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GENETICS AND PLANT BREEDING

Estimation of Phenotypic Coefficients of Variation (PCV), Genotypic Coefficients of Variation (GCV), Heritability and Genetic Gain for Yield and its Components in Rice Landraces of Odisha

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ABSTRACT

The present investigation was carried out to study genetic variability in sixty-four low land rice genotypes (including fifty-five landraces of Odisha) for twelve traits. Analysis of variance (ANOVA) revealed significant differences among the genotypes for all the studied characteristics. Flag leaf area, effective tillers per plant, filled grains per panicle, 100-grain weight and harvest index had moderate to high phenotypic coefficients of variation (PCV) and genotypic coefficients of variation (GCV) estimates suggesting that these traits are under the influence of genetic control and less affected by the environment. In the present study, all the characters exhibited a high degree of heritability and among those flag leaf area, number of filled grains per panicle, 100-grain weight, harvest index and grain yield per plant had high genetic advance indicating the presence of additive gene effect and hence selection based on phenotypic performance for these traits would be effective. Filled grains per panicle and flag leaf area followed by 100-grain weight and harvest index are important characters having high heritability, genetic advance as well as high coefficient of variation which should be considered while selecting for high yield.

Highlights

⊙ Variability present among different local landraces of rice for different yield and yield attributing characters were studied.

Keywords: Genetic advance, genetic variability, genotypic coefficients of variation GCV, heritability, phenotypic coefficients of variation PCV, rice landraces

Rice (*Oryza sativa* L.) is one of the major cereal grains which serve as staple food for a major part of world's population (FAO, 2017). During 2017 and 2018, India is the second largest producer after China with a production of 166.5 million metric tons (Statista 2019). Rice is grown in different agro-ecosystems such as irrigated, rainfed upland, rainfed lowland and flood prone areas.

Odisha had rice grown area of 3963000 hectare with production of 97.94 lakh metric tons during the year 2016-17 (Odisha Economic Survey, 2017-18). In India there are more than 50,000 rice varieties,

but unfortunately most of these varieties are fast vanishing because of faulty agricultural practices (Mishra and Sinha 2012). Now a day's farmers are mostly growing high yielding varieties which have developed through few races of rice and have stopped cultivating local varieties. Generally the high yielding varieties have lower adaptability and susceptible to different biotic and abiotic stresses. But local varieties are of enormous value in agriculture as they are the store house of infinite important genes as they have evolved in particular environment since millions of years. (Mishra and Sinha 2012).

Unlike high yielding varieties, landraces anchorage a great genetic potential for rice improvement. They are endowed with tremendous variability. This rich variability of complex quantitative traits still remains unutilized. Genetic improvement mainly depends on the amount of genetic variability present in the germplasm (Govindaraj *et al.* 2015). In Odisha, a large number of local landraces of rice are available which contribute to genetic variability for different characters. Collection, characterization and evaluation of landraces are essential part of the pre breeding process prior to rice improvement Realizing the importance, fifty five local landraces of rice cultivated in rainfed lowland situation which was collected from different parts of Odisha were investigated along with high yielding checks to assess the variability present among different local landraces of rice for different yield and yield attributing characters.

MATERIALS AND METHODS

The experiment was conducted by taking fifty-five rice landraces of Odisha, four improved varieties and five high yielding varieties suitable for lowland ecology. The experiment was conducted at Rice Research Station, Odisha University of Agriculture and Technology, Bhubaneswar during kharif, 2014. The experimental materials were evaluated in randomized block design RBD with two replications with spacing of 20 cm × 15cm. The recommended cultural practices and need based plant protection measures were followed to raise a normal crop. Observations were recorded in respect of all twelve morphological characters *viz.*, plant height (PH), flag leaf area (FLA), effective tillers per plant (EBT), panicle length (PL), fertility percentage (FP), filled grains per panicle (FGP), straw yield per plant (SYP), 100-grain weight (GW), grain yield per plant (GYP), harvest index (HI) and grain Length/Breadth ratio (LB) on five competitive plants from each replication selected randomly from the middle row of each plot, where as character like days to 50% flowering (DF) was recorded on plot basis. The recorded data were subjected to statistical analysis based on the sample mean for different studied characters.. The data were analysed by using analysis of variance ANOVA (Panse and Sukhatme 1961) and the genetic parameters such as phenotypic coefficient of variance (PCV) and genotypic coefficient of variance (GCV) were calculated by the formula proposed by

(Burton, 1952), heritability in broad sense by (Burton and DeVane 1953), and genetic advance in per cent of mean were calculated as suggested by (Johnson *et al.* 1955).

RESULTS AND DISCUSSION

A set of sixty four lowland rice genotypes involving fifty five local landraces collected from fourteen districts of Odisha, four improved and five high yielding genotypes were evaluated in rainfed lowland situation at the Rice Research Station of Department of Plant Breeding and Genetics, OUAT, Bhubaneswar during *kharif* 2014. Different yield and yield attributing traits were examined to study the extent of genetic variability.

Presence of genetic variability is a primary prerequisite in any crop improvement programme. The genetic variability in respect of a trait is the direct measure as to how far the character could be manipulated in a desired direction. From the variance analysis (Table 1) significant amount of genetic variation was displayed for traits like days to 50% flowering, plant height, flag leaf area, effective tillers per plant, panicle length, fertility percentage, filled grains per panicle, straw yield per plant, 100-grain weight, harvest index, grain L/B ratio and grain yield per plant. Characters having higher magnitude of genetic variance such as filled grains per panicle, plant height, fertility percentage and flag leaf area maybe sorted out as important selection criteria for realization of higher productivity in rice.

Phenotypic coefficient of variation (PCV) and genotypic coefficient variation (GCV) estimates indicated the existence of the significant amount of variability among the genotypes for all the studied characters (Table 1). In the present study, all the characters showed slightly higher PCV than GCV, but the difference was very less signifying less influence of the environment. Therefore, selection on the basis of phenotype for most of the characters is likely to be effective.

Among all the characters studied, GCV ranged from 2.82 for days to 50% flowering to 26.10 in grain yield per plant, and PCV ranged from 3.02 for days to 50% flowering to 27.00 for grain yield per plant (Table 2). Characters namely flag leaf area, effective tillers per plant, filled grains per panicle, 100-grain weight and harvest index had moderate to

Table 1: Analysis of variance of twelve characters (mean sum of squares) for 64 lowland rice genotypes

Sl. No.	Character	Source of variation(df)		
		Replication (1)	Genotype (63)	Error (63)
1	Days to 50% flowering	18.625	21.605**	2.696
2	Plant height (cm)	42.750	745.071**	135.528
3	Flag leaf area (cm^2)	0.266	130.030**	11.702
4	Effective tillers/plant	0.321	3.971**	1.067
5	Panicle length (cm)	0.461	13.587**	1.463
6	Filled grains per panicle	668.000	1625.599**	481.885
7	Fertility percentage (%)	2.438	174.691**	43.641
8	100 -grain weight	0.227	0.500**	0.030
9	Grain L/B ratio	0.016	0.403**	0.015
10	Straw yield/plant (g)	-0.016	40.217**	3.806
11	Harvest index	0.001	0.008**	0.001
12	Grain yield/plant (g)	0.963	19.810**	1.298

* Significant at 5% level of probability, ** Significant at 1% level of probability.

Table 2: PCV, GCV, h^2 and GA estimates for various characters of sixty four low land rice genotypes

Sl. No.	Characters	Mean	Range	PCV (%)	GCV (%)	Heritability (%)	GA (5%)	GA (% of Mean)
1	Days to 50% flowering	108.90	100.50- 121.00	3.02	2.82	87.52	5.06	4.65
2	Plant height(cm)	138.63	94.50- 165.00	13.92	12.59	81.81	27.79	20.05
3	Flag leaf area (cm^2)	34.95	19.32- 51.53	23.07	22.01	91.00	12.91	36.95
4	Effective tillers/plant	6.29	4.25- 9.66	22.40	19.15	73.12	1.81	28.83
5	Panicle length (cm)	24.88	19.00- 31.08	10.47	9.89	89.23	4.09	16.45
6	Filled grains/panicle	109.98	51.17- 167.51	25.92	21.74	70.36	35.30	32.10
7	Fertility percentage (%)	79.10	36.15- 95.05	11.82	10.23	75.02	12.34	15.60
8	100 -grain weight (g)	2.13	1.08- 3.11	23.43	22.71	93.95	0.83	38.73
9	Grain L/B ratio	4.10	2.88-5.30	10.95	10.74	96.17	0.76	18.53
10	Straw yield/plant (g)	26.17	14.16- 39.17	17.14	16.31	90.54	7.15	27.31
11	Harvest index	0.31	0.09- 0.43	20.58	19.53	90.10	0.10	32.63
12	Grain yield/plant (g)	11.65	3.41- 20.32	27.00	26.10	93.45	5.18	44.41

Table 3: Important characters to be considered during selection

Characters	Higher magnitude of variance	Moderate to high PCV and GCV	Heritability	Genetic advance	Rank
Days to 50% flowering	-	-	-	√	
Plant height(cm)	√	-	-	√	
Flag leaf area (cm^2)	√	√	√	√	1
Effective tillers/plant	-	√	-	√	
Panicle length (cm)	-	-	-	√	
Filled grains/panicle	√	√	√	√	1
Fertility percentage (%)	√	-	-	√	
100 -grain weight (g)	-	√	√	√	2
Grain L/B ratio	-	-	-	√	
Straw yield/plant(g)	-	-	-	√	
Harvest index	-	√	√	√	2
Grain yield/plant(g)	-	√	√	√	2

high PCV and GCV estimates suggesting that these traits are under the influence of genetic control and less affected by environment. Hence, these traits can be relied upon, and simple selection can be practiced for further improvement. Similar findings were also reported by Idris *et al.* (2012) for filled grains per panicle and harvest index; Seyoum *et al.* 2012 for 1000-grain weight and grains per panicle; Gangashetty *et al.* (2013) for effective ear bearing tillers per plant.

Heritability is an estimate of the ratio of genotypic variance to the total phenotypic variance. Very high to high degree of heritability estimates were observed for all the traits under study indicating the low or negligible influence of environment in the expression of these traits and may respond to selection for their improvement. However, broad sense heritability is also subjected to some experimental error. Hence, genetic advance along with heritability gives more reliable information for consideration of a character under selection. The expected amount of genetic advance can be estimated by the genotypic coefficient of variation along with heritability as suggested by Burton (1952).

In the present study, all the twelve characters exhibited high degree of heritability and among those flag leaf area, filled grains per panicle, 100-grain weight, harvest index and grain yield per plant had high genetic advance indicating the presence of additive gene effect and hence selection based on phenotypic performance for these traits would be effective. Similar observations were also recorded by Jaiswal *et al.* (2007) for grain yield per plant; Kole *et al.* (2008) for grain number and grain yield; Pandey *et al.* (2009) for effective ear bearing tillers per hill, test weight, harvest index and grain yield; Subudhi *et al.* (2009) for grains per panicle; Pfukrei *et al.* (2011) for grain yield per plant; Immanuel *et al.* (2011) for harvest index; Selvaraj *et al.* (2011) for grain yield per plant; Gangashetty *et al.* (2013) for grain yield per plant; Akinwale *et al.* (2011) for grains per panicle and grain yield.

Table 3 reveals that characters namely filled grains per panicle and flag leaf area followed by 100-grain weight and harvest index are important characters having high heritability, genetic advance as well as high coefficient of variation which should be considered while selecting for high yield. The following genotypes were identified as promising with respect to the said characters.

Sl. No.	Character	Promising genotypes
1	Filled grains/ panicle	Badashabhoga, Kanchan, Kadalipendi, Ranisaheba, Ganjeijata, Ganjamgedi, Parvatajeera, Juiphoola and Karpurakranti
2	Flag leaf area (cm²)	Jalagudi, Bhutia, Madhabi, Gunjimanika, Khandasagar, Mayurakantha, Jaladubi , Dhoiabankoi and Biradiabankoi
3	100 -grain weight (g)	Jaladubi, Kalakadamba, Biradiabankoi, Nilarpati, Champeisiali, FR 13A, Mahipal, Dhoiabankoi, Habira, Bankoi, T 1242, Baudiachampa and Dhulia
4	Harvest index	Ganjamgedi, T 141, FR 13A, Mrunalini, Seulapana, Madhabi, Dhulia, Nilarpati, Kanchan, Jagabalia, Kadalipendi and Ganjeijata

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