Original Research Article

GENETIC VARIABILITY STUDY FOR NITROGEN USE EFFICIENCY IN UPLAND RICE (*ORYZA SATIVA* L.) GENOTYPES OF NAGALAND

Abstract

A study was conducted in the Experimental Farm of Genetics and Plant Breeding, Nagaland University, Medziphema in Kharif 2021. The study consists of 28 genotypes laid in Randomized Block Design (RBD). To choose efficient genotypes in breeding programmes for boosting rice production in poor rice soils, it will be helpful for resource-poor farmers who have restricted access to the usage of N fertilizer. From the results, ANOVA revealed that all the traits studied are significant except for root dry weight. Similarly, traits like stem dry weight (g), harvest index and grain yield per plant (g) have high GCV and PCV and high heritability is also observed among these traits. High heritability along with high genetic advance as percent of mean was found for grain yield per plant, panicle weight, stem dry weight and harvest index which indicates the function of additive gene in regulating these traits.

Keywords *Rice, Genetic variability, Heritability, Genetic advance, mean*

Introduction

With chromosome number 2n=24, rice (Oryza sativa L.) is a self-pollinated plant belonging to the graminae family. There are 25 genera in the Oryza species, of which two, Oryza sativa and Oryza glaberrima, are domesticated. The other 23 genera are wild species. Additionally, rice can be grown as a ratoon crop for up to 30 years and as a perennial crop. Both temperate and tropical nations cultivate it as an annual crop. In most Asian countries, rice is the main food crop. In Asia, rice is an important part of both culture and society, and it also gives people jobs. More yields must be produced for farmers who can sell high-quality rice grains at competitive prices. In India, rice is another common food crop that is grown in both lowland and highland regions.

Global crop yields have increased as a result of an increase in nitrogen fertilizer consumption, particularly N fertilizer (Cassman, 1999). In order to increase rice production while using fewer nitrogen fertilizers, research on increasing NUE of the rice crop has concentrated on improving fertilizer management techniques over the past thirty years. This has been done by increasing N use efficiency (NUE) through improved N fertilizer management. It is also essential to accelerate the timing and rate of N treatment in order to better synchronize the supply and demand of N by the crop (Cassman *et al.*, 1998). The results of NUE's efforts and dedication to germplasm development, however, have not been very notable. Breeders have found it challenging to create crops that utilize nitrogen more effectively due to increased environmental concerns and the rising cost of fertilizer.

Improving yield and understanding the type and extent of genetic variation are the main breeding goals in rice breeding in order to carry out the inheritance of quantitative traits like yield and yield components. Breeders in crop development projects must analyze genetic variability measures including Genetic Coefficient of Variability (GCV) and Phenotypic Coefficient of Variability (PCV), heritability, and genetic advance for distinct traits. The goal of the current study was to provide explanations for specifics of genetic advance (GA), heritability, and variability in upland rice genotypes.

Materials and Methods

The experiment was carried out during Kharif 2021 at Experimental Farm of Genetics and Plant Breeding, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema. The genotypes consist of 28 upland rice genotypes grown in Randomized Block Design with three replications with spacing of 20 x 15cm. Data were recorded on five randomly selected plants for each replications for the traits. The data analysis was done by using WINDOSTAT software to study genetic coefficient of variation (%), phenotypic coefficient of variation (%), Heritability (%) (Broad sense) and Genetic Advance. The variability estimation was given by Burton and Devane (1953) and heritability percentage (broad sense) by Allard (1960) and genetic advance by Miller *et al*., 1958.

Results and Discussion

From the present study, analysis of variance revealed significant among all the genotypes studied except for root dry weight (Table 1). The estimates of genetic variability like genetic coefficient of variability (GCV), phenotypic coefficient of variability (PCV), heritability and genetic advance are presented in Table 2. Mean performance of genotypes were presented in table 3. Mean was highest for days to maturity, followed by plant height and days to 50% flowering and lowest on root dry weight and flag leaf breadth.

Genetic coefficient of variability (GCV) is lesser than phenotypic coefficient of variability (PCV). The GCV and PCV are classified as proposed by Sivasubramanian and Madhavamenon (1973). Traits like days to 50% flowering, days to maturity, plant height, flag leaf length, flag leaf breadth, panicle length, spikelet fertility and root length have moderate GCV and PCV whereas no. of ear bearing tillers, panicles per plant, root weight, total nitrogen (%) and crude protein have low GCV and PCV. The traits which have high GCV and PCV are flag leaf area (Saha *et al*., 2019), panicle weight, stem dry weight, harvest index, 100 grain weight and grain yield per plant. GCV and PCV were highest for grain yield per plant, stem dry weight, harvest index and flag leaf area. Similar findings were also found for high GCV and PCV in traits like yield and no. of grains/panicle (Lingaiah *et al*., 2014).

Heritability was observed to be high for almost all the traits studied viz., days to 50% flowering (99.7%), days to maturity (100%), plant height (93.4%), flag leaf breadth (92.4%), flag leaf length (85.6%), flag leaf area (90.5%), no. of ear bearing tillers (85.3%), panicle length (78.4%), panicle weight (92.4%), root length (89.2%), stem dry weight (94.5%), harvest index (99.7%), total nitrogen (96.8%), crude protein (96.8%), 100 grain weight (99.2%) and grain yield per plant (99.7%) except for spikelet fertility (37.8%) which shows moderate heritability and panicles per plant (19.1%) (Iftekharuddaula *et al*., 2001 and Hossain and Haque, 2003 which shows possibility that these traits may be crucial for selecting superior genotypes in rice development programmes. Root dry weight (16.2%) also shows low heritability. The genetic advance as percentage of mean for 19 traits revealed that grain yield per plant is highest (124.77) which is followed by harvest index (115.84), stem dry weight (114.17) and flag leaf area (79.48) whereas moderate genetic advance as percentage of mean was moderate for no. of ear bearing tillers (19.65), total nitrogen and crude protein (16.13) and low for traits like panicles per plant (7.19) and root dry weight (3.18).

The presence of additive gene action was demonstrated by moderate heritability and high genetic progress, although moderate heritability was primarily caused by environmental factors. Low genetic progress and high heritability demonstrated non-additive gene activity, suggesting that selection may not be favourable. Hybridization followed by progeny testing will be helpful for the development of such features.

Conclusion

The study concluded that yield contributing traits like days to 50% flowering (99.7%), days to maturity (100%), plant height (93.4%), flag leaf breadth (92.4%), flag leaf length (85.6%), flag leaf area (90.5%), no. of ear bearing tillers (85.3%), panicle length (78.4%), panicle weight (92.4%), root length (89.2%), stem dry weight (94.5%), harvest index (99.7%), total nitrogen (96.8%), crude protein (96.8%), 100 grain weight (99.2%) and grain yield per plant , spikelet fertility and panicles per plant showed moderate to high heritability indicating the predominant role of additive gene action. As a result, this study concludes that substantial improvement in the expression of these characters over base population can be expected through simple selection.

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Table 1: Anova Table

	Df	Days to 50% flowering	Days to maturity	Plant height (cm)	Flag leaf length (cm)	Flag leaf breadth (cm)	Flag leaf area (cm^2)	No. of ear bearing tillers (EBT)	Panicles/ plant	Panicle length (cm)
Treatments	27	646.23***	549.18***	899.4***	140.91***	0.41***	830.37***	5.17***	0.85*	40.3***
Error	54	0.714	0.011	20.82	7.48	0.01	28.03	0.28	0.58	3.38

	Df	Panicle weight (g)	Spikelet fertility	Root length (cm)	Root dry weight (g)	Stem dry weight (g)	Harvest Index	Total nitrogen(%)	Crude protein	100 grain weight (g)	Grain yield/ plant (g)
Treatments	27	12.11***	402.32***	7.78***	0.008	11.51***	847.03***	0.01***	0.412***	2.15***	17.82***
Error	54	0.32	142.62	0.303	0.005	0.22	0.97	0.0001	0.004	0.005	0.017

Significance at 5%-*, Significance at 1%- **, Significance at 0.1%- ***

Table 2: Estimates of genetic variability

Character	GCV	PCV	Heritability	GA
Days to 50% flowering	12.995	13.016	0.997	34.25
Days to maturity	10.882	10.882	1	28.727
Plant height (cm)	15.253	15.786	0.934	38.909
Flag leaf length (cm)	19.548	21.129	0.856	47.747
Flag leaf breadth (cm)	18.73	19.491	0.924	47.52
Flag leaf area (cm^2)	31.647	33.264	0.905	79.485
No. of ear bearing tillers (EBT)	8.059	8.725	0.853	19.65
Panicles/plant	6.238	14.275	0.191	7.197
Panicle length (cm)	12.579	14.203	0.784	29.413
Panicle weight (g)	61.027	63.473	0.924	154.9
Spikelet fertility	11.2	18.225	0.378	18.172
Root length (cm)	19.509	20.66	0.892	48.636
Root dry weight (g)	2.995	7.44	0.162	3.183
Stem dry weight (g)	44.486	45.761	0.945	114.171
Harvest Index	43.956	44.032	0.997	115.844
Total nitrogen (%)	6.211	6.313	0.968	16.131
Crude protein	6.211	6.313	0.968	16.131
100 grain weight (g)	21.695	21.782	0.992	57.046
Grain yield/ plant (g)	47.33	47.398	0.997	124.773

Table 3: Mean table

Character	Mean	Standard Error	Range
Days to 50% flowering	112.881	0.49	95.67-158
Days to maturity	124.33	0.06	117-171
Plant height (cm)	112.19	2.63	77.6-139.33
Flag leaf length (cm)	34.11	1.58	18.6-46.13
Flag leaf breadth (cm)	1.94	0.06	1.23-2.47
Flag leaf area (cm^2)	51.68	3.06	27.36-83.09
No. of ear bearing tillers (EBT)	15.84	0.31	13.33-18.33
Panicles/plant	5.5	0.41	4.33-6.67
Panicle length (cm)	27.89	1.06	20.17-37.37
Panicle weight (g)	3.25	0.33	1.02-7.7
Spikelet fertility	83.07	6.89	51.91-100
100 grain weight (g)	3.9	0.04	2.34-5.32
Grain yield/ plant (g)	5.15	0.07	2.57-13.69
Root length (cm)	8.09	0.32	5.17-12.13
Root dry weight (g)	1.06	0.04	1.05-1.29
Stem dry weight (g)	4.36	0.27	2.03-9.7
Harvest Index	38.2	0.57	18.99-100.68
Total nitrogen (%)	0.95	0.01	0.83-1.05
Crude protein	5.93	0.04	5.17-6.58