Osman et al., 2019). Despite lower grain count, these genotypes may still be viable considering other agronomic traits and environmental factors. The locally developed Jhumka was preferred, highlighting the importance of selecting genotypes with favorable grains per panicle traits. This analysis provides valuable insights for farmers in selecting suitable rice genotypes for optimal yield in Kailari Rural Municipality.

3.6 Sterility Percentage

The sterility percentage among spring rice genotypes exhibited statistically significant differences. IR17A3012 and IR17A3019 showed the lowest sterility (10.39 % and 10.61 %, respectively), signaling the potential for robust grain production. IR17A2949 followed closely with a sterility of 10.89 %. Genotypes IR17L1387, IR16A3838, Jhumka, and Hardinath-3 demonstrated moderate sterility, with IR17L1387, IR16A3838, and Jhumka statistically at par. While their sterility levels were slightly higher than low sterility genotypes, they still showed favorable grain production potential. IR16L1831 (21.64 %) and Hardinath-4 (21.44%) exhibited the highest sterility, statistically at par, followed by IR18A1451 with a sterility percentage of 18.56%. These genotypes had a larger proportion of sterile grains, impacting overall grain yield. High temperatures during flowering may have contributed to sterility in Hardinath-4 and IR16L1831, given the daily mean temperature exceeded 30 °C. Temperatures above the optimal range of 25-35 °C can hamper pollination and cause poor anther dehiscence, resulting in spikelet sterility (Ramesh et al., 2017). Proper varietal selection, considering sterility percentages and other agronomic traits, is crucial for maximizing crop yield in Kailari Rural Municipality.

3.7 Thousand-Grain Weight

Thousand-grain weight, a crucial parameter for assessing grain yield and quality, exhibited statistically significant differences among spring rice genotypes. IR16L1831 had the highest thousand-grain weight (26.33 g), followed by IR17A3012 (25.67 g) and IR17A3019 (25.33 g). The maximum thousand-grain weight observed might be due to the large size grain. These genotypes with larger and heavier grains suggest the potential for superior grain yield and quality. Hardinath-3, Hardinath-1 and Jhumka showed moderate thousand-grain weight, while Chaite-5 had the lowest (21.00 g), followed by IR17L1387, Hardinath-4, and IR17A2949. The findings aid farmers in selecting rice genotypes aligned with grain quality and yield potential, emphasizing the importance of proper varietal selection in Kailari Rural Municipality.

Table 4: Study of days to 50 % flowering, days to 85 % grain maturity, length of panicle, grains per panicle, and sterility percentage of twelve spring rice genotypes

Genotypes	Days to 50 % flowering	Days to 85 % grain maturity	Length of panicle (cm)	Grains per panicle	Sterility percentage
Jhumka	114.67^{b}	135.33^{b}	23.00^{c}	239.89^{a}	13.18^{def}
Hardinath-1	96.67^{g}	121.67^{g}	22.97^{c}	172.03^{ef}	16.37^{bc}
Hardinath-3	106.00^{d}	129.33^{e}	23.57^{c}	156.65^{efg}	13.87^{cde}
Hardinath-4	116.33^{a}	137.33^{a}	23.27^{c}	231.70^{a}	21.44^{a}
Chaite-5	106.33^{d}	131.33^{d}	25.70^{a}	220.82^{abc}	14.54^{cd}
IR16L1831	114.33^{b}	134.67^{bc}	25.30^{a}	153.90^{fg}	21.64^{a}
IR17L1387	109.67^{c}	133.33^{c}	25.48^{a}	154.26^{fg}	12.03^{def}
IR18A1451	105.67^{d}	129.33^{e}	25.20^{a}	133.44^{g}	18.56^{b}
IR17A2949	106.67^{d}	131.33^{d}	23.27^{c}	223.97^{ab}	10.89^{ef}
IR17A3012	105.33^{d}	128.67^{e}	23.93^{bc}	178.64^{de}	10.39^{f}
IR17A3019	101.33^{e}	125.67^{f}	25.57^{a}	199.04^{cd}	10.61^{f}
IR16A3838	98.33^{f}	123.33^{g}	24.93^{ab}	206.10^{bc}	12.38^{def}
SEm (±)	0.54	0.60	0.39	7.49	0.93
F-test	***	***	***	***	***
CV (%)	0.88	0.80	2.79	6.86	10.95
Grand Mean	106.78	130.11	24.35	189.20	14.66

Note: Means followed by the same letter in a column are not significantly different by DMRT at a 5 % level of significance. *** significant at 0.1 % level of significance, SEm (±) = standard error of mean, CV= coefficient of variation

Table 5: Study of thousand-grain weight (g), grain yield (t/ha), and harvest index of twelve spring rice genotypes

Genotypes	Thousand-grain weight (g)	Grain yield (t/ha)	Harvest index
Jhumka	22.67^{cde}	5.38^{cd}	0.27^{cd}
Hardinath-1	23.33^{cd}	5.14^{d}	0.26^{cde}
Hardinath-3	23.67^{c}	5.64^{bc}	0.31^{b}
Hardinath-4	21.67^{ef}	3.64^{f}	0.22^{f}
Chaite-5	21.00^{f}	4.60^{e}	0.24^{ef}
IR16L1831	26.33^{a}	3.76^{f}	0.23^{f}
IR17L1387	21.66^{ef}	4.59^{e}	0.19^{g}
IR18A1451	22.33^{de}	5.05^{d}	0.23^{f}
IR17A2949	22.00^{ef}	5.11^{d}	0.28^{c}
IR17A3012	25.67^{ab}	6.06^{a}	0.32^{b}
IR17A3019	25.33^{ab}	5.97^{ab}	0.34^{a}
IR16A3838	25.00^{b}	4.25^{e}	0.25^{def}
SEm (±)	0.39	0.12	0.01
F-test	***	***	***
CV (%)	2.87	4.33	4.25
Grand Mean	23.39	4.93	0.26

Note: Means followed by the same letter in a column are not significantly different by DMRT at a 5 % level of significance. *** significant at 0.1 % level of significance, SEm (±) = standard error of mean, CV= coefficient of variation

3.8 Grain Yield

Grain yield is a crucial agronomic parameter that measures the productivity of a crop. ANOVA revealed statistically significant differences among twelve spring rice genotypes. IR17A3012 showcased the highest yield (6.06 t/ha), followed closely by IR17A3019, Hardinath-3, and the local check variety (Jhumka) with yields of 5.97 t/ha, 5.64 t/ha, and 5.38 t/ha, respectively. These genotypes exhibited potential for high grain production, making them favorable choices for yield optimization. Hardinath-1, IR17A2949, and IR18A1451 demonstrated moderate yields. In contrast, Hardinath-4, with the lowest yield (3.64 t/ha), was at par with IR16L1831 (3.76 t/ha), possibly influenced by lower effective tillers and higher sterility. Enhancing the rice grain yield has the potential to address the food requirements arising from the swift growth of the global human population and the subsequent surge in worldwide food needs (Gouda et al., 2020). These findings guide farmers in genotype selection for optimal crop productivity and economic gains in Kailari Rural Municipality.

3.9 Harvest Index

Statistically significant differences in harvest index were observed among spring rice genotypes. IR17A3019 demonstrated the highest index (0.34), efficiently converting biomass into grain yield. IR17A3012 and Hardinath-3 followed closely with indices of 0.32 and 0.31, respectively. Moderate harvest indices were observed in IR17A2949, Jhumka, and Hardinath-1. IR16A3838 and Chaite-5 also showed moderate indices. The lowest indices were observed in IR17L1387, Hardinath-4, IR18A1451, and IR16L1831. These genotypes allocate a smaller proportion of biomass to grain formation, potentially impacting their yield potential. The harvest index data aids farmers in selecting genotypes for efficient resource use and maximizing productivity in Kailari Rural Municipality.

3.10 Pest Occurrence

General observations on disease and pest occurrence in different genotypes of spring rice were observed. Bacterial leaf streak disease was observed in the Chaite-5 genotype. Yellow stem borer and stink bug infestation was observed in Hardinath-1, Chaite-5, IR17L1387, IR17A2949, and IR16A3838 genotypes. These observations provide valuable insights for farmers in Kailari Rural Municipality, Kailali district, aiding in the selection of genotypes resistant to specific diseases and pests.

3.11 Preference Analysis

The preference score was calculated from the cast votes of 26 farmers from a farmer field school, Kailari-09, Kailali as shown in Table 6. The farmers were regularly observing and analyzing the genotypes from the time of seed sowing in the seedbed. The farmers cast votes based on traits that these farmers considered crucial for their rice plants to possess. These traits included early and uniform maturity for ensuring timely harvest, low disease and pest attack/ability to resist diseases and pests, the number of effective tillers, longer panicles, low sterility, good taste with a pleasant aroma and overall yield, all of which were considered vital for the health and productivity of their rice crops.

The genotype IR17A3019 received the highest preference score of 0.09, followed closely by IR17A3012 with a score of 0.08, making them the most favored among farmers. This preference was attributed to their early maturity, high number of effective tillers, larger panicles, low sterility, average plant height, and better yield. On the other hand, the genotype IR17L1387 and the local check variety (Jhumka) had minimum preference scores of -0.08, mainly due to delayed maturity, high sterility, longer plant height, lower grain yield, and harvest index. These varieties received fewer positive votes and more negative votes, indicating that they were less preferred by the farmers.

Table 6: Positive votes, negative votes, and preference scores of 26 participants for twelve spring rice genotypes at a farmer field school, Kailari-09, Kailali

Genotypes	Positive votes	Negative votes	Preference score	Rank
Jhumka	3	9	-0.06	9
Hardinath-1	1	5	-0.04	7
Hardinath-3	9	3	0.06	3
Hardinath-4	2	3	-0.01	6
Chaite-5	4	2	0.02	4
IR16L1831	2	7	-0.05	8
IR17L1387	2	10	-0.08	10
IR18A1451	2	1	0.01	5
IR17A2949	3	4	-0.01	6
IR17A3012	10	2	0.08	2
IR17A3019	12	3	0.09	1
IR16A3838	2	3	-0.01	6
Total casted votes	52	52		

Interestingly, even though the genotype IR17A3012 had the maximum grain yield, the preference score was higher for IR17A3019 during participatory varietal selection. This suggests that IR17A3019 possesses certain traits of particular interest to farmers. Similarly, genotypes with the minimum grain yield, such as IR16L1831 and Hardinath-4, did not have the minimum preference scores due to factors like a high number of grains per panicle, early maturing traits in Hardinath-4, and features like early maturation, maximum thousand-grain weight, and long panicles in IR16L1831.

These findings align with a study by which demonstrated that farmers prioritize traits beyond just grain yield during participatory varietal selection (Subedi et al., 2018). Farmers consider various factors such as maturity days, overall plant performance, and other yield components. Overall, the data underscores the importance of farmers' preferences and the influence of valued traits in their choices of rice genotypes.

4. CONCLUSION

In conclusion, the study in Kailari Rural Municipality, Kailali district, Nepal, emphasized the significance of genotype selection for achieving higher crop productivity and quality. Notably, IR17A3012, IR17A3019, and Hardinath-3 emerged as strong performers, offering promising choices for farmers aiming for better yields and overall productivity.

Participatory Varietal Selection empowered farmers to make informed decisions based on factors like growth traits, yield potential, and adaptability to specific environmental conditions. While IR17A3012 exhibited the maximum grain yield, IR17A3019 garnered the highest preference during participatory selection, suggesting that it possesses genes aligning with farmers' preferences.

Farmers in Kailari Rural Municipality considered various traits beyond just yield, such as maturity time, plant health, tiller count, panicle length, sterility, and other yield-related aspects. The findings highlight the importance of understanding farmers' preferences and selecting genotypes accordingly.

To reinforce these results, further research, practical demonstrations, and verification, along with participatory workshops, are recommended. Capacity-building training for farmers on optimal agronomic practices, integrating climate-smart farming, should be provided to promote sustainability. Overall, the study contributes valuable insights for rice cultivation in the region, aiding farmers in making informed decisions for improved food production and livelihoods.

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