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Genetic Variability Studies for Nitrogen Use Efficiency in Rice

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ABSTRACT

A field Experiment was conducted to study the genetic variability for nitrogen use efficiency and yield related traits in two crosses of local rice genotypes which includes low nitrogen use efficient genotypes (Bettasanna, Banavasi selection) and high nitrogen use efficient genotypes (Kaduvakalongi, Navali) at the college of Agriculture V.C. Farm Mandya during Rabi-Summer 2016-17. High Genotypic Coefficient of Variability (GCV) and Phenotypic Coefficient of variability (PCV) values with less difference were observed for nitrogen use efficiency in the cross Kaduvakalongi × Banavasi selection indicating less influence of environmental factors on their expression. Moderate genotypic coefficient of variability (GCV) and Phenotypic coefficient of variability (PCV) values with less difference observed for nitrogen use efficiency in the cross Bettasanna × Navali which indicated the influence of both additive and non-additive gene action in the inheritance of these traits. High heritability coupled with high genetic advance were recorded for yield per plant, Nitrogen use efficiency in both the crosses this indicated that these traits were predominantly controlled by additive gene action and amenable for selection.

Key words: *Nitrogen use Efficiency, Genetic Advance, GCV, PCV, Heritability.*

INTRODUCTION

Rice (*Oryza sativa* L., 2n = 24) is one of the major food crop of the world. Worldwide, more than 3.5 billion people depend on rice and it is a nutritious cereal crop, provides 20 per cent of the calories and 15 per cent of protein consumed by world's population. Besides being the chief source of carbohydrate and protein in Asia, it also provides minerals and fibre. The present world population of 6.3 billion which may reach 8.5 billion by 2030 with an approximate rice consumers of five billion people thereby, increasing the demand of rice up to 38% by 2030. To meet this challenge there is a need to develop rice varieties with higher yield potential and greater yield stability. Nitrogen and phosphorous are fundamental to crop development because they form the basic components of many organic molecules, nucleic acids and proteins[7]. Nitrogen plays an important role in rice production, increased nitrogen application increases rice yield per unit area and nitrogen fertilizer has a key role in rice life cycle.

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In the past 50 years, the application of nitrogen fertilizer to rice field resulted in a dramatic increase in yields but with considerable negative impacts on the environment. Continuous increase in rice production has to be achieved with less nitrogen fertilizer by improving nitrogen use efficiency (NUE) through better nitrogen fertilizer management and development of new nitrogen use efficient rice varieties. Some efforts were made to improve rice germplasm for NUE. The genotypic variation in NUE has been realized and however, plant traits that are associated with high grain yield and high NUE should be identified so that breeders are able to use these traits easily as selection criteria in the breeding programme to develop nitrogen use efficient varieties without the scare of playing with rice yield potential.

Variability studies in rice reveals the genotypic and environmental effect on yield and nitrogen use efficiency, which further provides the information about heritability of the character.Thus fundamental approach to develop cultivars with enhanced nitrogen use efficiency, in contrast to just improved yield requires evaluating the segregating population obtained by crossing low nitrogen efficient genotype to high nitrogen use efficient genotype and vice versa under native soil nitrogen condition so as to identify a nitrogen use efficient plants and compare its performance with that of other genotypes. The simplest definition of plant NUE is the grain yield per unit quantity of nitrogen applied.

Landraces of rice offer enormous genetic diversity for improvement of the crop. Variability for complex traits in these accessions still remains unexploited. The characterization of this would be of value in enriching the rice genepool with new variability from new sources of diversity. In view of above facts an attempt was made to study Genetic variability for nitrogen use efficiency in F_2 population of local rice genotypes.

MATERIAL AND METHOD

Experimental material consisted of four local rice genotypes including high nitrogen use efficient genotypes and low nitrogen use efficient genotypes drawn from the previous study conducted by Naveen Kumar[9] at Department of Genetics and Plant Breeding, College of Agriculture, V. C. Farm Mandya. The investigation was carried out at the Department of Genetics and Plant Breeding, College of Agriculture, V.C. Farm, Mandya. Four generations *viz.*, P_1, P_2, F_1 & F_2 were raised. The F_1's were obtained by crossing the above four parents which comprises of low nitrogen use efficient genotypes and high nitrogen use efficient genotypes. Crossing was made between low nitrogen use efficient genotype × high nitrogen use efficient genotype and *vice versa*, during *Rabi-summer*–2015. During *Kharif*-2016, advancement of F_1's were made to get F_2 seeds.

The final experiment was conducted during *Rabi-summer*- 2016-2017. Twenty-five to thirty days old seedlings were transplanted to the main filed with spacing of 30 cm between rows and 20 cm between plants in a row. All the plants were grown under No nitrogen condition (i.e., native nitrogen) to study variations in nitrogen use efficiency. Before the experiment was laid out, soil samples were collected from experimental sites and nutrient status was analysed (Table 1). The recommended agronomic practices were followed to raise the crop at College of Agriculture V. C farm Mandya. Observations were recorded for the following traits Chlorophyll meter reading (SPAD), Days to 50 per cent flowering, Plant height at maturity, Number of tillers per plant, Productive tillers per plant, panicle length, panicle weight, 1000 seed weight, yield per plant, nitrogen use efficiency, total nitrogen uptake.Near infrared reflectance spectroscopy (NIR system, FOSS, Denmark) system was used for the estimation of protein ,iron, zinc, amylose, carbohydrate and moisture content.

Phenotypic coefficient of variability (PCV) and Genotypic coefficient of variability (GCV) were estimated by using formulae suggested by Burton and Devane. Broad sense heritability was estimated by following the procedure suggested by Lush. The expected genetic advance as per cent of mean for each character was predicted by formula given by Johnson.

RESULTS AND DISCUSSION

In breeding programme, the mean performance and variability are the important factors for selection. Based on mean performance undesirable plant may be eliminated and the same variability may be used for selection procedure with a view to understand the extent to which the observed variations are due to genetic factors the range, mean, PCV (Phenotypic coefficient of variability), GCV (Genotypic coefficient of variability), broad sense heritability (h^2) and genetic advance as percent mean (GAM) were worked out and are presented for the cross Kaduvakalongi × Banavasi selection and the cross Bettasanna × Navali in Table 2 and 3 respectively

In the present study, the estimates of PCV were higher than their corresponding GCV for all the characters in both crosses viz; Kaduvakalongi × Banavasi selection and Bettasanna × Navali. The maximum value of PCV and GCV were recorded for number of productive tillers per plant (52.01% and 44.37% respectively) and for number of tillers per plant (43.22% and 41.48% respectively) in the cross Kaduvakalongi × Banavasi selection. For the cross Bettasanna × Navali maximum value of PCV and GCV were recorded for number of productive tillers per plant (62.23% and 50.22% respectively) and number of tillers per plant (50.09 % and 43.45% respectively) Moderate value of PCV and GCV were recorded for yield per plant (26.46% and 23.93% respectively) and for nitrogen use efficiency (24.86 % and 23.93% respectively) in the cross Kaduvakalongi × Banavasi selection and in the cross Bettasanna × Navali moderate value were recorded for panicle weight (25.03 % and 23.93 % respectively),this indicates the influence of both additive and non-additive gene actions in the inheritance of these traits, improvement in these traits would be possible through employing breeding methods which exploit both of these gene actions. These findings are in accordance with findings of Bagali *et al.*[2], and Shivapriya[10].

The low PCV and GCV recorded in the following traits Days to fifty per cent flowering, Chlorophyll meter reading (SPAD), Days to 50 per cent flowering, Plant height at maturity, panicle length, panicle weight, 1000 seed weight, total nitrogen uptake, protein content, iron content, zinc content, amylose content, carbohydrate content and moisture content for the cross Kaduvakalongi × Banavasi selection and chlorophyll meter reading (SPAD), Days to 50 per cent flowering, Plant height at maturity, panicle length, 1000 seed weight, nitrogen use efficiency, total nitrogen uptake,protein content, iron content, zinc content, amylose content, carbohydrate content and moisture content in the cross Bettasanna × Navali, those Characters having high phenotypic coefficient of variability and genotypic coefficient of variability indicate large scope for selection and improvement in the present set of local rice genotypes and less difference between phenotypic coefficient of variability and genotypic coefficient of variability indicating that less influence of environment on the expression of traits.

High heritability and genetic advance as percent mean were observed for the following traits in the cross Kaduvakalongi × Banavasi selection, number of tillers per plant, number of productive tillers per plant, panicle length, test weight, yield per plant, nitrogen use efficiency, Total nitrogen uptake and protein content, whereas in cross Bettasanna × Navali number of tillers per plant, productive tillers per plant, panicle weight, test weight and yield per plant showed high heritability and genetic advance. This indicates the predominance of additive genetic variance thereby simple selection procedures would bring about desired genetic improvement. These results were in agreement with the findings of Courtois *et al.*[4], and Haider *et al*[5]. But high heritability with moderate genetic advance were observed for zinc content, amylose content, moisture content and carbohydrate content in the cross Kaduvakalongi × Banavasi selection, while in cross Bettasanna × Navali plant height at maturity, panicle weight, zinc content and moisture content showed high heritability with moderate geneticadvance. Moderate and low heritability indicates simple selection is not sufficient for improvement of traits like SPAD value, panicle weight, and iron content in cross Kaduvakalongi × Banavasi selection and SPAD value in cross Bettasanna × Navali. Babu *et al.*[1], reported moderate heritability which are in agreement with the above results.

CONCLUSION

The present study indicates inclusion of Kaduvakalongi, Banavasi selection, Bettasanna and Navali lines as potential donors of NUE, Protein and nutrients for hybridization programme would result in the development of superior nitrogen use efficient rice cultivars.By knowing the gene action governing nitrogen use efficiency and yield, further these can be exploited by using suitable breeding procedures.

Table 1: Soil Properties of Experimental plot at before transplanting and after harvest

Soil properties	Before transplanting	After harvest
P^H	8.61	8.06
Electrical Conductivity (ds\m)	0.238	0.734
Organic Carbon (%)	0.730	0.560
Available Nitrogen Kg ha^{-1}	182.63	123.60
Available Phosphorous Kg ha^{-1}	37.82	23.25
Available Potassium Kg ha $^{-1}$	290.30	174.72

Table 2: Estimation of mean and genetic parameters for yield and yield attributing traits in F_2 generation of the cross Kaduvakalongi × Banavasi selection in local rice genotypes (*Oryza sativa*)

Characters	Mean	Range		Coefficient of Variability		Heritability % (Broad sense)	GAM %
		Minimum	Maximum	PCV %	GCV %		
SPAD value	38.67	22.5	48.5	15.38	11.61	56.95	18.05
Days to 50% flowering	80.56	72.00	88.00	4.68	4.08	76.17	7.34
Plant height at maturity (cm)	87.20	61.00	120.5	10.98	10.81	96.87	21.93
Number of tillers per plant	25.13	7.00	51.00	43.22	41.48	92.13	82.02
Productive tillers per plant	11.66	3.00	28.00	52.01	44.37	72.78	77.98
Panicle length (cm)	17.15	11.40	23.40	19.84	15.61	61.90	25.31
Panicle weight (g)	1.43	0.60	2.90	10.40	8.61	55.70	17.89
1000 seed weight (g)	22.15	17.60	28.70	12.00	11.92	98.82	24.42
Yield per plant (g)	14.34	8.10	29.60	26.46	23.93	92.67	47.46
Nitrogen use efficiency	26.17	14.78	54.02	24.86	23.93	92.67	47.46
Total nitrogen uptake (%)	100.07	70.54	117.79	17.62	17.45	98.06	35.60
Protein (%)	9.77	8.06	12.46	13.91	13.68	96.74	20.40
Iron (%)	12.18	10.67	13.24	4.92	3.37	58.03	5.29
Zinc (%)	26.64	23.02	30.12	5.69	5.24	86.39	10.13
Amylose (%)	38.06	30.18	45.94	7.52	6.86	83.21	12.90
Carbohydrate (%)	79.8	71.45	87.35	4.24	3.95	86.59	12.62
Moisture (%)	12.15	10.28	13.67	13.26	10.52	72.05	16.82

Table 3: Estimation of mean and genetic parameters for yield and yield attributing traits in F_2 generations of the cross Bettasanna × Navali in local rice genotypes (*Oryza sativa*)

Characters	Mean	Range		Coefficients of variability		Heritability %(Broad sense)	GAM (%)
		Minimum	Maximum	PCV %	GCV%		
SPAD value	37.75	27.60	46.70	12.96	9.83	57.50	15.35
Days to 50 % flowering	90.44	81.00	110.00	5.02	4.67	86.38	8.94
Plant height at maturity (cm)	96.63	63.00	119.60	9.43	9.20	95.27	18.51
Number of tillers per plant	11.82	3.00	28.00	50.09	43.45	75.25	77.65
Productive tillers per plant	8.50	1.00	16.00	62.23	50.52	65.91	84.49
Panicle length (cm)	19.45	15.00	27.50	14.18	11.75	68.69	20.06
Panicle weight (g)	1.55	0.50	2.90	25.03	23.09	92.20	17.01
1000 seed weight (g)	12.89	16.50	28.60	13.11	13.04	98.90	26.71
Yield per plant (g)	20.55	13.20	36.00	19.69	17.90	82.66	33.53
Nitrogen use efficiency	37.50	24.09	61.71	18.55	17.90	93.09	35.58
Total nitrogen uptake (%)	118.41	83.19	183.13	14.33	14.17	97.75	28.87
Protein (%)	8.52	7.58	9.90	16.20	14.69	88.27	8.99
Iron (%)	12.49	11.23	14.58	4.54	4.26	87.88	8.22
Zinc (%)	26.04	20.16	31.76	6.49	5.89	88.55	11.03
Amylose (%)	28.23	17.58	38.81	14.90	14.30	92.12	28.27
Carbohydrate (%)	81.66	73.23	91.67	5.21	4.62	78.62	8.44
Moisture (%)	12.19	11.21	13.31	15.19	11.52	76.50	12.14

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