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Genetic variability, heritability and genetic advance for yield contributing traits in aromatic and pigmented rice (*Oryza sativa* L.)

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Abstract
The knowledge of genetic variability in a given crop species for characters under improvement is important in any plant breeding programme. Heritability with genetic advance are more helpful in predicting the gain under effective selection. Twenty-five aromatic and pigmented genotypes of rice along with 3 checks were evaluated during kharif 2017 to estimate the genetic variability, heritability and genetic advance for 19 quantitative traits. Among the traits, grain yield per plant, biological yield per plant, 1000 grain weight, number of tillers per plant exhibited high estimate of genotypic coefficient of variation and phenotypic coefficient of variation. Highest board sense heritability was obtained for 1000 grain weight, biological yield per plant, number of filled spikelets per panicle, number of tillers per plant and grain length. High magnitude of heritability along with genetic advance was obtained for number of filled spikelets per panicle.

Keywords: Genetic variability, heritability, genetic advance, rice, *Oryza sativa* L.

Introduction
Rice (*Oryza sativa* L.) is one of the top three leading food crops in the world together with wheat and maize. In Asia, rice is the most important cereal crop providing the main energy source of carbohydrates for most of the Asian people (Mohanty, 2013) [8]. In the world rice is the second most important cereal crop after the corn. Rice is highly cultivated crop in India (Singh *et al*. 2017a; Singh *et al*. 2017b; Singh *et al*. 2017c; Singh *et al*. 2018; Tiwari *et al*. 2018; Tiwari *et al*. 2019a; Tiwari *et al*. 2019b; Kour *et al*. 2019; Singh *et al*. 2019b) [10, 11. 12. 13, 14, 15, 16, 17, 18]. Chhattisgarh state contributes 5.26% of the total rice production of the India. Central India is well known for its native wealth of rice genetic resources and among these the large number of indigenous short grained, scented and pigmented varieties cultivated in different area of Madhya Pradesh (MP) and Chhattisgarh (CG) state. These varieties in general are tall and sensitive to photoperiod with aromatic short and medium grains. Rice is rich in genetic diversity, with thousands of varieties grown throughout the world. In its natural dehusked state rice comes in many different colours, including brown, red, purple and even black. These colourful rice varieties are often prized for their health properties.
The knowledge of genetic variability present in a given crop species for the character under improvement is of paramount importance for the success of any plant breeding programs. Heritability and genetic advance are important selection parameters. Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection than heritability estimates alone. Therefore, the present study was conducted to assess the heritability, genetic advance and genetic variability of aromatic and pigmented genotypes of rice for yield contributing traits.

Matarials and Methods
The materials for the present investigation comprised of 25 aromatic and pigmented genotypes of rice along with 3 checks. These genotypes were sown in Randomized Block Design (RBD) with three replications at IGKV, RMD CARS, Research and Instructional Farm, Ambikapur

during *Kharif* 2017. Each genotype was sown as row to row and plant to plant distance of 20 cm and 15 cm, respectively. The observations on 19 quantitative characters was recorded based on five randomly taken plants from each genotype for some observations and for other observations will be recorded on whole plot basis. Data was collected on leaf length of blade, leaf width of blade, stem thickness, stem length, number of panicle per plant, number of tillers per plant, number of effective tillers per plant, number of spikelets per panicles, number of filled spikelets per panicles,1000 grain weight, grain length, grain width, grain length and breadth ratio, spikelet fertility%, grain yield per plant, biological yield per plant, harvest index per plant, time of heading (50%) and time to maturity (days). Heritability in a broad sense was calculated by the formula suggested by Hanson *et al.* (1956) [4]. Expected genetic advance (GA) was calculated by the method suggested by Johnson *et al.* (1955) [5]. The coefficient of variation for different characters was estimated by formula suggested by Burton and De Vane (1953) [1].

Results and Discussion

Variability

Variability refers to the presence of difference among the individuals of plant population. It results due to differences either in the genetic constitution of the individuals of a population or in the environment in which they are grown. Phenotypic variability refers to total variability which is observable. It related to genotypic and environmental variation. Genotypic variability refers to variability which remains unaltered by environmental conditions, this type of variability is more useful to a plant breeder for exploitation in selection or hybridization. The analysis of variance revealed that the mean sum of square due to genotypes were significant for all the traits (Table 1). The high magnitude of coefficient of variation at both phenotypic and genotypic level was recorded for grain yield per plant (47.051, 48.055) followed by number of filled spikelet per panicle, (32.791, 35.101), biological yield per plant (32.725, 33.469), number of tillers per plant (31.969, 34.434), 1000 grain weight (27.235, 27.732), harvest index per plant (26.617, 30.938), Spikelet fertility% (24.121, 26.880) and Grain length: grain breadth ratio (22.354, 24.974). The moderate magnitude of coefficient of variation at both phenotypic and genotypic level was recorded for grain width (17.011, 19.409) followed by grain length (16.432, 19.119) and number of spikelet per plant (15.347, 19.196) whereas low magnitude of coefficient of variation at both phenotypic and genotypic level was recorded for time of maturity (4.034, 5.944) followed by time of 50% heading (3.750, 6.164), leaf length (4.682, 9.206), leaf width (6.908, 14.725), stem thickness (7.115, 10.487), number of panicle per plant (9.887, 16.224) and number of effective tiller per plant (8.568, 15.714) (Table 2). Genotypic coefficient of variance expressed in percentage (GCV%) is a good measure of the magnitude of variation present in the test population for different traits. The phenotypic coefficient of variation was higher than the genotypic coefficient of variation for all the characters, indicating that the variation among them is not only genetic but also due to the influence of environment. Similar result recorded by Lingaiah (2015) [7] for phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) in 1000 grain weight and also recorded by Chaudhary *et al* (2004) [3] for biological yield per plant and harvest index per plant and Sharma and Bhuyan (2004) [19] for number of grains per panicle followed by grain yield per plant and number of effective panicles per plant.

Heritability

Heritability refers to the ratio of genotypic variance to the phenotypic variance or total variance. It is a good index of the transmission of traits from parent to their offspring. The high magnitude of heritability was observed for 1000 grain weight (78%) followed by grain yield per plant (77%), biological yield per plant (77%), number of filled spikelet per panicle (76%), number of total tiller per plant (76%), grain length (75%), grain width (75%), grain length: grain breadth ratio (75.5), spikelet fertility (75%), harvest index per plant (75%), stem length (72%), stem thickness (71%) and days to maturity (71%). Moderate magnitude of heritability was observed for number of panicles per plant (70%) followed by time of heading (70%), number of effective tillers per plant (69%), leaf length of blade (68%) and leaf width of blade (67%). (Table 2). Similarly, Kavitha and Reddy (2002) [6] recorded maximum heritability for number of spikelets per panicle and number of filled spikelets per panicle, Chandra and Pradhan (2003) [2] recorded moderate magnitude of heritability for fifty percent of heading, and Sharma and Bhuyan (2004) [19] recorded high heritability for number of effective tillers per plant. It indicates the heritability is due to additive gene effect and selection may be effective.

Genetic Advance

Genetic advance refers to the improvement in the mean genotypic value of selected plants over the parental population. It is the used to measure of genetic gain under selection. The high magnitude of genetic advance was observed for number of filled spikelet per panicle (81.73). Moderate magnitude of genetic advance was observed for number of spikelet per plant (56.59). whereas, low magnitude of genetic advance was observed for biological yield per plant (33.93) followed by spikelet fertility% (33.77), stem length (20.06), harvest index per plant (19.41), 1000 grain weight (12.33), days to maturity (9.34), number of tillers per plant (6.74), time of 50% heading (6.15), leaf length (3.28), grain length (2.92), grain length: grain width ratio (1.55), grain width (1.10) number of effective tillers per plant (0.82), stem thickness (0.14) and leaf breath (0.11) (Table 2). High value of genetic advance which is least influenced by environmental effect and low value of genetic advance which is highly influenced by environmental effect. Similar findings were also reported by Kavitha and Reddy (2002) [6], Chandra and Pradhan (2003) [2] and Sharma and Bhuyan (2004) [19]. High heritability along with high genetic advance was observed for number of filled spikelets per panicle. This indicated that this trait was controlled by additive type gene action and selection may be effective for this character. Prasad *et al.* (2017) [9] observed high magnitude of heritability along with high genetic advance as% of mean for number of tillers per plant, number of productive tillers per plant, number of filled grains per panicle, 1000 grain weight and grain yield per plant.

Table 1: Analysis of variance for different yield contributing traits.

S. No.	Sources of variation	Mean sum of square	
		Replication	Genotype	Error
	Degree of freedom	48	2	24
1	Leaf length (cm)	23.2463	35.0867*	17.1439
2	Leaf width (cm)	0.0390	0.0602*	0.0326
3	Time of heading (days)	5.6233	68.9311**	24.9428
4	Stem thickness (mm)	0.0192	0.0258**	0.0073
5	Stem length (mm)	155.9817	421.7657**	95.9757
6	Number of panicles per plant	0.8892	2.0568**	0.7418
7	Number of tillers per plant	0.5717	23.9016**	1.2112
8	Number of effective tillers per plant	0.2025	1.7966**	0.7966
9	Number of spikelets per panicle	1088.5125	2563.2844**	406.017
10	Number of filled spikelets per panicle	415.9297	3455.0308**	160.221
11	1000 grain weight (g)	0.2781	68.7181**	0.335
12	Grain length (mm)	0.0112	5.5885**	0.5895
13	Grain width (mm)	0.0069	0.7505**	0.0686
14	Grain length: grain width ratio	0.0184	1.4069**	0.1075
15	Spikelet fertility%	44.6145	659.49599	9.3601
16	Grain yield per plant	0.2823	111.8191**	1.5846
17	Biological yield per plant	19.5077	526.5310**	7.9435
18	Harvest index per plant	2.6569	244.8100**	25.6453
19	Time maturity (days)	2.0933	113.4043**	31.8294

Note -: **Significant at 1% level of probability
* Significant at 5% level of probability

Table 2: Genotypic and phenotypic coefficient of variability, heritability and genetic advance for different characters in rice.

S. No.	Characters	GCV (%)	PCV (%)	h^2 (bs) (%)	GA	GA as% of mean
1	Leaf length (cm)	4.68	9.20	68	3.28	6.28
2	Leaf width (cm)	6.90	14.72	67	0.11	8.55
3	Time of heading (days)	3.75	6.16	70	6.15	6.02
4	Stem thickness (mm)	7.11	10.48	71	0.14	12.75
5	Stem length (mm)	8.94	12.27	72	20.06	17.22
6	Number of panicle per plant	9.88	16.22	70	1.06	15.90
7	Number of tillers per plant	31.96	34.43	76	6.74	78.35
8	Number of effective tillers per plant	8.56	15.77	69	0.82	12.28
9	Number of spikelet per panicle	15.34	19.19	73	56.59	32.39
10	Number of filled spikelets per panicle	32.79	35.10	76	81.73	80.86
11	1000 grain weight (gm)	27.23	27.73	78	12.33	70.61
12	Grain length (mm)	16.43	19.11	75	2.92	37.28
13	Grain width (mm)	17.01	19.40	75	1.10	39.36
14	Grain length: grain width ratio	22.35	24.97	75.5	1.55	52.82
15	Spikelet fertility%	24.12	26.88	75	33.77	57.12
16	Grain yield per plant	47.05	48.05	77	15.66	121.62
17	Biological yield per plant	32.72	33.46	77	33.93	84.47
18	Harvest index per plant	26.61	30.93	75	19.41	60.45
19	Time maturity (days)	4.03	5.94	71	9.34	7.22

Conclusion

Among the traits, grain yield per plant, biological yield per plant, 1000 grain weight, number of tillers per plant exhibited high estimate of GCV and PCV. High heritability along with high genetic advance was observed for number of filled spikelet per panicle. It indicates that the heritability is due to additive gene effect and variation exists in the genotypes, which provides opportunities for genetic improvement.

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