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Research Article

GENETIC ANALYSIS AND TRAITS ASSOCIATION IN $F_{2:3}$ POPULATION OF RICE UNDER ZINC DEFICIENT CONDITION

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Abstract- Genetic variability assessment gives basic information concerning the genetic properties of the population based on which breeding methods could be formulated for further improvement of the crop. The estimates of heritability, coefficients of variability and genetic advance were computed in 276 $F_{2:3}$ lines of a cross Kinandang Patong× A69-1 for 12characters including zinc deficiency tolerance and yield contributing traits under zinc-deficient condition during *kharif* season 2016. The highest genotypic coefficient of variation (GCV) was found for leaf bronzing score. High heritability with high genetic advance was obtained in filled grains per panicle, grain yield per plant and plant height which is indicative of additive gene action. The correlation analysis revealed that the grain yield per plant had a highly positive significant association with all traits except seedling survival and leaf bronzing score. High heritability coupled with high and moderate genetic advance was observed for all the traits observed. However, grain yield per plant was negatively significantly correlated with unfilled grains per panicle. This implies that selection for these characters would lead to simultaneous improvement of grain yield.

Keywords- Variability, Correlation, Heritability, Rice (*Oryza sativa* L.), Zinc.

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Introduction

Rice (*Oryza sativa* L.), a member of the *Poaceae* family, is the major food crop of more than half of the global population and will continue to occupy the pivotal place in global food and livelihood security systems [1]. Humans require at least 49 nutrients for their normal growth and development, and the demand for most nutrients is supplied by cereals, particular rice due to its staple role [2]. Zinc is one of the essential nutrients for plants and its deficiency is one of the major micronutrient constraints to crop production throughout the world[3].One-third of the world population is at risk due to the low dietary intake of Zn [4], including 2 billion people in Asia and 400 million in sub-Saharan Africa [5]. Rice germplasm shows large variation in tolerance of Zn-deficient soils [6, 7] and in the ability to concentrate Zn in grains [8-10].

It was earlier proved that the problem of leaf bronzing is due to zinc deficiency [6, 11]. [12] reported that Zn is involved in many physiological processes, including enzyme activation and protein synthesis. Zn deficiency affects rice most severely during the seedling stage, following 2-3 week after transplanting, when plant mortality may occur. Many factors, including high soil pH (>7) and high bicarbonate, as well as phosphate and organic matter content, contribute to sequestering Zn in the soil, resulting in rice Zn deficiency [13, 14].

Rice yield and growth is very sensitive to zinc and it can be corrected by adding zinc compounds to the soil or plant, but the high cost associated with applying zinc fertilizers in sufficient quantities to overcome zinc deficiency places a considerable burden on resource-poor farmers and it has therefore been suggested to improve the tolerance to zinc deficiency in rice cultivars [15, 3].The development of new genotypes requires some knowledge about the genetic variability presents in the germplasm of the crop which helps to know if these variations are heritable or non-heritable. The magnitude of variation due to the heritable component is very important because, it would be a guide for the selection of parents for crop improvement [16]. Genetic variability for agronomic and quantitative traits is the key component of a breeding programme for broadening the gene pool of rice [17].

Heritability estimates guide a breeder in the choice of parents for crop improvement programmes [18]. Estimate heritability along with genetic advance conjointly are helpful in predicting the gain under selection than heritability alone, due to the influence of the environment [19, 20] reported that grain yield is a complex trait, quantitative in nature and a combined function of a number of constituent traits. Consequently, selection for yield may not be satisfying without taking into consideration yield component traits. Thus, positives correlated between yield and yield components are required for effective yield component breeding, increasing grain yield in rice [20]. Keeping the above facts in view, the objective of the present study was to assess and evaluate genetic variability of rice $F_{2:3}$ lines based on agro-morphological traits and analyze the relationships between these traits.

Materials and Methods

Experimental plan: A $F_{2:3}$ population having 276 lines were developed from Kinandang Patong (zinc deficiency sensitive) and A69-1 (zinc deficiency tolerant) parents using modified single seed descent method. 276 lines of this mapping population along with parents were grown in the field during *Kharif* season 2016 at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi in RBD with three replications. Ten plants of each $F_{2:3}$ line was sown in two rows of 1 m length by maintaining the spacing of 15 cm between rows.

Analysis of Zn content in soil: Soil samples were collected from six different places in the experimental field to know zinc nutrient present in the soil. These soil samples were analyzed using Atomic Absorption Spectrophotometry (AAS). Readings of these samples were ranged between 0.5ppm to 1.0ppm. Readings were compared with the critical level of soil below which zinc deficiency might occur is 1.0ppm [21].

Observation taken: Data were recorded on five plants form each replication respectively for seedling survival (%), leaf bronzing score (0-9), days to 50 per cent flowering (days), days to maturity (days),number of productive tillers per plant, plant height (cm), panicle length (cm), filled grains per panicle, unfilled grains per panicle, test weight (g), grain yield per plant (g) and total dry matter (g) in single plant observation. All field experiments were conducted on a highly Zn-deficient soil. Two weak after transplanting, the numbers of survived plants per row was determined and were scored for leaf bronzing. Leaf symptoms were scored based on classification according to [7].

Statistical analysis: The mean data for each character individually was subjected to statistical analysis. Standard statistical procedures were used for the analysis of mean variance, genotypic and phenotypic coefficients of variation [22], heritability [23] and genetic advance. The coefficient of correlation was determined using the technique outlined by [24].

Result and discussion

Analysis of variance and genetic parameters

It is evident from the analysis of variance that the treatment differences are given to the 276 $F_{2:3}$ lines were highly significant for all quantitative traits [Table-1] confirming the results obtained by [25-27]. Variability parameters were estimated for yield and Zn deficiency trait in$F_{2:3}$ generation presented in [Table-2]. Expectedly phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the characters studied, probably due to environmental effects. High heritability estimates obtained for all the characters except seedling survival, leaf bronzing score and unfilled grains per panicle suggesting that the environmental factors did not affect greatly the phenotypic performance of these traits. Highest PCV (66.50%) and GCV (47.71%) were observed for leaf bronzing score. PCV ranged between 3.80% for days to maturity to 66.50% for leaf bronzing score. Similarly, GCV ranged between 3.66% for days to maturity to 47.71% for leaf bronzing score. A similar finding of higher PCV than GCV for days to maturity and zinc score, respectively was also reported by [28]. Heritability in broad sense estimate varied from 42% for unfilled grains per panicle and 98% for grain yield per plant and total dry matter, respectively. Similarly, the genetic advance was ranged between 3.17% for productive tiller per plant and 48.32% for filled grains per panicle. A joint consideration of GCV, heritability broad sense, and genetic advance revealed that total dry matter (31.37, 98 and 29.12%) and grain yield per plant (25.97, 98and 13.49%) combined high GCV, high heritability broad sense, and moderate genetic advance. Thus, high estimates of GCV and heritability could be good predictors of seed yield. Furthermore, moderate to high heritability, GCV and GA% in a mean could be explained by additive gene action and their improvement could be achieved through mass selection [29] [Table-2].

Table-1 *Analysis of variance (ANOVA) of 12 traits for zinc deficiency tolerance across the environment in an $F_{2:3}$ population of a cross KinandangPatong x A69-1*

Source of Variation	d.f	SS	LBS	DFF	DM	PTP	PH (cm)	PL (cm)	FGP	UFGP	TW(g)	GYP(g)	TDM(g)
Replication	2	2.15	2.97	2.15	2.97	0.76	0.01	0.63	0.25	0.01	1.47	0.01	0.001
Treatment	279	5.1**	36.3**	55.1**	36.3**	17.9**	40.6**	20.6**	21.7**	3.1**	19.4**	240.2**	283.2**
Error	558	1.40	1.47	1.40	1.47	0.49	12.97	0.94	91.11	140.32	1.10	0.54	2.14

Note: ** Significant at P<0.01

d.f (Degree of freedom), SS(Seedling survival), LBS (Leaf bronzing score), DFF (Days to 50% flowering), DM (Days to maturity), PTP (Productive tiller per plant), PH (Plant height), PL (Panicle length), FGP (Filled grains per panicle), UFGP (Unfilled grains per plant), TW (Test weight), GYP (Grain yield per plant), TDM (Total dry matter)

Table-2 *Phenotypic performance of parents and $F_{2:3}$ population of the cross KinandangPatong x A69-1 for zinc deficiency tolerance.*

Quantitative Traits	Mean± SE	CV%	PCV	GCV	h^2	GA	GA% Mean
Seedling survival (%)	56.07± 6.29	19.4	32.93	26.58	65	24.79	44.21
Leaf bronzing score	4.73± 1.26	46.3	66.50	47.71	51	3.33	70.51
Days to 50% flowering	80.27± 0.68	1.4	6.43	6.26	94	10.07	12.55
Days to maturity	113.56± 0.70	1.0	3.80	3.66	92	8.23	7.25
Productive tiller per plant	8.06±0.40	8.6	22.45	20.69	85	3.17	39.31
Plant Height (cm)	121.68± 2.08	2.9	11.16	10.76	93	26.00	21.37
Panicle length (cm)	23.18± 0.56	4.2	11.55	10.76	86	4.78	20.65
Filled grains per panicle	123.30± 5.51	7.7	21.77	20.35	87	48.32	39.19
Unfilled grains per panicle	47.88± 6.83	24.7	32.52	21.11	42	13.52	28.24
Test weight (g)	25.96± 0.60	4.0	10.83	10.04	86	4.98	19.19
Grain yield per plant (g)	25.38± 0.42	2.9	26.14	25.97	98	13.49	53.18
Total dry matter (g)	45.29± 0.84	3.2	31.54	31.37	98	29.12	64.29

CV (Coefficient of variance), h^2 (Heritability), GCV (Genotypic coefficient of variance), PCV (Phenotypic coefficient of variance), GA (Genetic Advance), GA%Mean (Genetic Advance % as mean)

Correlation studies revealed that Grain yield per plant was positively significantly correlated with days to 50 per cent flowering (0.17***), days to maturity (0.17***), productive tiller per plant (0.29***), plant height (0.25***), panicle length (0.27***), filled grains per plant (0.36***), test weight (0.16***) and total dry matter (0.47***).Thus results [Table-3] suggest that selection to improve rice yield directed by the phenotype of these traits may be effective [20, 30]. Similarly, a significant positive association of grain yield was observed with plant height, number of productive tillers [30-33], panicle length [34], test weight [34, 35] above-ground biomass and straw yield [36-38]. However, Grain yield per plant was negatively significantly correlated with unfilled grains per plant (-0.13***). Similar findings were also recorded by [39] for unfilled grains per plant. Days to 50 per cent flowering recorded significant positive correlation with leaf bronzing score and day to maturity at the phenotypic level. Productive tillers per plant also showed a positive correlation with days to 50 per cent flowering, days to maturity, plant height, panicle length and total dry matter. The filled grains per panicle were highly significant with the total dry matter. Under the zinc-deficient condition of the field, most of the trait was found with significant positive phenotypic correlation coefficients which indicated that a strong association among themselves and with grain yield per plant. Results are very close to the findings of [20]. The results suggested that an effective number of tillers and spikelet fertility may be taken into account in rice breeding programme for high yield and better improvement of the rice variety.

Table-3 *Correlation Co-efficient among phenotypic traits studied in an $F_{2:3}$ population of KinantongPatong and A69-1.*

	SS	LBS	DFF	DM	PTP	PH	PL	FGP	UGP	TW	TDM	GYP
SS	**1.000**	-0.58***	-0.09**	-0.03	-0.04	-0.06*	0.02	0.03	-0.04	0.04	0.03	0.02
LBS		**1.000**	0.07*	0.06	0.03	0.08*	0.01	0.05	0.03	-0.01	-0.02	0.01
DFF			**1.000**	0.83***	0.10**	-0.08*	-0.07*	0.08	-0.17***	-0.03	0.18***	0.17***
DM				**1.000**	0.21***	-0.01	-0.03	0.14***	-0.15***	-0.01	0.12***	0.17***
PTP					**1.000**	0.10**	0.19***	0.06	-0.10**	0.04	0.23***	0.29***
PH						**1.000**	0.40***	0.17***	-0.11***	0.08**	0.23***	0.25***
PL							**1.000**	0.12***	-0.13***	0.20***	0.17***	0.27***
FGP								**1.000**	-0.17***	-0.12***	0.19***	0.36***
UGP									**1.000**	-0.03	-0.04	-0.13***
TW										**1.000**	0.05	0.16***
TDM											**1.000**	0.47***

Conclusion

Among the two seventy-six rice lines, 42 lines recorded highest mean performance for the grain yield per plant along with lowest leaf bronzing score and highly tolerant to zinc deficient condition. Lines which show good yields and other yield components would be more suitable for the direct selection and hybridization in order to make the desirable rice improvement programme.

Application of research: High variable lines could be used in hybridization programme.

Authors Contribution: All author contributed equally.

Conflict of Interest: Authors have no conflict of interest.

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