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Yield Variation of Rice Selections for Aerobic Planting in Water Scarce Situations

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A B S T R A C T

An investigation with fourteen genotypes grown under water saving aerobic condition revealed significant difference for all the characters studied except for 1000-grain weight. Number of tillers, and grain yield recorded high phenotypic and high genotypic co-efficient of variability. All the characters studied exhibited high heritability and characters like, number of tillers, grain yield and fodder yield recorded high genetic advance as percent over mean. Estimates of correlation coefficient indicated that fodder yield and harvest index manifested positive and significant correlation with grain yield. At phenotypic level, fodder yield followed by harvest index and days to first flowering showed positive direct effect on grain yield. Whereas negative direct effect on grain yield was exhibited by plant height and plant height had positive indirect effect through days to first flowering.

Introduction

Rice is mostly grown under submerged soil condition and requires much water and is labour intensive compared to other crops. It is estimated that 5000 liters of water is needed to produce one kilo gram of rice. Water is most limited natural resource of late, due to failure of rains and over-exploitation of ground water. The declining availability of water threatens the traditional way of irrigated rice production. Farmers are seeking alternate methods of cultivation for growing rice to combat this water scares situation. Aerobic rice is one such method to overcome water shortage problem. University of Agricultural Sciences, Bangalore has made a pioneering effort to develop rice varieties for aerobic cultivation and also they have standardized the irrigation schedule and package of practices for maximization of yield (Shailaja Hittalmani, 2007).

To make aerobic rice successful, new varieties and management practices must be developed. Considerable work is in progress in identifying the suitable genotype of rice for unpuddled conditions. However, the performance of genotypes with respect to plant growth, yield and quality vary greatly under aerobic condition. Further, there is no systematic study and information available with respect to suitability of different rice genotypes under aerobic conditions.

Therefore, there is a felt need to evaluate the rice genotypes that are suitable for aerobic conditions.

Materials and Methods

Fourteen elite rice genotypes, obtained from Marker Assisted Selection (MAS) lab, Department of Genetics and Plant Breeding, UAS, GKVK, The MAS genotypes were developed by introgression of the traits of root morphological parameters, water use efficiency and high yielding characters. The donor lines used to develop the genotypes were, IR64, Azucena, Moroberekan and Doddi gentoypes. During *Kharif*– 2007, fourteen elite rice genotypes were sown in the field. The experiment was laid out in a randomized block design (RCBD). Each genotype was sown in 5 × 3 square meter plots with spacing of 30 cm between the plant and 25 cm between rows. Aerobic condition was maintained by giving irrigation once in seven days when there was no rainfall. The crop was mostly maintained by rainfall. For Determination of $\Delta^{13}c$ the plant material was dried at 80^0C after which the samples were powdered in a ball mill. The powdered sample was stored in labeled Eppendorf tubes until analysis. The $\Delta^{13}c$ of the leaf samples were determined using the Isotope Ratio Mass Spectrometer (IRMS) at the National Facility for stable isotope studies in biological sciences in the Department of Crop Physiology, UAS, Bangalore.

Results and Discussion

Analysis of variance for yield and yield attributes in rice genotypes presented in Table 1 indicated significant difference for all the characters studied except for 1000-grain weight. Mean, range, phenotypic and genotypic variance, phenotypic and genotypic co-efficient of variation, heritability and genetic advance in respect to yield and yield attributing characters is presented in Table 2. Days to first flowering, Days to 50% flowering, Days to maturity, Panicle length and 1000-grain weight exhibited low PCV and GCV values. Harvest index exhibited low GCV but moderate PCV Number of tillers, and grain yield recorded high PCV and GCV fodder yield also recorded high GCV. All the characters studied exhibited high heritability and characters like, number of tillers, grain yield and fodder yield recorded high genetic advance as percent over mean.

Estimates of correlation coefficient indicated that fodder yield (r =0.6219*) and harvest index (r =0.5841*) manifested positive and significant correlation with grain yield. Significant influence of total dry matter on grain yield was also reported by Sundaram *et al.,* 1988; Yadav *et al.,* 1988 and Nanaja reddy *et al.,* 1996). The harvest index is usefull measure of yield and is positively correlated with yield (Singh and Staskoppf, 1971). Strong positive association between grain yield and harvest index was reported by many workers Nakano, 1989; Deosarkar and Narkar, 1995; Yolanda and Das, 1995 and Chauhan, 1996).

At phenotypic level, fodder yield (0.8419) followed by harvest index (0.7947) and days to first flowering (0.0762) showed positive direct effect on grain yield. Where as negative direct effect on grain yield was exhibited by plant height (-0.0433) and plant height had positive indirect (0.0330) effect through days to first flowering. Fodder yield recorded high magnitude of positive direct effect on grain yield followed by harvest index was reported by Surek *et al.,* (1998) and Meenakshi *et al.,* (1999). Mokate *et al.,* (1998) reported that straw yield was the important yield contributing character. Chen *et al.,* 1986; Balaln *et al.,* 1999; Venkataravana 1991 and Bagali *et al.,* 1999 reported strong direct positive effect of harvest index on grain yield at phenotypic level (Table 3 and 4).

Table.1 Analysis of variance for yield and yield attributes in rice genotypes

Source	d.f.	Plant height	Days to first flowering	Days to 50 % flowering	Days to maturity	Number of tillers	Panicle length	1000 grain weight	Grain yield (kg/ha)	Fodder yield (kg/ha)	Harvest index (%)
Replication	2	812.08	13.31	19.60	14.38	10.31	0.15	0.08	48308.92	499626.61	**21.31**
Genotypes	13	290.92**	183.92**	106.03**	121.68**	192.84**	2.61**	1.93	1884458.37**	2112567.41**	**54.23****
Error	26	54.60	6.75	3.49	8.12	11.31	0.28	0.05	105695.11	212855.85	**11.94**
Total	**41**	**166.48**	**63.24**	**36.79**	**44.43**	**68.82**	**1.01**	**0.65**	**666893.89**	**829192.24**	**25.81**

Table.2 Mean, range, phenotypic and genotypic variance, phenotypic and genotypic co-efficient of variation, heritability and genetic advance in respect to yield and yield attributing characters in rice

Characters	Mean ± SE	Range	Vp	Vg	PCV	GCV	Heritability (%)	GA	GA (%)
Plant height	75.89 ± 1.99	64.13 - 106.02	345.52	78.77	11.70	15.22	59.06	14.05	**18.51**
Days to first flowering	90.93 ± 1.23	73 - 102	190.67	59.06	8.44	8.91	89.75	15.00	**16.48**
Days to 50% flowering	104.57 ± 0.94	92 - 114	109.52	34.18	5.59	5.87	90.73	11.47	**10.97**
Days to maturity	132.29 ± 1.03	122 - 147	129.80	37.85	4.66	5.13	82.33	11.50	**8.70**
Number of tillers	35.57 ± 1.29	14 - 48	204.15	60.51	21.78	23.64	84.89	14.76	**41.33**
Panicle length	22.01 ± 0.16	20.21 - 23.64	2.89	0.78	4.01	4.67	73.76	1.56	**7.09**
1000 grain weight	23.39 ± 0.12	21.80 - 24.63	1.98	0.63	3.39	3.52	93.03	1.58	**6.74**
Grain yield (Kg/ha)	3494.86 ± 126.02	2216 - 5280	1990153.48	592921.09	22.03	23.92	84.87	2.19	**41.81**
Fodder yield (Kg/ha)	4552.21 ± 140.51	2858 - 6056	2325423.26	633237.19	17.48	20.21	74.84	2.13	**31.15**
Harvest index (%)	**43.36 ± 0.78**	**36.55 - 49.00**	**66.17**	**14.10**	**11.77**	**8.66**	**54.13**	**5.69**	**13.12**

Table.3 Phenotypic correlation co-efficient value of grain yield and yield components in rice genotypes

Characters	PH	DFF	DF50%	DM	NT	PL	$\Delta^{13}C$	TW	FY	HI	GY
PH	1	0.4349	0.1367	0.5440*	-0.8528**	0.1320	0.0307	-0.0144	-0.4197	-0.1093	**-0.4496**
DFF		1	0.6899**	0.7123**	-0.4281	-0.3084	0.1250	-0.3850	-0.3810	-0.0067	**-0.2598**
DF50%			1	0.8148**	-0.2073	-0.5695*	0.6213*	-0.3406	-0.3098	-0.0392	**-0.2400**
DM				1	-0.6447*	-0.4003	0.3625	-0.1737	-0.4144	-0.0358	**-0.3278**
NT					1	-0.0772	-0.0120	-0.2083	0.3829	-0.0290	**0.3097**
PL						1	-0.3654	0.0057	0.3533	-0.1904	**0.1440**
$\Delta^{13}C$							1	-0.2984	0.0801	-0.1488	**-0.0372**
TW								1	0.1722	0.4433	**0.4118**
FY									1	-0.2596	**0.6219***
HI										1	**0.5841***
GY											**1**

PH Plant height (cm) **DFF** Days to first flowering **DF50%** Days to 50 % flowering **DM** Days to maturity
NT Number of tillers **PL** Panicle length (cm) **$\Delta^{13}C$** $\Delta^{13}C$ values (Water use efficiency) **TW** Test weight (g)
FY Fodder yield (kg/ha) **HI** Harvest index (%) **GY** Grain yield (kg/ha)

* Significance at p≤ 0.05 ** Significance at p≤ 0.01

Table.4 Path co-efficient analysis showing the direct and indirect effects of different characters on grain yield in rice at phenotypic level

Characters	Plant height	Days to first flowering	Fodder yield	Harvest index	Correlation with grain yield (kg/ha)
Plant height	-0.0433	0.0330	-0.3532	-0.0871	**-0.4496**
Days to first flowering	-0.0188	0.0762	-0.3131	-0.0037	**-0.2598**
Fodder yield	0.0182	-0.0283	0.8419	-0.2061	**0.6219***
Harvest index	**0.0048**	**-0.0004**	**-0.2183**	**0.7947**	**0.5841***

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