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GENETIC DIVERSITY AND EVALUATION OF RESTORERS IN AEROBIC CONDITION FOR GRAIN ZINC CONTENT IN RICE *(Oryza sativa L.)*

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ABSTRACT

The current research was carried out by Department of Genetics and Plant breeding, Annamalai university, Chidambaram. The experiment trail was conducted at ICAR- Indian Institute of Rice Research, Hyderabad. The aim of this study was to investigate 59 genotypes comprising of 25 back cross inbreed lines (BILs) derived from the cross KMR 3/ N22, thirty-one restorers along with a check under aerobic condition during *Kharif*, 2023. In this study the back cross inbreed line PSV 6363 has high grain zinc content with 31.10 ppm which higher than the check zincorice.

INTRODUCTION

A fundamental approach to reduce water inputs in rice is to grow aerobically like an irrigated upland crop such as wheat and maize. For rice to be successful as an aerobic crop, it should tolerate intermittent water deficits and high soil impedance created due to aerobic conditions. Hence, specific aerobic rice cultivars with high yield potential and tolerance to water deficit are essential. Producing nutritious and safe foods sufficiently and sustainably is the ultimate goal of modern agriculture. (Anusha et al., 2021)

Micronutrient deficiency has been designed as the most serious challenge to humanity as two-third of the world's population is at risk of deficiency in one or more essential mineral elements. Micronutrient malnutrition is also called hidden hunger (Senguttuvel et al., 2023) The zinc concentration in brown rice should be more than 28 mg/kg to overcome hidden hunger. Zinc uptake through biofortified is estimated at 2.9 g/day per person (Sanjeeva Rao et al., 2020) Breeders are now focusing on breeding for nutritional enhancement to overcome the problem of malnutrition.

Materials and methods

Plant material

Twenty-five promising lines derived from KMR-3 and N22 and 31 individual restorer along with a check zincorice were used in the study. KMR -3 is a promising restorer used in hybrid production and Nagina 22 is a heat resistance rice cultivar released by the international rice research institute.

Experimental details

The field and lab experiments were conducted in Indian Institute of Rice Research (IIRR), Hyderabad, India where all the 59 genotypes used in the study belongs too. The genotypes were raised under aerobic condition (direct seeded rice) in the wet (*kharif*) season of 2023 and standard agronomic practices, integrated pest and diseases management was followed throughout crop growing season. Recommended dosage of NPK fertilizers were followed. All yield and yield contributing characters were recorded in three replications. After harvest 20 gm of well dried paddy samples from each sample were de- husked using non-metallic du husker. De husked seeds without any contamination were subjected to ED-XRF.

Estimation of zinc content

Grain zinc concentration was determined by Energy Dispersive X - Ray fluorescence Spectrometry (ED - XRF). In XRF the preselected wavelength of incident X – rays expel the electrons from the inner most orbit followed by the transfer of one of the electrons from the outermost orbit to the inner most orbit leading to release of specific wavelength of X – rays. The energy of the emitted radiation is specific for a particular atom. Therefore, it is

simultaneously identified and quantified by the detector. This instrument is quite useful in non – destructive determination of relative iron and zinc concentrations in rice samples. The concentration of zinc will be expressed in parts per million.

Result and discussion

Mean performance of genotypes

The mean data on yield and yield attributes *viz,* days to 50% flowering, plant height, panicle length, total number of tillers, total number of productive tillers per plant, total number of grains per panicle, spikelet fertility, 1000 grain weight, grain yield per plant, and zinc concentration in grains were collected and analysed. Analysis of variance showed highly significant differences among the genotypes for all the characters studied in the present investigation (Table 1). These results suggest that genotypes exhibited high amount of genetic variation for most of the characters studied.

The magnitude of variation between genotypes was reflected by high values of mean and range. The findings of the study showed the mean value of single plant yield was 18.99 g while it ranged from maximum of 35.45 g and minimum of 6.10 g. The mean value of grain zinc content was 18.71 ppm while it ranged from a maximum of 31.10 ppm and minimum of 10.77 (Table 2). These results are similar to the reports of Ratnam et al. (2024).

Diversity analysis

A total of 59 genotypes which includes backcross inbred lines with restorer genes, individual restorers, parents and a check were grouped into five clusters based on yield, yield contributing characters and micronutrient trait. Cluster I has maximum of 37 genotypes, cluster II has 11 genotypes, cluster III has 9 genotypes, cluster IV and V has 1 genotype each under aerobic condition. (Fig 1). Similar results were reported by Behera et al. (2018), Nirosha et al. (2016) and Vanitha et al. (2014); Rajesh et al., 2019; Lellapalli Rithesh (2020).

Correlation analysis

A thorough understanding of the interaction of characters among themselves had been of great use in plant breeding. The efficiency of selection for yield mainly depends on the direction and magnitude of association between yield and its component characters and also among themselves.

The single plant yield recorded a non-significant positive correlation with days to fifty percent flowering, panicle length, spikelet fertility and grain zinc content, non-significant negative correlation with thousand grain weight. Significant positive correlation with plant height, total number of tillers, number of productive tillers and total number of grains under aerobic condition (Fig 2). Similar results has been reported by Dixit et al. (2019) and Shaha et al. (2023)

The grain zinc content recorded a non-significant positive correlation with panicle length, number of productive tillers, spikelet fertility, thousand grain weight and single plant yield, non-significant negative correlation with total tillers, significant negative correlation with days to 50 percent flowering, plant height and total number of grains under aerobic condition (Fig 2). Similar results has been reported by Anusha et al. (2021) and Chandu et al. (2024).

CONCLUSION

In this study the back cross inbreed line PSV 6363 has high grain zinc content of 31.10 ppm and a moderate single plant yield. Which can be used in hybridisation program to produce hybrids with high grain zinc content and good yield.

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Table 1. Analysis of variance for grain yield and yield contributing characters in aerobic conditions

Source of variation	d.o.f	Days to 50 % flowering	Plant height (cm)	Panicle length (cm)	Total Number of tillers/plant	Number of productive tillers/plant	Number of grains /panicle	Spikelet Fertility (%)	1000 Grain Weight (g)	Grain yield / plant(g)	Zinc concentration (ppm)
Genotypes	58	79.27***	326.3***	11.320***	22.51***	12.765***	4780***	170.27***	45.07***	135.70***	58.02***
Replications	2	12.47	120.1	0.982	0.23	0.605	198	9.31	2.31	41.71	2.47
Residuals	116	4.45	14.3	2.041	2.30	1.685	441	29.43	5.55	17.74	1.91

d.o.f- degrees of freedom; *P<0.05; **P<0.01;***P<0.001

Table 2 Mean value 59 genotypes recorded under aerobic condition

S.NO	GENOTYPES	DFF	PH	PL	TT	NPT	TG	SF	TW	SPY	ZN
1	SV 14	94.00	85.50	25.92	7.67	4.67	177.00	94.06	24.53	12.98	24.11
2	SV 16	88.67	84.00	22.67	8.22	7.89	159.89	82.78	21.50	13.24	21.53
3	SV 26	84.00	80.33	20.61	8.00	5.78	158.67	85.58	25.91	18.89	22.09
4	SV 28	90.67	88.67	21.78	9.89	7.67	153.44	85.14	19.77	17.66	18.07
5	SV 31	92.67	97.00	27.22	10.00	8.11	190.89	90.36	23.01	24.22	19.82
6	SV 36	94.00	93.33	22.22	8.11	7.33	163.78	92.56	20.08	14.81	20.68
7	SV 37	94.67	104.67	26.17	7.89	6.78	259.22	81.10	18.69	25.72	16.63
8	SV 43	95.50	91.00	25.00	11.00	8.50	135.50	78.97	14.93	6.10	23.14
9	SV 44	96.67	94.00	26.28	7.33	5.44	213.00	84.10	16.95	17.32	18.66
10	SV 46	89.33	92.50	22.00	12.33	11.67	208.50	80.41	17.23	24.65	21.96

11	SV 51	102.00	108.67	25.00	7.44	7.44	199.00	83.59	20.88	20.33	22.52
12	SV 53	93.33	104.67	27.22	9.11	9.00	210.00	86.85	17.95	27.48	19.10
13	SV 54	95.00	93.67	23.83	11.67	10.44	207.11	96.27	21.57	30.67	21.63
14	SV 61	90.67	88.67	25.56	10.22	6.89	181.33	76.74	20.74	13.81	18.67
15	SV 64	100.00	97.00	21.67	8.56	7.89	157.78	93.43	26.22	18.12	19.13
16	SV 86	86.50	96.00	21.50	13.67	9.67	119.00	90.35	19.54	19.05	19.71
17	SV 93	103.67	84.33	22.06	6.67	5.22	173.67	93.13	24.39	16.23	15.23
18	SV 106	95.00	79.50	24.42	13.50	11.00	169.50	91.48	20.49	29.10	16.00
19	SV 111	104.33	85.33	22.67	8.67	8.00	183.33	82.41	22.98	21.70	18.37
20	SV 112	102.67	106.33	24.11	5.89	6.44	214.22	91.34	20.43	26.58	20.90
21	SV 153	98.00	92.67	24.83	7.67	7.00	139.33	94.54	19.58	15.67	18.33
22	SV 155	92.33	99.33	28.92	5.42	4.50	239.21	90.77	19.56	19.15	18.45
23	SV 168	90.67	80.00	23.42	10.00	8.00	142.89	89.97	21.80	17.24	18.83
24	SV 169	94.33	86.33	23.11	7.11	6.00	136.00	94.86	22.58	11.50	19.10
25	PSV 6363	90.67	80.67	25.11	6.33	5.50	185.83	91.26	22.03	15.42	31.10
26	KS 106	100.33	103.50	22.50	13.00	9.00	229.50	89.46	23.06	29.45	19.40
27	KKR 6	90.67	99.50	22.92	4.50	4.33	143.67	98.17	27.92	9.45	12.25
28	KKR 16	97.33	112.50	23.00	15.83	11.67	158.50	84.20	21.41	25.75	15.05
29	KKR 22	99.67	99.56	22.78	9.67	8.11	221.44	71.09	13.37	12.38	10.77
30	KKR 24	99.00	94.67	25.17	7.22	6.22	161.89	83.62	17.40	19.37	18.70
31	KKR 25	99.00	87.67	26.33	6.17	4.83	209.67	85.13	23.09	16.15	13.10

32	KKR 26	97.50	90.50	22.75	13.00	10.00	205.00	78.33	14.42	14.70	18.75
33	KKR 28	95.50	100.50	22.25	11.33	9.33	97.00	76.26	26.44	19.75	14.50
34	KKR 30	95.00	115.50	24.00	14.50	10.50	158.00	84.34	26.92	29.95	14.60
35	KKR 31	92.00	89.50	21.50	12.00	10.00	148.00	88.86	20.62	16.50	12.85
36	KKR 32	90.00	108.75	25.00	12.50	11.00	255.00	75.31	11.62	26.00	12.50
37	KKR 33	90.67	78.50	23.50	9.50	9.00	109.00	80.91	20.41	12.75	17.00
38	KKR 34	94.00	103.00	26.75	15.00	10.00	193.50	87.30	14.25	35.45	16.55
39	KKR 37	93.50	100.17	22.50	13.50	10.50	171.50	86.81	25.52	31.90	16.00
40	KKR 40	98.33	88.33	26.06	8.56	8.33	147.22	78.69	18.70	15.38	14.77
41	KKR 41	91.50	82.50	21.00	12.00	9.50	179.50	79.58	15.52	8.95	17.50
42	KKR 42	93.50	91.33	24.50	7.67	7.17	180.83	72.80	14.86	14.17	15.35
43	KKR 51	100.50	90.33	24.42	12.17	9.33	176.17	65.98	16.40	23.03	14.50
44	KKR 62	101.50	88.25	25.63	6.08	6.08	150.00	87.65	22.94	13.53	19.50
45	KKR 64	90.33	99.44	25.56	7.44	7.22	135.22	92.19	21.94	8.80	20.07
46	KKR 67	92.50	90.67	25.33	5.33	4.33	163.17	94.22	23.20	10.73	15.50
47	KKR 68	97.50	87.50	21.00	9.00	7.50	275.00	88.56	15.94	15.55	12.00
48	KKR 71	98.00	91.33	24.50	10.67	9.00	127.00	90.14	21.40	24.30	26.53
49	KKR 75	98.00	83.17	25.50	6.50	5.75	234.83	82.64	16.21	24.72	12.15
50	KKR 77	91.00	96.00	24.50	10.00	8.00	250.00	78.41	13.26	13.25	15.20
51	KKR 61	95.00	90.33	24.42	12.17	9.33	176.17	65.98	16.40	23.03	22.55
52	KKR 29	90.00	100.67	26.08	6.00	5.00	144.50	85.49	26.51	21.50	21.80

53	KKR 39	95.00	137.00	29.25	5.83	4.00	114.50	79.26	21.83	7.53	18.75
54	KKR 66	96.50	86.50	23.75	6.00	4.00	132.50	94.31	24.22	10.95	13.05
55	KKR 60	95.50	95.17	25.75	8.00	8.00	125.00	86.00	20.40	16.50	24.70
56	KKR 45	98.00	80.50	22.42	10.67	9.33	191.67	77.37	19.02	26.00	24.70
57	KMR 3	102.00	98.50	25.25	9.50	7.50	178.50	93.05	20.78	24.40	22.33
58	N22	74.00	83.33	23.00	9.17	7.67	132.50	84.35	18.00	16.75	29.95
59	ZINCO RICE	98.00	85.50	22.00	10.50	10.50	211.50	69.44	13.76	24.25	27.07
	Maximum	104.33	137.00	29.25	15.83	11.67	275.00	98.17	27.92	35.45	31.10
	Minimum	74.00	78.50	20.61	4.50	4.00	97.00	65.98	11.62	6.10	10.77
	General Mean	94.75	93.63	24.14	9.38	7.78	175.69	85.05	20.19	18.99	18.71
	S.E(d)	1.72	3.08	1.16	1.23	1.06	17.146	4.42	1.92	3.43	1.12
	(CD) 5%	3.41	6.11	2.31	2.45	2.10	33.96	8.77	3.81	6.81	2.24
	(CD) 1%	4.51	8.07	3.05	3.24	2.78	44.90	11.60	5.04	9.01	2.96
	C.V %	2.23	4.03	5.92	16.17	16.69	11.95	6.38	11.67	22.18	7.40

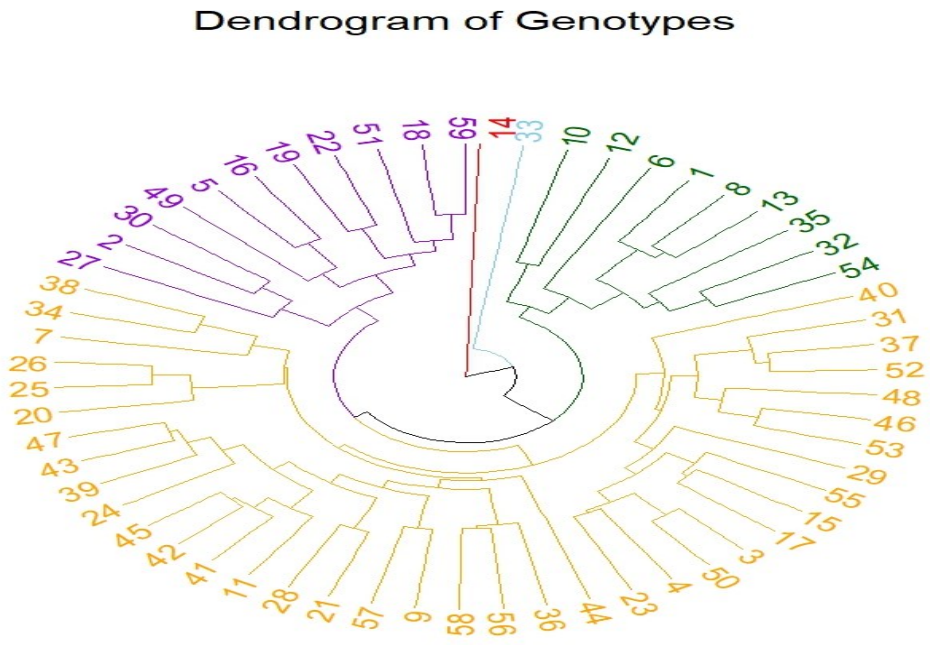

Fig 1 Diversity analysis for 59 genotypes

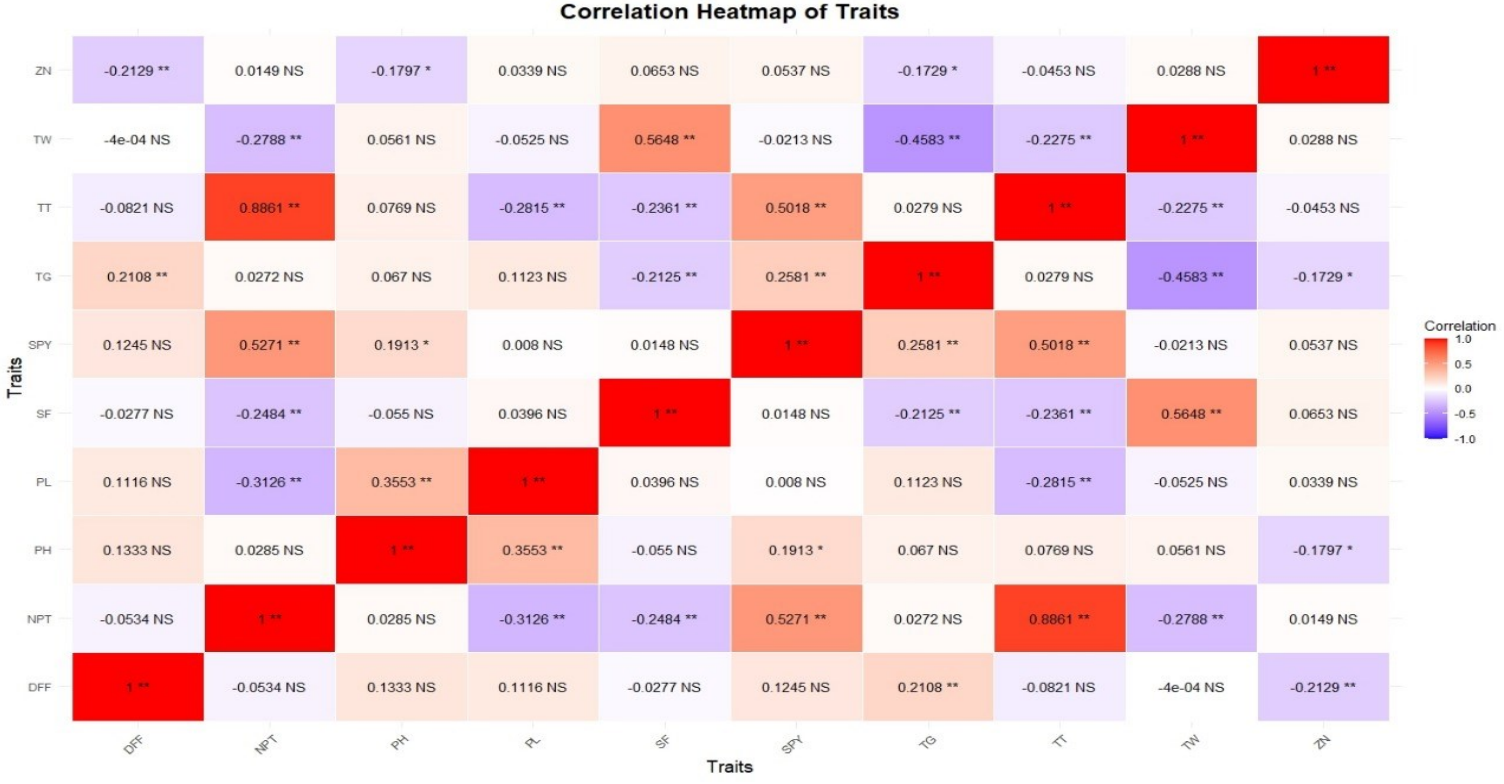

Fig 2 Correlation analysis for 59 genotypes