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Genotypic Evaluation of Different Rice Varieties for Yield and Yield Related Traits

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Abstract

The associations among phenotypic and genotypic traits of rice and the pattern influence on rice grain yield were investigated among 18 rice varieties. This evaluation is vital to know the effects of various characters on yield for selection criteria for high yielding genotype. Experiment was carried out in randomized complete block design (RCBD) with three replications. Yield and yield related traits were studied. Statistical analysis exhibited that rice varieties differed significantly for days to 50% heading (DH), number of primary (PB) and secondary branches per panicle (SPB), spikelets per panicle (SP), days to maturity (DM), thousand grain weight (TGW), and grain yield (GY). Moreover, significantly positive genotypic correlations of grain yield with PB, SPB, SP and TGW were observed. Principal component analysis also classified superior varieties. *Swat-1*, *IR-8*, *DR-82* and *Fakhr-e-Malakand* showed superiority for yield and yield related traits. These four varieties can be used as commercial cultivars in Peshawar area after multi- location yield test trials.

Keywords: Rice; Varieties; Evaluation; Yield; Phenotype

Introduction

Improving rice (*Oryza sativa L.*) production per unit area will be a major threat in future due to the increasing global population and rice demand in the world. Rice is the main food of majority of the world's population. It provides at least 27% of the nutritional diet and 20% of the protein consumption in the developing world. In Pakistan, rice is an important export item that contributes 6.4% of total agriculture production and accounts 1.4% to GDP. Rice is cultivated on an area of 2.96 million hectares with total production of 6.95 million tons [1]. In Pakistan, rice is mostly cultivated in four different agriculture zones. The first region includes the hilly areas of Khyber Pakhtunkhwa with mostly colder regions. The second zone of rice cultivation areas are irrigated land between Chenab and Ravi rivers of Punjab region where the weather is generally suitable for cultivation of fine aromatic rice varieties. The third and fourth zones include western bank of the Indus River and its Delta, respectively, as the climatic conditions of these regions are appropriate for the cultivation of coarse rice cultivars [2].

Morphological characterization is healthy, reliable, vigorous and cost-effective method for categorization of germplasm. It aids in assessing genetic diversity among varieties, accessions, breeding populations and wild relatives of a particular crop. This characterization of genetic diversity in diverse germplasm in turn helps in estimation of morphological and agronomic traits have been employed for studying classification and genetic variation in rice germplasm [3,4]. Therefore, the main objectives of most crop development programs are to know, classify and develop high yielding varieties. However, grain yield of cereals is a complex trait, determine by the interaction among its components [5]. Indirect selection is generally more convenient to produce high yielding varieties, as yield traits are hard to be improved through direct selection [6]. While, indirect selection depends on strong correlations among secondary traits, primary traits and high heritability of traits [7]. Phenotypically such correlations are the effect of environmental and genetic factors [8]. Mostly, various yield related traits show positive genotypic and phenotypic correlations with grain yield [6,9,10]. Correlation analysis of the traits is a useful method to identify the important association between two characters [11]. The main objectives of the present study were; (1) to evaluate rice varieties for yield and yield related traits; (2) to study the phenotypic and genotypic correlations among various yield related traits.

Material and Methods

Genotypic evaluation of 18 rice varieties was done at Research Farm of Khyber Pukhtunkhwa Agricultural University Peshawar, Pakistan. The varieties viz., *Bas-2000*, *Bas-Pak*, *Shaheen-Basmati*, *Bas-370*, *Sugdesi*, *Fakhr-e-Malakand*, Kangni-27, *IR-8*, *Malhar-346*, *DR-82*, *Swat-1*, *Shadab-31*, *Kashmir Basmati*, *Bas-385*, *PK-177*, *JP-5*, *NIABIR-9* and *Pakhal* were sown in RCBD with three replicates. Firstly, rice nursery was grown and then seedlings were transplanted after three weeks into a well puddled rice field. Each variety was grown in three-rows with row length of 2 m, with a distance of 20 cm between plants and 30 cm between the rows. All essential cultural practices like weeding, fertilizer, pesticides and irrigation were applied equally to all the experimental plots. At maturity five randomly selected plants per plot were used for data recording. Days to 50% heading (DH) was recorded for all varieties from seedling date to the day when 50% of panicles developed. Five randomly selected panicles per plant were used for data recording on various panicle traits at maturity. DM was calculated from the seeding day to the day when appropriately 85% of the total seed grains on the panicles got fully matured. GY was

recorded in kilograms after threshing all the three rows of individual plot and then the data was converted into kg ha^{-1}. The data were evaluated using Analysis of Variance technique [12] with the help of statistical tool (SAS institute, 1985). Further, least significant difference (LSD) test was used to check significant differences among the treatments. To know the phenotypic and genotypic correlation coefficients among various characters were determined using SAS statistical tool according to the following formulae

$rg = COVgij/(\delta 2gi \times \delta 2gj)1/2$, $rp = Mij/(Mii \times Mjj)1/2$

Where rp and rg are the phenotypic and genotypic correlation coefficients for the characters i and j. COVgij and δ2gi are used for covariance and variance, respectively for the traits i and j. Mij stand for mean product for varieties while Mjj and Mii are the varieties means squares for the characters j and i, respectively.

Results

Days to 50% heading (DH)

For DH, significant differences ($p \leq 0.01$) among the rice varieties were observed (Table 1). DH among the varieties ranged from 84 to 137 days. Minimum DH (84) was noted for *JP-5* while maximum DH (137) was recorded for *Bas-Pak* (Table 2). Moreover, it is also confirmed by phenotypic and genotypic correlations of DH with DM which showed significantly positive correlation (Table 2).

SOV	DF	DH	PB	SB	SP	DM	TGWT	GY
Replications	2	12.5	33.9**	13.1	1029*	12.7	93	348721
Genotypes	17	559**	7.1**	210.0**	3054**	537**	657	15526532**
Error	34	8.1	0.3	16.61	291.1	5.52	93	2835
*,**significant at 5 and 1% levels of probability, respectively.								

Table 1: Mean squares for days to 50% heading (DH), PB, SB, SP, DM, TGW and GY.

Number of primary branches per panicle (PB)

Rice varieties exhibited significant ($p \leq 0.01$) variation for PB (Table 1). Mean PB among the varieties ranged from 8 to 14. Least PB (8) was observed for *Kashmir Basmati* while *Swat-1* had maximum PB (14) (Table 2). PB exhibited significantly positive phenotypic and genotypic correlation with SP (Table 3).

Rice genotypes	DH	PB	SB	SP	DM	TGWT (g)	GY(kg ha^{-1})
Bas-2000	130	13	46	220	161	36.6	8148
Bas-Pak	137	11	15	131	169	23	8889
Shaheen Basmati	114	10	39	204	146	31.4	12222
Bas-370	121	9	35	176	153	31.8	12222
Sugdesi	130	9	38	197	163	30.8	9815
Fakhr-e-Malakand	106	10	31	164	139	21.6	8148
Kangni-27	92	11	47	218	125	36.8	9259
IR-8	114	12	46	222	146	38.4	15370
Malhar-346	90	11	30	188	123	35.7	9815
DR-82	115	11	47	252	147	34.9	13148
Swat-1	105	14	47	217	138	34.9	12963
Shadab-31	118	11	41	206	151	33.9	14444
Kashmir Basmati	92	8	28	144	123	31.6	10926
Bas-385	121	11	41	213	145	27.1	12533
PK-177	114	13	33	190	146	36.9	13889
JP-5	84	13	38	191	114	36.9	12963
NIAB-IR-9	112	12	39	240	145	33.3	14074
Pakhal	93	11	30	162	126	35.1	13518
LSD (0.05)	4.7	0.93	6.7	28.3	3.9	50.6	28.3

Table 2: Average of the days to 50% heading (DH), PB, SB, SP, DM, GW and GY.

Number of secondary branches per panicle (SB)

Rice varieties reflected significant differences ($p \leq 0.01$) for SB (Table 1). SB among the varieties ranged between 15 and 47. Least SB (15) was noted for *Bas-Pak* while highest SB (47) was recorded for *Kangni-27*, *DR-82* and *Swat-1* (Table 2). Phenotypic correlation of SB with SP was significantly positive whereas genotypic correlation of SB was significantly positive with TGW (Table 3).

Number of spikelets per panicle (SP)

Significant difference ($p \leq 0.01$) was noticed among the rice varieties for SP (Table 1). Least SP (131) was noted in *Bas-Pak* while maximum SP (252) observed in *DR-82* (Table 2). Phenotypic correlation of SP was significantly positive with PB and SB. SP had significantly positive genotypic correlation with PB, GY and TGW (Table 3).

Days to maturity (DM)

Results from the data analysis revealed highly significant variation at the level of $p \leq 0.01$ among the rice varieties for DM (Table 1). Mean data exhibited that the difference for DM among the varieties ranged from 114 to 169 days. *JP-5* variety showed least DM (114) whereas, plant of *Bas-Pak* took highest number of days (169) to get fully matured (Table 2). Significantly positive genotypic correlation for DM with DH had observed (Table 3).

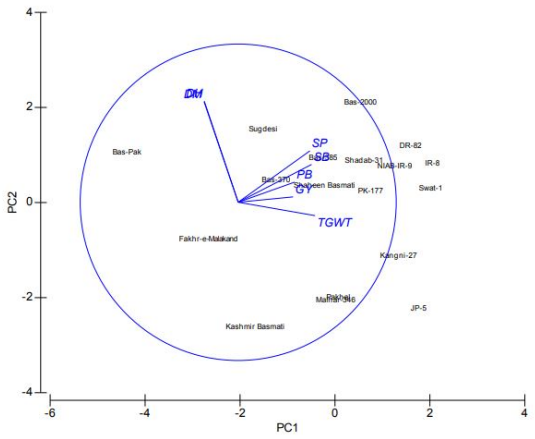

Figure 1: Principal component analysis (PCA) of yield and its related traits; 50% heading (DH),PB,SB,SP,DM,TGW and GY among 18 rice varieties.

		DH	PB	SB	SP	DM	TGWT	GY
DH	rp	-	0.17	-0.03	0.07	0.99**	-0.37*	-0.14
	rg		0.07	-0.04	0.04	0.98**	-0.32*	0.04
PB	rp		-	-0.38	0.46*	0.12	-0.39	-0.14
	rg			-0.04	0.44*	0.1	-0.32*	0.04
SB	rp			-	0.88**	-0.06	0.39	0.24
	rg				0.06	-0.03	0.53**	0.28
SP	rp				-	0.05	-0.35	-0.12
	rg					0.06	0.47**	0.27*
DM	rp					-	0.35	-0.12
	rg						-0.35	-0.13
TGWT	rp						-	-0.46*
	rg							0.28*
GY	rp							-
	rg							

rp=phenotypic correlation; rg=Genotypic correlation; *,**significant at 5 and 1% levels of probability, respectively.

Table 3: Correlation coefficients for days to 50% heading (DH), PB, SB, SP, DM, TGW and GY.

Thousand grain weight (TGW)

Rice varieties showed non-significant differences ($p \geq 0.01$) for TGW (Table 1). TGW among the varieties varied from 21.6 and 38.4 g. Least TGW (21.6 g) was observed for *Fakhr-e-Malakand* while heaviest grains (38.4 g TGW) was produced by variety *IR-8* (Table 2). Significantly positive genotypic correlation of TWG was observed with SP, SB and GY (Table 3).

Grain yield (GY)

Significant grain yield difference ($p \leq 0.01$) was observed among the rice varieties (Table 1). Mean data revealed that the difference in GY among the varieties ranged from 8148 to 15370 kg ha^{-1}. *Bas-2000* and *Fakhr-e-Malakand* showed lowest GY (8148 kg ha^{-1}) while *IR-8* had highest GY (15370 kg ha^{-1}) (Table 2). GY showed significantly positive genotypic correlation with SP and TGW (Table 3). Superior varieties on the bases of yield traits were also depicted through principle component analysis (Figure 1).

Discussion

Yield related traits are significant and fundamental task before making any successful breeding research program. Selection for increased GY should not be based on yield only because of its complexity and relationship with other yield components [13]. Therefore, other yield-related traits should also be taken into consideration. Significant differences among rice varieties were observed for DH (Table 1). This difference for DH in varieties may be resulting from different genetic backgrounds of rice [14], and different genetic makeup could be the possible reason for such differences among varieties. Further, it is also confirmed by phenotypic and genotypic correlations of DH with DM were observed significantly positive (Table 3). The considerable differences between varieties indicate the effect of environment for the expression of the trait [14]. Number of PB and SB exhibited significantly positive phenotypic and genotypic correlation with number of SP, GY and TGW (Table 3). Similar observations were also reported previously, emphasizing that yield can be improved through the production of a good number of panicles per branch, number of PB and SB [6,10,14]. The statistical analysis showed significant differences among the rice varieties for number of SP (Table 1). Minimum number of SP (131) was recorded for *Bas-Pak* while maximum number of SP (252) was recorded for *DR-82* (Table 2). Difference in number of SP depend on growth and development of panicle and the interval of spikelet initiation [10,14]. Phenotypic correlation of number of SP was significantly positive with number of PB and number of SB which was also depicted by Sarawgi et al. [9], stated that varieties having these traits would offer a better option for development and improvement of rice varieties through conventional selection. The number of DM plays a key role in the cropping system. Early maturing crops vacate the land early for the next growing crops and protect the crop from insect pest attack and timely handled. Highly significant variations among the varieties were noted for DM (Table 1). Basmati rice is very low yielding varieties due to tall stature of the plants and late maturity [15] (Table 2). DM had significant positive genotypic correlation with DH (Table 3) which is in consistent with findings of Zafar et al. [16]. Karim study on 41 aromatic rice varieties for genetics and phenotypic parameters and observed, that phenotypic variance for studied parameters was higher than the genotypic variance [17]. Previous study showed that variation for DM was due to genetic component rather than environment. Short duration varieties could be a better source for breeders to use as parental lines. Variations in GW might be due to diverse genetic make-up of rice varieties and their different response to prevalent environment during grain filling stage [6,14,18-20]. TGW had significantly positive genotypic correlation with number of GY, number of SB and number of SP (Table 3). Selection of genotype based

on yield linked traits would be effective for increasing grain yield [9,10,21,22]. Mean data depicted variation in grain yield among the varieties which may be due to the difference in response of varieties to environmental conditions or function of genotypes [23].

Conclusion

In the present study 18 rice varieties were analyzed for morphological traits. Data were recorded on yield and related components. Significant genetic variations were observed among the rice varieties for all the studied parameters except TGW. For instance, *Swat-1* had maximum PB. Maximum SB was noted for *Kangni-27*, *DR-82*, and *Swat-1*, whereas, highest SP was displayed by *DR-82*. *JP-5* exhibited least DM. Moreover, maximum TGW and GY were recorded for *IR-8*. *Swat-1*, *Kangni-27*, *DR-82* and *Fakhr-e-Malakand* which was also revealed from PCA. As these varieties excelled in performance for yield and yield components, thus, could be recognized for commercial cultivation in Peshawar valley. Based on these superior traits, the genetic potential of these rice varieties can also be exploited in rice breeding programs.

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