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ORIGINAL RESEARCH ARTICLE

Evaluation of different spring rice genotypes for seedling stage growth at Tulsipur, Dang, Nepal

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ABSTRACT

Rice is the fundamental staple crop of Nepal. For food security, the production rate of main season rice is insufficient; nevertheless, spring rice can be a possibility. Spring rice is short duration crop as compared to the main season crop as, it can be best utilized through its cultivation. An experiment on spring rice (*Oryza sativa*) was performed to examine ten different elite rice genotypes in irrigated seedling stage at Campus of Live Sciences, Tulsipur, Dang from April to May 2023 with an objective to assess the response of different genotypes of seedling stage under controlled environment condition and to compare seedling stage growth and development of different spring rice variety The study was conducted with three replications on a completely randomized design (CRD). Data on the seedlings' growth was gathered at intervals of ten days. The outcome showed that there were statistical differences in morphological features between various genotypes. In comparison to other plants, IR09R270 had the highest average plant height (12.9 cm), IR17A106 had the greatest amount of leaves (2.44), IR09R270 had the greatest length of leaves (6.59 cm), Svin080 had the widest leaves (0.18 cm), IR112208B-B-RGA-BRGA had the longest shoots length (16.46 cm), and IR112208B-B-RGA-BRGA had the longest roots length (9.30 cm). The sample with the highest percentage of germination (85.65%) was IR112208B-B-RGA-BRGA. The majority of genotypes were found to have heritability more than 60%, indicating a greater contribution from genetic factors than environmental conditions. It was discovered that the phenotypic coefficient of variance (PCV) was marginally larger than the genotypic coefficient of variance (GCV), suggesting that the environment had little effect on how characters are expressed. The study's conclusions demonstrated that the rice genotypes IR09R270 and IR112208B-B-RGA-BRGA were preferable to other elite genotypes found in the Terai region. In conclusion under irrigated conditions, rice genotypes IR09R270 and IR112208B-B-RGA-BRGA performed well.

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INTRODUCTION

Roughly half of the world's population eats rice every day. The consumption is highly concentrated in eastern and southern Asia as compared to other location. Paddy production has increased by 6.94% to 5.486 million tons in the fiscal year 2022/23 compared to last year's production. A total of 5.13million tons of rice was produced in that last fiscal year 2021/22 (MOALD, 2021/22). It accounts for 16% of agricultural GDP and 52% of total grain consumption (Yadav & Chaudhary, 2017). The spring (Chaite) season covers 7% of the rice growing area, while the main (Barkhe) season accounts for 92%. Boro and Bhadaiya rice are also grown in a few Terai districts, accounting for less than 1% of the total area (CDD, 2015).

The region covered by spring rice on the mountain, hill, and Terai has been determined to be 5.48, 24.85, and 69.67 percent, respectively (Regmi *et al.*, 2022). Because spring rice has more sunny days, higher fertilizer usage efficiency, better water control, less weed infestation, and other factors, it yields more than main season rice (Shrestha *et al.*, 2022). The cultivation practices are done with the proper tillage operation which significantly increases the organic matter and organic carbon content in the soil (Angon *et al.*, 2023). In places with abundant irrigation, spring rice is grown, which helps to minimize weed invasion. In the spring, there is lighter, which increases yield. During rainy season flooding and landslides prone areas can also be used to grow spring rice (Subedi *et al.*, 2018). Spring season rice yields around 4.50 metric tons per hectare, while main season rice yields 3.70 metric tons per hectare. This makes spring season paddy a better producer than main season paddy (MOAD, 2017/18). Compared to main season crops, spring rice has a shorter growing season so it can be best used through cultivation. Inadequate knowledge about suitable varieties for various agro climatic zones and techniques for early development of seedlings to prevent stress from cold are the key obstacles to spring rice production (Biswas *et al.*, 2019). Farmers view a lack of enhanced cultivars as the most significant constraint, with 88.33% of respondents responding. Despite several initiatives in Nepal to develop varieties of rice, comparatively little success has been achieved (Ghimire *et al.*, 2015). Similarly, absence of a suitable watering system is listed as the third most significant technological barrier, as assessed by 53.33% of all respondents (Basyal *et al.*, 2019). Rainfall pattern and early completion of rainfall were considered as the third and fourth constraints, respectively. Due to lack of high yielding and vigor genotype Nepalese farmers rely on the limited number of cultivars available. The daily demand for rice is rising, but there is no way to increase surplus rice from the same quantity of land. Thus, the only method to boost rice production is to increase productivity through various means such as the use of high yielding fertilizer responsive cultivars, increased irrigation capacity, and timely and proper supply of chemical fertilizers (Kushwaha *et al.*, 2015). Therefore, this study was conducted for the evaluation of different spring rice genotypes for seedling stage growth at Tulsipur, Dang, Nepal

MATERIALS AND METHODS

Experiment site description

The research was carried out on laboratory of Campus of live sciences, Tulsipur, Dang, in the year 2023, 647masl with latitude 28°07'09.71" N and longitude 82°17'48.80'E in the spring season. Elite rice genotypes were brought from nearby NARC station and was used in this study. In this study 10 genotypes in total were examined (Table 1). The experimental site had a temperature ranging between 21°C and 27.5°C. The average relative humidity was recorded to 28.25% in the first week and was increasing gradually. Temperature and relative humidity were noted using a hygrometer (Table 2).

Experimental setup

A laboratory experiment was conducted at Campus of Live Sciences from April to May. The experiments were conducted in plastic pots. The ten rice genotypes were tasted under normal condition (non-water stress) in completely randomized design (CRD) with three replications. The seeds of all selected rice genotypes were pre-soaked in water for 12 hrs. The surface water of presoaked seeds was removed using the tissue then the drowned seeds of good quality were planted in plastic pot (KC *et al.*, 2020). The size of plastic pots used in the experiments had 16.5 cm of bottom diameter and 22.5 cm of top diameter and 18cm of the height. Eight seeds per hills were planted and germinated in a plastic pot and was irrigated twice a day (200ml/pot). The established plastic pots were kept in morning sunlight for two hours a day.

Data collection

After seeding, measurements of the plant's height, number of leaves, leaf length, leaf width, shoot length, and root length were made at 10, 20, and 30 days. The variance parameter such as genotypic variance, phenotypic variance, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance in the percentage of mean were calculated according to the formula given by (Johnson *et al.*, 1955) and (Singh & Chaudhary 1985)

Statistical evaluation

The collected data were tailed and examined. Data entry was done using Microsoft Excel 2019. These data were processed into R version 4.3.1 and R studio for analysis: *, ** and *** indicate significant differences respectively at P≤ 0.05, P<0.01, and P<0.001. Mean comparison was performed using the least significance difference test with a 5% level of significance (Gomez & Gomez, 1984)

Table 1. List of rice genotypes used for the study.

S. No.	Genotypes
1	Chaite-5
2	IR17A1715
3	Hardinath-1
4	IR17A1710
5	IR17A1002
6	IR16L1411
7	Svin080
8	IR09R270
9	IR17A1066
10	IR112208B-B-RGA-BRGA

Table 2. Temperature and relative humidity of experimental site.

Days	Morning		Evening	
	Temperature (°C)	Humidity (%)	Temperature (°C)	Humidity (%)
1	23.7	28	25	25
6	21	34	24.9	26
11	22.2	28	23.4	28
16	22.3	26	22.5	29
21	25.2	30	26.3	25
26	23	35	27.5	30

RESULTS AND DISCUSSION

Germination percentage

Determination of germination is the initial crucial steps to evaluate the performance of the genotype. Germination is upregulated by the function and influence of hormones. It is also the responses of seed towards environmental situation, genetic control, stress induced response (KC, 2023). There was a difference among the varieties for germination percentages. IR17A1710 has the highest germination percentages (87.5) followed by IR112208B-B-RGA-BRGA (85.65). Hardinath-1 showed the lowest germination percentages (64.76) (Table 3)

Plant height

The result reveals that the seedlings plant height varies significantly ranging from 12.04 -16.64cm Highest number of plant height was found on IR09R270 (16.64cm) followed by IR17A1066 (15.36cm) while lowest plant height was found on IR16L1411 (12.04cm) (Table 4) The variance in plant height of different rice genotypes may be related to varied climatic requirements of different rice genotypes (Rabbani *et al.*, 2010). There was a substantial variation in plant height, days to flowering, maturity, thousand grain weight, and grain yield amongst the rice genotypes employed in the research (Adhikari, 2018). Abd El-Mageed *et al.* (2022) reported the methods for the estimation of growth parameters of plants under inadequate watering were poorer compared to those under continuous irrigation.

Number of leaves

The data analysis represented in the table indicates that number of leaves for different genotypes of rice varieties varies significantly ranging from 2.33cm-3 cm. Svin080 (3.00cm) had a highest number of leaves which is statistically at par with IR17A1066 (3cm) followed by IR17A1710 (2.89cm) which is statistically at per with IR16L1411 (2.89) cm. Lowest number of leaves were observed in Chaite-5 (2.33cm). Multiple studies have proven the correlation between plant height, leaf count, and biomass in several crops (Hidayati *et al.*, 2016, Ribas *et al.*, 2017). The growing circumstances, including soil temperature and moisture, planting depth, and, to a certain extent, seed strength, determine how long it takes for seeds to emerge, which is typically five to ten days (Gerik *et al.*, 2024). The primary culm produces one leaf every week on average; however, this can be affected by environmental variables. The time period between leaf productions is not as long throughout the early growth stage (4-5 days) and longer during the latter stages (8-9 days) (Vergara, 1991). In general, low temperatures reduce the rate at which leaves initiate, which lowers the quantity of leaves and, in turn, lowers the rate at which leaf cells divide and elongate, lowering the dry mass of leaves (De Freitas *et al.*, 2019).

Table 3. Germination percentage of spring rice genotypes.

Genotype	Germination %
Chaite-	74.53
IR 17A	80.55
Hardinath	64.76
IR17A17	87.5
IR17A1002	75.38
IR1621411	72.19
Svin080	67.02
IR09R270	84.70
IR17A106	74.98
IR112208B-B-RGA-BRGA	85.65

Leaf length

The data analysis represented in the table indicates that leaf length for different genotypes of rice varieties varies non-significantly ranging from 8.57-5.52cm. IR09R270 (8.57cm) had a highest number of leaf length. Lowest leaf length was observed in IR16L1411 (5.52cm). Among the several leaf allometric relationships, functions that take into account the product of the leaf's length and breadth are better calculator of leaf size than those that only take into account the dimension's linearity (Shi *et al.*, 2019a; Yu *et al.*, 2020). The length and breadth of leaf adds to an exaggeration of leaf size (Cain and De Oliveira Castro, 1959).

Leaf breadth

The data analysis presented in the table revels that leaf breadth is significant for rice genotypes ranging from 0.18-0.26cm where the highest no of leaf breadth is found to be in Chaite-5 (0.26cm) followed by IR17A1066 (0.22cm) which is statistically at par with IR112208B-B-RGA-BRGA (0.22cm). Similarly, the lowest number of leaf breadth is to be found in Hrdinath-1 (0.18cm) which is statistically at par with Svin080 and IR09R270. The principal environmental determination of crop growth appearance and leaf area is temperature, higher the temperature, the beneficial impact on the increase of leaf area (Hatfield & Prueger, 2015).

Shoot and root length

The data analysis presented in the table revels that rice genotypes vary non-significantly for shoot length and root length. The result reveals that highest shoot length was found in IR112208B-B-RGA-BRGA (16.78cm) and shorter root length was found in IR16L1411 (13.53cm). Highest root length was found in Chaite-5 (9.70cm) and shorter root length was found in IR17A1066 (7.13cm).

Phenotypic and genotypic coefficient of variation

Examining the data reveals that for every character, PCV was greater than GCV, representing that the environment has an impact on how the qualities are expressed. The relationship between various rice characteristics and the environment has also been documented by Bhadru *et al.* (2012) and Akter *et al.* (2018). GCV for root length was found to be the highest (19.82%) followed by leaf length per plant (19.50%) whereas, the lowest was found in shoot length (11.50%) followed by number of leaf (11.65%). PCV was recorded highest for the leaf length (25.36%) and lowest for the number of leaf (14.71%). Mishra & Verma (2002) and Rasel *et al.* (2018) have previously reported high PCV and high GCV for root character.

Table 4. Morphological traits (at 30 days after sowing) of spring rice genotypes under non-stress conditions at Tulsipur, Dang Nepal.

Treatment	Plant height (cm)	Number of Leaves (cm)	Leaf length (cm)	Leaf Breadth (cm)
Chaite-5	12.13[cd]	2.33[c]	5.90[b]	0.26[a]
IR 17A 1715	14.94[ab]	2.78[ab]	7.20[ab]	0.19[bc]
Hardinath-1	14.91[ab]	2.72[abc]	7.29[ab]	0.18[c]
IR17A1710	13.67[bcd]	2.89[ab]	6.31[b]	0.19[bc]
IR17A1002	14.37[abc]	2.78[ab]	6.51[b]	0.19[bc]
IR1621411	12.04[d]	2.89[ab]	5.52[b]	0.20[bc]
Svin080	14.26[bcd]	3.00[a]	6.75[ab]	0.18[c]
IR09R270	16.64[a]	2.55[bc]	8.57[a]	0.18[c]
IR17A106	15.36[ab]	3.00[a]	7.25[ab]	0.22[b]
IR112208B-B-RGA-BRGA	14.25[bcd]	2.78[ab]	6.73[ab]	0.22[b]
Grand mean	14.26	2.7	6.8	0.20
CV%	9.51	8.98	16.21	9.33
LSD	2.31	0.42	1.89	0.03
F test	*	*	NS	**

Treatment	Shoot length	Root length
Chaite-5	14.15[bc]	9.70[a]
IR 17A 1715	16.62[ab]	9.37[a]
Hardinath-1	16.10[ab]	9.30[a]
IR17A1710	14.33[abc]	7.88[b]
IR17A1002	15.13[abc]	7.57[bc]
IR1621411	13.53[c]	7.45[bc]
Svin080	15.82[abc]	7.37[bc]
IR09R270	16.50[ab]	7.50[bc]
IR17A106	15.82[abc]	7.13[c]
IR112208B-B-RGA-BRGA	16.78[a]	9.45[a]
Grand mean	15.47833	8.271667
CV%	9.42	3.86
LSD	2.48	2.19
F test	NS	NS

Note: CV= Coefficient of variation, LSD=Least significant difference NS=Non-significant Significant code: *, ** and *** denote significantly different respectively at P≤0.05, P<0.01, and P<0.001 means within the column followed by the same letter are non-significantly different at 5% level.

Table 5. GCV (%), PCV (%), heritability, genetic advance as percent of mean of five different parameters of spring rice genotypes.

S. No.	Character	(δ 2g)	(δ 2p)	GCV (%)	PCV (%)	h^2 (%)	GA
1	Plant height	5.24	7.08	16.05	18.66	74	28.44
2	Number of leaf	0.10	0.17	11.65	14.71	63	18.99
3	Leaf length	1.76	2.98	19.50	25.36	59	30.89
4	Shoot length	3.16	5.3	11.50	14.87	60	18.33
5	Root length	2.69	4.35	19.82	25.21	62	32.10

Note: δ 2g=Genotypic variance, δ 2p=Phenotypic variance, GCV= Genotypic coefficient of variation, PCV=Phenotypic coefficient of variation, h^2 =broad sense heritability, GA=Genetic advance as percent of mean.

Estimation of heritability and genetic advance

All the characters exhibit heritability less than 90%, The parameter plant height showed the highest heritability (74%) whereas lowest was observed in leaf length(59%) .Since the majority of heritability is higher than 60% which showed that genetic factors have a greater influence than environmental factor Genetic advances as percent of mean varies from 18.33-32.10. Root length showed highest advance in percent of mean (32.10), shoot length and number of leaf showed very low genetic advance(>10 percent). A strong genetic gain in percent of mean for root length was observed by Hoque *et al.* (2021). Additive gene action was superior in controlling the characters that with soaring heritability and genetic improvement, which could be upgraded through selection. Johnson *et al.* (1955) also suggested that, better image for choosing the genotypes was provided by high GCV, high heritability, and genetic progress (Table 5)

Conclusion

In the examined rice genotypes, differences in morphological characteristics such as plant height, number of leaves per plant, leaf length and breadth, shoot length, and root length were noted. The study's conclusions demonstrated that the rice genotypes IR09R270 and IR112208B-B-RGA-BRGA were superior to other elite genotypes found in the Terai region. In summary, rice genotypes perform best in irrigated conditions.

DECLARATION

Authors contribution statement

Conceptualization: DK and AS; Methodology: DP; Software and Validation: DP, AS, AG, and SG; Formal analysis: DP and AS; Investigation: AS, AG, and SG; Writing original draft preparation: DK; Writing review and editing: DP, AS, AG, SG; Visualization and Supervision: DP and SA. All authors have read and agreed to the published version of the manuscript.

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