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GENETIC VARIATION FOR YIELD AND YIELD COMPONENTS IN RICE

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ABSTRACT

Five exotic rice genotypes along with a local check were evaluated for yield and yield contributing traits under the climatic conditions of Swat. Minimum days to flowering were taken by rice genotype YUNLEN2 (59.7 days) and were 14 days early in maturity than check. Minimum Flag Leaf Area of 10 cm^2 was taken by rice genotype PR26881-JP16-4B-78-5-1 and the maximum for IRI 384 (13.1cm^2). Minimum numbers of tillers $plant^{-1}$ of 10.7 were taken by rice genotype IRI384. The PR26881-JP16-4B-78-5-1 took maximum number of 15.3 tillers $plant^{-1}$. Minimum plant height of 82.2 was recorded by YUNLEN2 while maximum heights of 124.9 were recorded by J.P.5. Minimum panicle length was recorded by IRI384 i.e. 19.2, while maximum panicle lengths of 24.1 were recorded by J.P.5. Minimum primary branches $paninle^{-1}$ of 9.3 was recorded by IRI 384, while maximum primary branches $panicle^{-1}$ of 11.3 were recorded by J.P.5. Minimum number of grain $panicle^{-1}$ of 10 was recorded by PR26881-JP16-4B-78-5-1, while maximum numbers of grain $panicle^{-1}$ of 13.1 were recorded by IRI384. Minimum 1000-grain weight was recorded by IRI384, while maximum 1000-grain weights were recorded by ILLABONG. Minimum Grain yield $plant^{-1}$ was recorded by YUNLEN2, while maximum grain yield $plant^{-1}$ was recorded by J.P.5.

Keywords: rice, yield, yield components, rice performance, Swat.

INTRODUCTION

Rice (*Oryza sativa*) belongs to family gramineae. Morphologically, rice is an annual grass and one of the most important crops. Globally it is grown extensively in tropical and sub-tropical regions of the world. More than half of the people on the globe depend on rice as their basic diet and, generally extensively consumed in the producing countries. It is expected that the world population increase by about 2 billion in the next two decades and half of this increase will in Asia where rice is the staple food (Gregory *et al.,* 2000). To feed this increasing population, 35% more rice will be required than the present level of rice production globally (Duwayrie *et al.,* 1999). The chief rice production countries are; China, India, Indonesia, Bangladesh, Vietnam, Thailand, Myanmar, Philippine, Brazil, Japan, U.S.A and Pakistan. China is the prime producer of rice. Pakistan is an important rice growing and exporting country. Where rice occupies 2.5 million hectare that is 11% of the total cultivated area with production of 5.5 million tonnes of milled rice and contributed about 17 % towards total cereal grain production of the country (PARC, 2008). It is grown under diverse climatic and edaphic conditions. Basmati predominates in traditional rice growing tracts of Punjab. In Swat at high altitude mountain valleys, cold tolerant rice is grown. In the South of NWFP, Sindh and Balochistan IRRI type long grain heat tolerant tropical rice are grown. In Pakistan's agrarian economy rice plays multifarious roles. Firstly, it is second staple food and contributes more than 2 million tonnes to our national food requirement. Secondly, rice industry is an important source of employment and income for rural people. Thirdly, it contributes in the country's foreign exchange exchequer i.e. contributes 5.5 % of the total value added in agriculture and 1.1 to GDP (PARC, 2005-2006). For instance, during 1999-2000 about 2 million tonnes rice of worth 26 billion rupees was exported. The barter trade on Afghanistan border was in addition to this export. In Pakistan, rice export has rapidly increased and at present about 1.8 million tones of rice is exported annually. Rice production in 2005-06 showed an increase of 10.4 % as compare to 2004-2005 which is due in part to the lucrative market prices received by growers, better irrigation practices, and better use of fertilizers and genotypes and more cultivated area. The significance of this commodity in our economy is evident from the above facts. Therefore, it is imperative to focus on the efforts needed to further improve its competitiveness in the international market. To meet the ever growing domestic needs of food and enhance exports and to achieve sustainability and stability of rice production the research in varietal improvement, evaluation, modification of plant architecture, development of hybrid rice technology, wide-hybridization, soil and nutrient management and integrated pest management would receive priority.

MATERIALS AND METHODS

To study genetic variation for maturity, panicle and yield characteristics of rice in Swat valley, this experiment was designed and conducted during the farming season, 2006 at NWFP Agricultural Research Institute (North), Mingora, Swat. Six exotic rice genotypes; ILLABONG, YUNLEN2, GZ5830-63-1-2, PR26881-PJ16-4B-78-5-1-PJ16-4B-78-5-1 and IRI384 were employed, together with check J.P.5, locally called Swati Chawal/Begamai. The 30 days nursery was transplanted in Randomize Complete Block Design (RCBD) in triplicates. Each genotype was sown in three

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rows in plot size of 2.08 m^2 with row length of 2.6 m. The row to row and plant to plant distance was 20 cm. The field was well ploughed and irrigated before transplanting. Each plot was continuously irrigated and fertilizer applied at the rate of 120-60-40 kg NPK hac^{-1} to the field in two split 60-60-40 kg NPK at the time of transplanting and 60-00-00 NPK kg $acre^{-1}$ after one month of transplanting. Furadan granules were applied for stem borer and other pest. Standard agronomic practices were carried out during the growing season. Data was collected from two central rows on Days to 50 % flowering, Days to Maturity (Days), Flag Leaf Area (cm^2), Tillers plant $^{-1}$, Plant height (cm), Panicle length (cm), Primary branches panicle $^{-1}$, Grains $panicle^{-1}$,1000-grain weight and Grain yield $plant^{-1}$.

Statistical analysis

The data were statistically analyzed using MStat-C software recommended for randomized complete block design. Mean for different traits of six rice genotypes were separated using least-significance difference (LSD) test at 5% probability level as described by Steel and Torri, 1980.

RESULTS AND DISCUSIONS

One of the main objectives of any breeding program is to produce high yielding and better quality lines for release as cultivars to farmers. The prerequisite to achieve this goal the presence of sufficient amount of variability, in which desired lines are to be selected for further manipulation to achieve the target. Introduction of new populations can be made from one region to the other easily and may be used for further manipulation to develop breeding lines. The present study was conducted to evaluate the performance of six exotic lines in order to assess the presence of variability for desired traits and a significant amount of variation for different parameters was conducted.

Days to 50% flowering

The analysis of variance shows highly significant genetic variations ($P \leq 0.01$) among the genotypes for days to 50 % flowering (Table-1). Coefficient of variation (CV) and determination (R^2) for days to flowering were 4.84% and 0.92, respectively. Number of days to flowering ranged from 59.7 to 85.7 (Table-2). Minimum days to 50 % flowering were observed by the genotype YUNLEN2 (59.7 days) in contrast to check with 85.7 days. The remaining lines ranged between 62 and 69 days. Similar results have been reported by Tahir *et al.* (2002) in rice. This type of variability might be due to the genetic makeup of the exotic lines and genotypic environmental interaction. The better performance of the tested genotypes over the check might be the genotypic novelty and adaptability to the present environment or the over exploitation of the local cultivars. It is therefore suggested that these lines are further studied to confirm its stability

Days to maturity

The number of days to reach maturity plays a significant role in the cropping system. Early maturing crops evacuate the land early for the next crops and escape from insect pest attack and timely handled. Significant variability was found among the tested genotypes ($p < 0.05$) for days to maturity (Table-1). Coefficient of variation (CV) and determination (R^2) for days to maturity were 4.2 % and 0.63, respectively. Days to maturity among rice genotypes ranged from 96.7 to 110.7 (Table-2). Minimum days to maturity of (96.7) were taken by rice genotype YUNLEN2 .The check genotype J.P.5 took maximum days of 110.7 to mature. Thus, genotype YUNLEN2 was 14 days early in maturity than the check. Karim *et al.* (2007) studied 41 aromatic rice genotypes for variability and genetic parameter analysis and found highly significant mean sum of square due to genotypes for Days to maturity. He reported that variation for days to maturity was attributed by genetic constituent rather than environment. Short duration lines can a good source for breeder to use as parents.

Flag leaf area

The data analysis of flag leaf area showed that genetic differences among rice genotypes were non significant ($p \geq 0.05$), (Table-1). Coefficient of variation (CV) and determination (R^2) for Flag Leaf Area were 19.48 % and 0.41, respectively. Flag Leaf Area among rice genotypes ranged between 10 and 13.1 cm^2 (Table-2). Minimum Flag Leaf Area of 10 cm^2 was observed in the rice genotype PR26881-PJ16-4B-78-5-1. The IRI 384 had maximum Area of 13.1 cm^2 of Flag Leaf. IRI 384 with more flag leaf area can perform more photosynthetic activities than the J.P.5. These results are in conformity with earlier reported by Bharali *et al.* (1994) and found higher direct effect of flag leaf area on grain yield. Similarly Li *et al.* (1994) reported the effect of temperature and photosynthesis efficiency of flag leaf area. The flag leaf area is various from genotype to genotype and is effected by the temperature, photoperiod and other traits like; plant height and plant population density.

Productive tillers $plant^{-1}$

Genetic differences among rice genotypes were non significant ($p \geq 0.05$) for tillers $plant^{-1}$ (Table-1). Coefficient of variation (CV) and determination (R^2) for tillers $plant^{-1}$ were 11.35% and 2.7, respectively. Tillers $plant^{-1}$ among rice genotypes ranged from 10% to 13.1 (Table-2), minimum tillers $plant^{-1}$ of 10 were produced by rice genotype PR26881-PJ16-4B-78-5-1. The IRI 384 produced maximum number of tillers 13.1 $plant^{-1}$. This observation is supported by Zahid *et al* (2005), who studied twelve genotypes of coarse rice to check their yield performance in Kallar tract and reported highly significant variation for different traits including the no of productive tillers $plant^{-1}$, an important yield component in the rice. Shah *et al.* (1999), Prasad *et al.* (2001) and Hassan *et al.* (2003) studied the affect of environment, temperature, genotype and found significant heritability for yield and yield contributing traits.

Plant height

Analysis of variance for Plant Height was found highly significant ($p \leq 0.01$) as shown in (Table-1) among the tested genotypes. Plant Height ranged between 82.2% and 124.9 (Table-2). Minimum plant height was recorded in YUNLEN2 while maximum height was recorded in J.P.5. Prasad *et al* (2001) studied genetic variability, coefficient of selection and correlation for various yield and yield contributing parameters and found significant correlation between grain yield and plant height. Hussain *et al.* (2005) reported that transplantation time, water and soil condition, planting and sowing method affect plant height in rice. Zahid *et al.* (2005) studied 14 genotypes of basmati rice and observe high heritability couple with high genetic advance for plant height and 1000-grain weight. He also reported that plant height has negative correlation with yield. In addition he observed the positive relationship of plant height with grain quality. Coefficient of variation and determination for plant high were 7.06% and 089, respectively.

Panicle length

Data regarding panicle length is shown in Table-1. Significant levels of variability ($p \leq 0.05$) among the tested genotypes were observed. Coefficient of variation and determination for panicle length were 6.70% and 0.71, respectively. The data for panicle length ranged 19.2 and 24.1 (Table-2). The minimum panicle length was recorded in IRI 384 while maximum panicle lengths were recorded in J.P.5. Tahir *et al*. (2002) studied genetic variability for different characters in ten rice genotypes variability for various traits. He found that these traits are under the genetic control and could be use in the selection of a desirable trait. Sudden exposed to the harsh environmental conditions, time of sowing and transplantation along interrelationship among various traits also responsible for variation, which affect the expression of genes. Photoperiod, leaf area index, sink and source relationship, inter-competition among plant population and plant density also contributes and crop performance.

Primary branches panicle^{-1}

Genetic difference for primary branches were non significant among the tested genotypes of rice (Table-1). Coefficient of variation (CV) and determination (R^2) for primary branches panicle^{-1} were 9.83 % and 0.42. The data for primary branches paninle^{-1} ranged between 9.3 and 11.3 (Table-2). Minimum primary branches paninle^{-1} was recorded in IRI 384, while maximum were recorded in J.P.5. This is supported by Tahir *et al* (2000).

Number of grain panicle^{-1}

Data regarding number of grain panicle^{-1} non significant ($p \geq 0.05$) amount of variability among the tested genotypes (Table-1). Coefficient of variation (CV) and determination (R^2) were 15.18 % and 0.63 respectively. The data for number of grain panicle^{-1} ranged 10.0 and 13.1 (Table-3). The least number of grain panicle^{-1} was recorded for PR26881, while maximum numbers were recorded in IRI 384. Mirza *et al.* (1992), who studied 25 early maturing genotypes for interrelationship and found that number of grains panicle is positively correlated with panicle length, 1000-grains weight and grain yield. Prasad *et al.* (2001) also reported highly genetic heritability for the number of grains panicle^{-1} in contrast to our results. Similarly Tahir *et al.* (2002) reported highly significant variation for the grains panicle^{-1} for different genotypes. Other factors i.e. soil fertility, plant nutrients translocation and weather condition might also responsible.

Thousand grain weight

Analysis of the data showed non significant variation ($p \geq 0.05$) among the tested genotypes of rice (Table-1). Coefficient of variation (CV) and determination (R^2) were 6.79% and 0.49, respectively. Thousand grain weight ranged 10.2-14.7 g (Table-3). Minimum thousand grain weight of (10.2 g) was recorded by IRI 384, while maximum (14.7 g) were recorded by ILLABANG. This in contrast with Tahir *et al.* (2002), who reported highly significant variation among different traits and observe that these traits are under the control of genotypic difference among the genotypes. Bharali *et al.* (1994) reported the correlation and influence of 1000-grain weight by flag leaf area. Other factors like; adoptability, temperature, soil fertility, transplantation season and time might also be responsible for thousand grain weight.

Grain yield plant^{-1}

Analysis of the data regarding number of Grain yield plant^{-1} showed non significant variability ($p \geq 0.05$), among the tested genotypes (Table-1). Grain yield plant^{-1} ranged from minimum 82.2 and 124.9 (Table-3). Minimum Grain yield plant^{-1} was recorded by YUNLEN24, while maximum were recorded by J.P.5. The same variability were reported by Zahid *et al.* (2005), who studied twelve genotypes of coarse rice to check their yield performance in Kallar tract and reported highly significant variation for different traits. This variation in the grains yield might be due to the environment (Mahpattra, 1993) or the correlation of grain yield plant^{-1} with various yield contributing characteristics like; fertility of soil, flag leaf area, grains panicle^{-1}, number of grains panicle^{-1}and grain wight and correlation with these traits. Similarly Mirza *et al*, (1992), reported positive correlation among number of panicle plant^{-1}, panicle length, number of grains panicle^{-1} and 1000-grain wight and grain yield plant^{-1}

CONCLUSIONS AND RECOMMENDATIONS

The overall results show that YUNLEN2 was early maturing among the tested rice genotypes. J.P.5 yielded maximum plant height, panicle length, number of primary branches and grain yield per plant. On the basis of overall results, J.P.5 (the check cultivar) was exhibited better performances than the introduced lines. However, among the tested lines, ILLABAN resulted in higher panicle length, number of primary branches, 1000-grain weight and grain yield per plant. Thus, these lines should be acclimatized before further breeding manipulation or release.

Table-1. Analysis of variance for days to 50% flowering, days to maturity, flag leaf area, tillers plant^{-1}, plant height, panicle length, primary braches plant^{-1}, days to grainsplant^{-1}, 1000-grain weight and grains yield plant^{-1}of six rice genotype evaluated at Agricultural Research Institute, Mingora, Swat during 2006.

Parameter	Replication	Mean Square	Error mean square	C.V
Days to 50% flowering	0.39 ^{ns}	258.62**	10.79	4.84
Days to maturity	1.56 ^{ns}	67.82*	10.79	4.20
Flag leaf area	6.91 ^{ns}	4.48^{ns}	5.17	19.48
Tiller Plant^{-1}	1.17 ^{ns}	8.77^{ns}	2.23	11.35
Plant height	2.22 ^{ns}	724.73**	45.5	7.06
Panicle length	1.31 ^{ns}	9.27*	1.97	6.70
Primary branches Plant^{-1}	0.00 ^{ns}	1.57^{ns}	1.07	9.83
No. of grains panicle^{-1}	1015.17 ^{ns}	825.47^{ns}	361.83	15.18
1000-grains weight	0.14 ^{ns}	6.42^{ns}	3.39	6.79
Grains yield plant^{-1}	44.77 ^{ns}	24.85^{ns}	46.92	20.19

*: Highly significant, **: Significant, ns: Non-significant

Table-2. Means for days to 50 % flowering, maturity, flag leaf area, productive tillers plant^{-1} and plant height of six genotypes of rice evaluated at Agricultural Research Institute, Mingora, Swat during 2006.

Genotypes	**Days to 50% Flowering** (No.)	**Days to maturity** (No.)	**Flag leaf area** (cm^2)	**Tiller plant^{-1}** (No.)	**Plant height** (cm)
ILLABONG	69.0 b	103.0 abc	12.2	13.3 abc	99.6 b
PR26881	65.3 bcd	100.4 bc	10.0	15.3 a	86.2 c
YUNLEN2	59.7 d	96.7 bc	10.4	14.0 ab	82.2 c
IRI384	65.7 bc	104.7 abc	13.1	10.7 c	88.1 bc
GZ5830	62.0 cd	105.3 ab	12.0	14.0 ab	92.0 bc
J.P. 5	85.7 a	110.7 a	12.4	11.7 bc	124.9 a
LSD (5 %) **R^2**	6.0 0.92	8.0 0.63	ns	2.7 0.67	12.3 0.89

Means followed by the same latter in a column are not significant different from each other at 0.05 % probability level.

Table-3. Means for panicle length plant^{-1}, primary braches panicle^{-1}, number of grains panicle^{-1}, thousand grain weight and grain yield plant^{-1} of six genotypes of rice evaluated at Agricultural Research Institute, Mingora, Swat during 2006.

Genotypes	**Panicle length** (cm)	**Primary braches panicle^{-1}** (No.)	**Grains panicle^{-1}** (No)	**1000-grain weight** (g)	**Grain yield Plant^{-1}**(g)
ILLABONG	21.4 b	11.0 ab	12.2	14.7 a	99.6 b
PR26881	20.3 b	10.0 ab	10.0	11.8 ab	86.2 c
YUNLEN2	19.6 d	10.7 ab	10.4	11.5 ab	82.2 c
IRI384	19.2 b	9.3 b	13.1	10.2 b	88.1 bc
GZ5830	21.0 b	10.7 ab	12.0	12.9 ab	92.0 bc
J.P. 5	24.1 a	11.3 a	12.4	13.9 a	124.9 a
LSD (5 %) R^2	2.6 0.71	2.0 0.42	ns	2.7 0.49	12.3 0.31

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