Research Article

Evaluation of Elite Rice (*Oryza sativa* L.) Lines for Yield and Yield Components

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Abstract | The present research work was aimed to explore the amount of genetic variability that may exist in the available genetic material and to study the variability of yield and yield attributes in advance rice lines. For this purpose, fourteen elite rice lines namely Line-21, Line-25, Line-28, Line-31, Line-37, Line-46, Line-48, Line-50, Line-64, Line-73, Line-80, Line-128, Line-130 and Line-140 developed in the background of Basmati-385 by Department of Genetics, Hazara University Mansehra Pakistan were evaluated along with check variety Swat-1 for yield and yield components. Experiment was conducted at National Tea and High Value Crops Research Institute (NTHRI), Shinkiari Mansehra during the rice growing season of 2017. Data were recorded on various growth parameters like plant height, tillers per plant, stem diameter, flag leaf length, 1000-grain weight and yield per hectare. Except for stem borer attack no prominent disease attack was observed in the experiment during the growth period. Significant differences were observed in the genetic material for all the parameters studied. Maximum plant height of 165.8 cm was recorded for Line-31. Maximum number of tillers per plant 23.9 was recorded for Line-80. Maximum stem diameter of 7.20 mm was recorded for Line-140. The highest flag leaf length of 47.9 cm was recorded for Line-28. The 1000 grain weight of 39.0 g was equally recorded for Line-46 and Line-73. Yield data reveal that maximum yield of 4.92 t/ha was recorded for Line-37 followed by Line-28 and Line-25 having 4.52 and 4.44 tons yield per hectare respectively. Lowest yield of 2.80 t/ha was recorded for Line-31. Lines performed well in the experiment, will be promoted to next year trial for further investigation.

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Introduction

Among cereal crops after wheat, rice (*Oryza sativa* L.) ranks second and is a staple food of more than 50% world's population. Asia dominates both in rice production and consumption i.e. about 90%. The remaining 10% rice area is scattered in different parts of the world. It is expected that world population may reach the figure of 8 billion up to year 2025. Increasing population demands for increase both in area and per unit production. Keeping the present consumption pattern in view, 35 to 40% more rice production will be needed in 2025 to cater public demands.

China and India are major rice growing countries in the world. Krishnakumar et al. (2005) have reported that in India, rice is cultivated on an area of 42.2 million ha with a production of 110.9 million tons

of rice, while China produces 187.45 million tons of rice on the area of 33.1 million ha. In Pakistan during 2017-18, rice was cultivated on an area of about 2900 thousand hectares with production of more than 7.4 million tons (Ali, 2018). Pakistan ranks 11th in world rice production and 3rd in rice export which is also a major source of foreign exchange earnings for the country. In rice trade, Pakistan share 7% of the total world market (Rasheed et al., 2002). Due to its quality and aroma, Pakistani basmati rice is famous in all over the world and 94% alone is produced in Punjab province only (Anonymous, 2011). Most of rice crop is grown in the fertile lands of Sindh and Punjab provinces with millions of farmers depending on rice cultivation as their major source of employment and income. Major rice growing areas in the country are districts Gujranwala, Hafizabad, Sheikhupura, Sialkot, Jhang and Okara of Punjab province and Larkana, Jacobabad, Shikarpur, Badin, Dadu and Thatta districts of Sindh province. It is also cultivated in the Nasirabad district of Balochistan province.

In Khyber Pakhtunkhwa (KPK) province, rice is cultivated on an area of 55,255 hectare by having 111,876 tons production with an average yield of 2024 kg per hectare (Anonymous, 2013-14). Nisar et al. (2014) have reported that in the recent years the area under rice crop has decreased whereas their production increased due the corresponding increase in per hectare yield of rice crop. The major rice growing districts in KPK are Dir (both upper and lower), D.I. Khan, Swat and Malakand. Rice is also cultivated in Mansehra district on an area of 2317 thousand hectares by producing 5672 thousand tons with an average yield of 2448 kg per hectare (Kamal and Naushad, 2019). It is very evident from the statistics that average yield is very low at district, province and even at national levels. It is the dire need of time to replace low yielding varieties with high yielding disease resistant varieties to cater the demand of increasing population at rapid pace. Present study was conducted to evaluate the performance of some elite rice lines for yield and other attributes.

Materials and Methods

Fourteen elite rice lines developed at Hazara University Mansehra were evaluated along with check variety Swat-1 at National Tea and High Value Crops Research Institute (NTHRI), Shinkiari Mansehra during the rice growing season of 2017. Experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Twenty five days old seedlings were transplanted in the field. Each plot has six rows of 4 feet length. Plant to plant and row to row distance was kept at 25 cm. Recommended dose of fertilizer (N, P_2O_5, K) was applied at the rate of 120-60-0 kg/ha. Data were recorded on various growth parameters like plant height, number of tillers per plant, stem diameter, flag leaf length, 1000 grain weight and yield per hectare. The recorded data was subjected to the analysis of variance technique and the significant means were subsequently separated by the LSD test (Steel and Torrie, 1980). All required agronomic practices were carried out during the growth period. No prominent disease attack was observed on the experimental material. Stem borer attack damaged the crop to some extent. Weather data recorded on temperature, relative humidity and rainfall during growth season i.e. from May to October 2017 are given in Table 1. A total of 827.3 mm rainfall was received during the experimental period.

Table 1: *Meteorological data recorded during the growing season of 2017.*

Months	Mean Temperature (°C)		Mean Relative Humidity	Rainfall (mm)
	Minimum	Maximum		
May	15	33	30.5	52
June	22	37	49	100
July	20	33	43.5	292.5
August	19.5	33	45	368.8
September	16	32	28	14
October	10	31.4	20	0
			Total =	827.3

Source: *Weather station at National Tea and High Value Crops Research Institute Shinkiari, Mansehra.*

Results and Discussions

Significant differences were observed in the genetic material for all parameters studied (Table 2). Same results have been reported by Misbah et al. (2014) when they had conducted trial to find out the correlation and level of significance between six rice genotypes and two checks. Tahir et al. (2002) also observed highly significant variation among different traits and reported that these traits were under the control of genotypic difference among the genotypes.

Table 2: *Data recorded on various growth parameters and pest damage percentage.*

Line/ variety	Plant Height (cm)	Tillers Per Plant	Stem Diameter (mm)	Flag Leaf Length (cm)	1000 Grain Weight(gm)	Yield/ha (ton)	Stem borer(%)
Line-21	141.9 h	12.5 bc	5.00 ef	45.4 ab	35.3 bcde	3.06 fg	28.6
Line -25	145.4 fgh	10.7 de	6.47 abcd	47.2 a	34.7 de	4.44 b	7.1
Line -28	150.2 de	13.0 b	7.10 ab	47.9 a	37.7 abc	4.52 b	7.1
Line -31	165.8 a	10.0 e	5.27 def	37.5 e	30.0 f	2.80 g	34.1
Line -37	151.7 bcd	7.4 g	7.00 abc	46.6 ab	38.0 ab	4.92 a	7.1
Line -46	150.0 de	10.9 de	6.13 abcde	42.4 c	39.0 a	4.20 bc	7.9
Line -48	100.0 j	10.6 de	4.40 fg	39.2 de	30.7 f	3.64 de	7.1
Line -50	146.9 efg	8.7 f	5.70 de	42.0 cd	37.0 abcd	3.76 d	11.1
Line -64	151.5 cd	10.9 de	5.80 cde	43.8 bc	38.0 ab	4.34 b	21.4
Line -73	149.5 de	8.0 fg	6.27 abcd	45.7 ab	39.0 a	4.36 b	16.7
Line -80	121.4 i	23.9 a	3.73 g	32.1 f	34.7 de	3.00 fg	0
Line -128	147.4 ef	8.9 f	5.90 bcde	39.0 e	34.0 e	3.05 fg	10.3
Line -130	154.5 bc	11.5 cd	5.67 de	43.7 bc	28.0 f	3.81 d	11.1
Line -140	155.2 b	8.3 fg	7.20 a	46.0 ab	38.3 a	3.26 ef	15.9
Swat-1	143.6 gh	10.7 de	5.83 cde	43.8 bc	35.1 cde	3.93 cd	7.8
LSD (0.05)	1.73	0.49	0.60	1.44	1.43	0.18	
C.V (%)	1.47	5.46	12.68	4.14	4.98	6.07	

Plant height (cm)

Plant height data was recorded at the time of crop maturity. Significant differences were found for this parameter among all the tested material. Similar findings were reported by Rasheed et al. (2002) for plant height differences in rice genotypes. Recorded values range from 100 cm to 165.8 cm. Maximum plant height of 165.8 cm was recorded for Line-31 followed by Line-140, Line -130 and Line -37 having 155.2 cm, 154.5 cm and 151.7 cm respectively. Lowest plant height of 100 cm was recorded for Line-48. Khush et al. (1999) reported that short stature of varieties reduces the susceptibility of rice crop to lodging.

Tillers per plant

It is an important parameter and significant differences for it were recorded for all tested genotypes. Zahid et al. (2005) also found highly significant variation among twelve genotypes of coarse rice in number of tillers per plant. The recorded data values range from 7.4 to 23.9. Maximum number of tillers per plant (23.9) was recorded for Line-80 followed by Line-28, Line-21 and Line-130 having 13, 12.5 and 11.5 respectively. The lowest value of 7.4 was recorded for Line-37. In contrary to Padmavathi et al. (1996) findings in which they have reported that highest numbers of productive tillers are responsible for higher yield whereas in our experiment Line-80 which produced the maximum number of tillers i.e. 23.9 was among the lowest yielding lines. On the other hand Line-37 with average number of tillers i.e. 7.4 gave the maximum yield. These findings were also confirmed by Khush et al. (1999) when they had reported that according to new plant type concept reduced tillering habit (6-10 tillers/plant) would give higher yield than the varieties having 20-25 tillers.

Stem diameter (mm)

It is another important parameter recorded to assess the strength of particular variety or line against lodging. Significant differences were recorded among all the tested genotypes. Kato et al. (2007) reported significant differences among six rice cultivars for stem diameter in their experiment. In our experiment recorded values for stem diameter ranges from 3.73 to 7.20 mm. Maximum stem diameter of 7.20 mm was recorded for Line-140 followed by Line-28, Line-37 and Line-25 having 7.10, 7.0 and 6.47 mm respectively. The lowest value of 3.73 mm was recorded for Line-80. The result also proves that Line-28 and Line-37 which have second and third maximum stem diameters produce highest yield whereas the Line-80 with minimum stem diameter was amongst the lowest yielding lines proving the importance of the parameter.

Flag leaf length (cm)

Leaves are food factory for plants nutrition. Flag leaf measurement is important criteria for selection in rice breeding. Rahman et al. (2013) have reported that flag leaf provides the most important source of photosynthetic energy during reproduction and grain filling and has great impact in panicle development and grain yield in rice. Significant amount of variation was recorded in the breeding material for flag leaf length. Recorded data values ranges from 30.6 cm to 47.9 cm. The highest flag leaf length of 47.9 cm was recorded for Line-28, followed by Line-25, Line-37 and Line-73 having 47.2, 46.6 and 45.7 cm respectively. The lowest value of 32.1 cm was recorded for Line-80 which has shown poor performance for yield.

1000-Grain weight (g)

Vigorous seed size and weight have more impact on determining the yield potential of any variety. In this experiment significant differences for 1000-grain weight were recorded among all the tested genotypes. Recorded values range from 30 to 39 g respectively. The 1000-grain weight of 39.0 g was equally recorded for Line-46 and Line-73 followed by Line-140 and Line-37 having 38.3 g and 38.0 g respectively. The lowest value of 30.0 g was recorded for Line-31. Zahid et al. (2005) studied fourteen genotypes of basmati rice and observed high heritability coupled with high genetic advancement for 1000-grain weight.

Yield per hectare (tons)

Yield is the main criterion which determines the future of breeding material. Like other parameters, significant differences were also recorded among tested genotypes for the yield per hectare. Significant variation for grain yield was also found among the twelve genotypes of coarse rice (Zahid et al., 2005). This variation in grains yield might be due to environment (Mahapatra, 1993) or correlation of grain yield/plant with various yield contributing characteristics like; fertility of soil, grains/panicle, filled grains /panicle and grain weight.

The recorded rice yield values range from 2.80 to 4.92 t/ha. Maximum yield of 4.92 t/ha was recorded for Line-37 followed by Line-28, Line-25 and Line-73 having 4.52, 4.44 and 4.36 tons yield per hectare respectively. Lowest yield of 2.80 t/ha was recorded for Line-31. Tested material has shown great potential for future prospective. Lines performed well in the experiment will be advanced to next year trial for further investigation.

Insect/pest attack

Diseases in various forms attack crops causing yield reduction. Ghazanfar et al. (2013) have reported that the incidences of diseases were relatively higher on fine rice varieties. The ultimate objective of the breeders is to develop disease resistant varieties which not only increase the yield but also are environment friendly and posing no threats to ecology. In the present experiment; except stem borer attack, no prominent pest or disease had been observed on all tested lines and varietal check. As far as stem borer attack is concerned, Line-31 was found most susceptible (34.1%) followed by Line-21 and Line-64 having 28.6% and 21.4% crop damages respectively. The rest of the lines have shown medium to high tolerance against this insect.

Table 3: *Phenotypic correlation among the traits.*

	FLL	TPP	PH	SD	TGW
TPP	- 0.5587				
PH	0.4154	- 0.4279			
SD	0.6380	- 0.5284	0.5613		
TGW	0.3802	- 0.1335	0.2125	0.4652	
YPH	+ 0.6233	- 0.3139	+ 0.1360	+ 0.4652	+ 0.4248

FLL: *Flag Leaf Length;* **TPP:** *Tillers Per Plant;* **PH:** *Plant Height;* **SD:** *Stem Diameter;* **TGW:** *1000 Grain Weight;* **YPH:** *Yield Per Hectare.*

Correlation analysis (Table 3) revealed that number of tillers per plant is negatively correlated with rest of the parameters like plant height, stem thickness, flag leaf length, 1000-grain weight and yield. It is evident from the data that Line-37 which out yielded all other lines in competition including the check variety showed best performance for all the studied parameters except the number of tillers per plant. This finding will help the breeders for the selection criteria. Other lines which showed good performance for most of the parameters studied are Line-28 and Line-25. These lines have also shown tolerance to stem borer attack by having less than 8% damages. Though Line-64 and Line-73 have good yield potential but found susceptible for stem borer attack by having 21.4 and 16.7 % crop damages respectively. The rest of the lines have shown either average or poor performance for most of the studied parameters. Amazingly poorest performance shown by Line-80 for yield was found highly tolerant for this particular pest. This line could be considered for future hybridization program for crosses with high yielding susceptible varieties/lines for the transfer of resistant genes. Based on

the performance, lines 25, 28, 37, 64 and 73 will be promoted to next year trial for further investigation.

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Author's Contribution

Basharat Hussain Shah: Overall Management of the article.
Farrukh Siyar Hamid: Technical Input at every step.
Shams ul Islam: Result and discussion.
Naveed Ahmed: Data collection.
Fayaz Ahmad: Conceived the idea.
Noorullah Khan: Did SPSS analysis.
Qamar uz Zaman: Wrote abstract and methodology.

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