EVALUATION OF RICE HYBRIDS FOR YIELD AND YIELD COMPONENTS IN THREE DIFFERENT ENVIRONMENTS

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NARC, Islamabad, *RRI, KSK, **NIAB, Faisalabad

ABSTRACT

Fifteen rice hybrids contributed by six seed companies including four multinational and two national were evaluated for yield and yield attributing traits at NARC Islamabad, RRI Kala Shah Kaku and NIAB Faisalabad in comparison with cultivar KS-282. Two hybrids viz., MK Hybrid 111 and 27P72 produced more productive tillers than KS 282. All most all the hybrids produced more number of grains per panicle and higher 1000-grain weight. Yield advantage of the hybrids over the commercially grown rice variety ranges between 4.59-21.33% except RH-257 and GNY-40. These two hybrids were low yielder by 4.20 % and 14.95%, respectively, than the check variety. PHB-71 was found better than KS-282 in cooking. Level of resistance to major insect pests and diseases was also discussed.

Key words: Rice hybrids, KS-282, Productive tillers, Grains/panicle, Paddy yield, Cooking quality, Insect pests, Diseases, Resistance

INTRODUCTION

In Pakistan, rice is an important crop due to its significance as country's second staple food after wheat and as a source of foreign exchange earning. The rice export has steadily increased during current years and a worth of rupees 69 billion was earned during 2005-06 (Anonymous, 2006). This amount can further be enhanced with the increase in rice production.

Rice yield in Pakistan is very low as compared to other rice growing countries of the world. In future, there is no scope for further expansion in rice area; hence vertical increase in rice production is vital with increase in yields. To achieve this goal, conventional breeding methods need to be supplemented with the innovative techniques. Hybrid rice technology is one among these techniques. This technology is globally known since China announced the successful development and cultivation of the rice hybrids in 1976 (Kueneman, 2006). Reports revealed that hybrid rice gave 37% higher net return/ha over conventional varieties. In China, national rice yield jumped from 4799 kg/ha to 6475 kg/ha with the adoption of hybrid rice. Chinese experience attracted the attention of researchers in other Asian countries like India, Indonesia, Veitnam and Korea. A number of research projects have been started on the development of rice hybrids in these countries. Outside Asia, hybrid rice varieties have also been successfully developed and cultivated in the United States (Way, 2004) and Egypt (FAO, 2003).

Pakistan is famous for the production and export of Basmati (aromatic) as well as non-Basmati rice. So far our research efforts for the development of improved rice varieties have been restricted to conventional breeding techniques. Conventional breeding techniques need to be supplemented. Heterosis or hybrid vigor phenomenon is an important technique which can efficiently be used in rice. Jones (1926) was the first in USA to report heterosis in rice. Several other reports indicated significance of heterosis for various agronomic traits in rice (Davis and Rutgar, 1976; Virmani *et al*., 1981). Shinjyo (1969) suggested that breeders could develop a commercially viable F1 hybrid in rice. However, no interest was shown to this idea any where until China reported the successful production of rice hybrids in 1976. It is an established fact that exploitation of plant heterosis is an effective approach to increase food production. Rice hybrids can produce more than 20% higher yield than the best inbred varieties under the same cultivation conditions (Pingali *et al*., 1998 and Paroda, 1998). Malabanan (2007) reported 32.6% yield advance of hybrids over the inbred varieties in the Philippines.

In Pakistan research work has been initiated for the development of commercially viable rice hybrids by different institutions in the public and private sectors. In addition, some multinational and national seed companies are importing rice hybrids for commercial use. Rice is cultivated in diverse climatic conditions of Pakistan. Such conditions demand an extensive testing of imported rice hybrids as direct introduction and cultivation of such hybrids can pose a serious threat to our rice crop due to infestation of exotic pest problem like insects and diseases.

MATERIALS AND METHODS

Fifteen rice hybrids imported by different seed companies (Table-1) were evaluated along with KS-282

at NARC Islamabad, Rice Research Institute Kala Shah Kaku and NIAB Faisalabad during 2005 crop year. Rice variety KS-282 was used as check. The trial was conducted in a randomized completed block design with three replications. Plant to plant and row to row distance was maintained at 20 cm. Normal cultural practices were followed. The fertilizer application was given @ 120-60-60 NPK (kg/ha) according to the recommended time and doses. The crop was protected from insect pests through chemical control as and when needed. Zinc Sulphate @ 15 kg/ha was also applied. Data on days to maturity, productive tillers/plant, grains/panicle, 1000-grain weight and yield (kg/ha) were recorded. In a separate set of experiments, these hybrids were screened against leaffolder (LF) and whitebacked planthopper (WBPH) under controlled conditions at NARC, Islamabad. Screening of the hybrids was also done against paddy blast, stem rot and bacterial leaf blight (BLB) at RRI, Kala Shah Kaku. The damage rating was calculated according to IRRI's Standard Evaluation System for Rice. As for the quality traits, milling and cooking quality of each hybrid was also determined. Data were analyzed statistically and DMRT was used to determine significance between treatment means.

RESULTS AND DISCUSSION

Most of the hybrids matured in 97-102 days after transplanting except MK hybrid-117, PHB-71, 27P-72 and Arize-403 which matured in 106 days. On the average, the check variety (KS-282) matured in 97 days (Table-2). At Islamabad, Arize-403 took the longest period (111 days) to mature. The PHB-71 matured 14 days late than KS-282 at Kala Shah Kaku, while PHB-71 and 27P-72 were 10 days late in maturity than the check variety at Faisalabad. The medium long grain rice varieties taking more than 100 days to mature are not desired as they do not fit in our cropping system.

The data on mean values for productive tillers/hill (Table-3) showed that all the hybrids except 27P-72 produced the same number of productive tillers/hill as that of KS-282. Hybrid 27P-72 produced significantly higher (16) tillers/hill as compared to 13 tillers/hill of KS-282. Productive tillers are an important yield component in rice. The variety or hybrid with low tillering capacity is not wanted in transplanted rice culture. The number of grains/panicle is another important yield component in rice. Of the fifteen, thirteen hybrids produced more number of grains/panicle than the check. The increase ranged from 4.30 to 37.96% (Table-4). Similarly, 1000 grain weight (test grain weight) is also an important component that contributes towards increase in yield. The 1000 grain weight in the hybrid varieties ranged from (20.33-29.33 grams). On an average, MK hybrid-111 produced the minimum 1000 grain weight (20.33 grams). Low value of test grain weight is an indication towards grain fineness. MK Hybrid-111 looks more like basmati grain. GNY-402 produced the highest (29.33 grams) 1000 grain weight followed by GNY-406 and MK hybrid-117 which produced 27.66 grams each. In case of check variety, KS-282 it was 24.56 grams/1000 grains (Table-5).

Table-1: Rice hybrids provided by various seed companies

Hybrids	Source
MK Hybrid-109	Emkay Seeds (Pvt.) Ltd., Lahore
MK Hybrid-110	Emkay Seeds (Pvt.) Ltd., Lahore
MK Hybrid-111	Emkay Seeds (Pvt.) Ltd., Lahore
MK Hybrid-117	Emkay Seeds (Pvt.) Ltd., Lahore
PHB 71	Pioneer Pakistan Seeds Ltd.
27 P 72	Pioneer Pakistan Seeds Ltd.
H 8002	ICI, Pakistan
RH 257	Monsanto Pakistan, Limited
GNY-401	Guard Rice (Pvt.) Ltd., Lahore
GNY-402	Guard Rice (Pvt.) Ltd., Lahore
GNY-403	Guard Rice (Pvt.) Ltd., Lahore
GNY-404	Guard Rice (Pvt.) Ltd., Lahore
GNY-405	Guard Rice (Pvt.) Ltd., Lahore
GNY-406	Guard Rice (Pvt.) Ltd., Lahore
Arize-403	Bayer Crop Sciences
KS-282 (Check)	RRI, KSK

Table-2: Performance of hybrids (maturity days) at different locations

Hybrids	Islam-abad.	Kala Shah Kaku	Faisal-abad.	Mean
MK Hybrid-109	101^{E}	97^{E}	95^{F}	98
MK Hybrid-110	101^{E}	96^{EF}	95^{F}	97
MK Hybrid-111	101^{E}	102^{CD}	100^{D}	101
MK Hybrid-117	107^{C}	106^{B}	104^{BC}	106
PHB 71	104^{D}	109^{A}	106^{A}	106
27 P 72	106^{C}	106^{B}	106^{A}	106
H 8002	106^{C}	101^{D}	99^{D}	102
RH 257	101^{E}	92^{I}	91^{H}	95
GNY-401	101^{E}	90^{J}	91^{H}	94
GNY-402	103^{D}	95^{EFG}	93^{G}	97
GNY-403	101^{E}	87^{K}	88^{I}	92
GNY-404	103^{D}	101^{D}	100^{D}	101
GNY-405	101^{E}	93^{HI}	91^{H}	95
GNY-406	104^{D}	94^{GHI}	95^{F}	98
Arize-403	111^{A}	104^{G}	103^{C}	106
KS-282 (Check)	101^{E}	95^{FGH}	96^{E}	97

In a column, figures followed by a common letters are not significantly different at 5% level by DMRT.

Table-3: Performance of hybrids (No. productive tillers/hill) at different locations

Sr. No.	Hybrids	Islamabad	Kala Shah Kaku	Faisalabad	Average
1	MK Hybrid-109	10^{BCD}	13_{BCD}	14^{BCD}	12
2	MK Hybrid-110	9^{D}	11^{EF}	12^{CD}	11
3	MK Hybrid-111	12^{ABC}	12_{CDE}	17^{A}	14
4	MK Hybrid-117	11^{ABCD}	13^{BCD}	14^{ABC}	13
5	PHB 71	11^{ABCD}	14^{BC}	13^{BCD}	13
6	27 P 72	12^{AB}	16^{A}	13^{BCD}	16
7	H 8002	11^{ABCD}	14^{B}	12^{CD}	12
8	RH 257	9^{D}	12^{CDE}	11^{CD}	11
9	GNY-401	11^{ABCD}	12^{DE}	11^{D}	11
10	GNY-402	8^{D}	10^{F}	12^{CD}	10
11	GNY-403	9^{CD}	12^{DE}	11^{D}	11
12	GNY-404	11^{ABCD}	11^{EF}	13^{BCD}	12
13	GNY-405	10^{ABCD}	12^{DE}	13^{BCD}	12
14	GNY-406	12^{ABC}	12^{CDE}	11^{CD}	12
15	Arize-403	12^{ABC}	14^{B}	13^{CD}	13
16	KS-282 (Check)	13^{A}	12^{DE}	16^{AB}	13

In a column, figures followed by a common letters are not significantly different at 5% level by DMRT.

Table-4: Performance of hybrids (No. grains/panicle) at different locations

Sr. No.	Hybrids	Islamabad	Kala Shah Kaku	Faisalabad	Avg.	Increase over check (%)
1	MK Hybrid-109	147.3^{F}	109.3^{EFG}	207.3^{ABC}	155	13.13
2	MK Hybrid-110	172.3^{BC}	128.3^{CD}	208.7^{ABC}	170	24.08
3	MK Hybrid-111	125.3^{H}	100.7^{HI}	202.0^{ABC}	143	4.30
4	MK Hybrid-117	170.0^{BC}	115.7^{E}	202.7^{ABC}	163	18.97
5	PHB 71	200.0^{A}	102.3^{HI}	205.3^{ABC}	169	23.35
6	27 P 72	123.0^{H}	104.3^{GHI}	187.0^{BCD}	138	0
7	H 8002	127.7^{GH}	112.7^{EF}	171.7^{CD}	137	0
8	RH 257	149.3^{EF}	106.7^{FGH}	228.7^{A}	162	18.25
9	GNY-401	157.0^{DEF}	107.0^{FGH}	197.7^{ABCD}	154	12.41
10	GNY-402	171.0^{BC}	148.3^{B}	199.7^{ABCD}	173	26.27
11	GNY-403	147.3^{F}	124.7^{D}	174.3^{CD}	149	8.70
12	GNY-404	137.0^{G}	112.0^{EF}	191.7^{ABCD}	147	7.30
13	GNY-405	164.0^{CD}	157.7^{A}	190.7^{ABCD}	171	24.81
14	GNY-406	158.7^{DE}	132.0^{C}	206.3^{ABC}	166	21.16
15	Arize 403	178.0^{B}	162^{A}	227.3^{AB}	189	37.96
16	KS-282 (Check)	152.3^{EF}	98 I	160.3^{D}	137	—

In a column, figures followed by a common letters are not significantly different at 5% level by DMRT

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The data on yield revealed that thirteen hybrids produced significantly higher paddy yield than the check variety (Table-6). This increase in yield over the check ranged from 4.59-21.33%. On an average, Arize-403 produced the highest yield (7586 kg/ha) compared to all other hybrids and check variety KS-282. Hybrid, GNY-401 produced 14.95% lower than the check variety (5317 kg/ha *vs* 6252 kg/ha). Another hybrid, RH 257 produced 4.20% less yield than the check. Over all the hybrids produced higher yield than the standard rice cultivar. The yield advantage of rice hybrids over inbred varieties has already been reported by several researchers (Virmani 1986, Young and Virmani 1990, Peng and Virmani, 1991). Yield increased in hybrids seems due to heterosis in number of grains/panicle and 1000-grain weight (Virmani *et al*., 1982).

Quality of rough rice, milled rice and cooking was assed at rice grain quality laboratory Rice Research Institute, Kala Shah Kaku. The data on the quality of paddy grain revealed that six hybrids were found to be at par with KS-282. However, four hybrids were better and five were rated inferior to KS-282. Regarding kernel shape, appearance, length and breadth, nine hybrids were found equal to KS-282 and two were inferior to KS-282. The ultimate preference of the consumers is based on the cooking of any rice variety. Out of these 15 hybrids, only PHB-71 was found better than KS-282 and Arize-403 was found equal to KS-282 (Table-7).

To determine the level of resistance against major insect pests and diseases, hybrids were also evaluated against leaffolder (LF), whitebacked planthopper (WBPH) at National Agricultural Research Centre, Islamabad and for paddy blast, stem rot and bacterial leaf blight (BLB) at Rice Research Institute, Kala Saha Kaku.

The results indicated that none of the hybrid was found resistant to both the insect pests. However, hybrid line 27P72 was moderately resistant to LF. Rice hybrids MK hybrid-111, GNY-401 and Arize-403 were found moderately resistant to WBPH (Table-8). MK hybrid-111 was found resistant to paddy blast, whereas MK hybrid-109 and PHB-71 were rated as moderately resistant to paddy blast. None of the hybrids was found to resistant to stem rot, rather all were either susceptible or highly susceptible to this disease. Five hybrids were found moderately susceptible to BLB, the most destructive disease of the rice crop at the moment (Table-9).

Cultivation of insect resistant rice varieties is major tactic in the IPM and is compatible with other control tactics. Farmers do not have to bear extra cost by growing resistant varieties, do not disturb the natural balance and pose no problem to environment (Rehman, 2003). Hence, cultivation of high yielding, comparatively resistant to major insect pests and diseases and with desirable grain quality rice hybrids will lead to enhance sustainable rice production in Pakistan.

Table-5: Performance of hybrids (1000-grain weight (grams) at different locations

Sr. No.	Hybrids	Islamabad	Kala Shah Kaku	Faisalabad	Average
1	MK Hybrid-109	24.33^{DEF}	25.00^{DEFG}	24.33^{D}	24.55
2	MK Hybrid-110	23.67^{F}	24.00^{FGHI}	22.67^{FG}	23.44
3	MK Hybrid-111	22.00^{G}	18.67^{J}	20.33^{H}	20.33
4	MK Hybrid-117	25.33^{D}	30.00^{A}	27.67^{B}	27.66
5	PHB 71	24.00^{EF}	23.67^{GHI}	24.00^{DE}	23.89
6	27 P 72	24.67^{DEF}	23.00^{I}	21.67^{G}	23.11
7	H 8002	22.23^{G}	26.33^{CD}	26.00^{C}	24.88
8	RH 257	25.00^{DE}	24.67^{EFGH}	22.67^{FG}	24.11
9	GNY-401	29.00^{B}	26.33^{CD}	25.0^{CD}	26.77
10	GNY-402	30.00^{A}	28.33^{B}	29.67^{A}	29.33
11	GNY-403	22.33^{G}	31.00^{A}	29.33^{A}	27.55
12	GNY-404	26.33^{C}	23.33^{HI}	22.67^{FG}	24.11
13	GNY-405	26.67^{C}	25.33^{DEF}	24.67^{D}	25.56
14	GNY-406	28.67^{B}	27.00^{BC}	27.33^{B}	27.66
15	Arize 403	24.33^{DEF}	25.67^{CDE}	23.00^{EF}	24.33
16	KS-282 (Check)	24.67^{DEF}	24.33^{EFGH}	24.67^{D}	24.56

In a column, figures followed by a common letters are not significantly different at 5% level by DMRT.

Table-6: Performance of hybrids (paddy yield (kg/ha) at different locations

Sr. No.	Hybrids	Islamabad	Kala Shah Kaku	Faisalabad	Avg.	% change over check
1	MK Hybrid-109	5833^{BCD}	4485^{EF}	9298^{DE}	6539	+ 4.59
2	MK Hybrid-110	4542^{EF}	5248^{BC}	10769^{AB}	6843	+ 9.45
3	MK Hybrid-111	4917^{DEF}	4783^{DE}	11251^{A}	6984	+ 11.70
4	MK Hybrid-117	5083^{CDEF}	5822^{A}	10276^{BC}	7060	+ 12.90
5	PHB 71	5625^{BCD}	5654^{AB}	9950^{CD}	7076	+ 13.18
6	27 P 72	5833^{BCD}	6043^{A}	7905^{F}	6594	+ 5.5
7	H 8002	5083^{CDEF}	5917^{A}	9052^{E}	6684	+ 6.9
8	RH 257	4167^{F}	5126^{CD}	8674^{E}	5989	- 4.20
9	GNY-401	5500^{BCDE}	4314^{F}	6136^{G}	5317	- 14.95
10	GNY-402	6083^{BC}	5892^{A}	9890^{CD}	7288	+ 16.57
11	GNY-403	5875^{BCD}	5754^{A}	10408^{BC}	7345	+ 17.48
12	GNY-404	5750^{BCD}	4404^{EF}	10285^{BC}	6813	+ 18.97
13	GNY-405	5912^{BCD}	5315^{BC}	8868^{E}	6698	+ 17.13
14	GNY-406	7083^{A}	5100^{CD}	8662^{E}	6948	+ 11.13
15	Arize 403	6292^{AB}	4412^{EF}	10389^{BC}	7586	+ 21.33
16	KS-282 (Check)	5542^{BCDEF}	6078^{A}	8802^{E}	6252	—

In a column, figures followed by a common letters are not significantly different at 5% level by DMRT.

Table-7: Quality status of rice hybrids in comparison with cultivar KS-282

Hybrids	Quality		
	Paddy grain	Rice grain	Cooked grain
MK Hybrid-109	= KS 282	= KS 282	<< KS 282
MK Hybrid-110	> KS 282	> KS 282	<< KS 282
MK Hybrid-111	= KS 282	> KS 282	< KS 282
MK Hybrid-117	> KS 282	> KS 282	<< KS 282
PHB 71	= KS 282	= KS 282	> KS 282
27 P 72	> KS 282	= KS 282	< KS 282
H 8002	= KS 282	= KS 282	< KS 282
RH 257	= KS 282	< KS 282	< KS 282
GNY-401	< KS 282	= KS 282	< KS 282
GNY-402	< KS 282	= KS 282	< KS 282
GNY-403	> KS 282	> KS 282	= KS 282
GNY-404	< KS 282	= KS 282	< KS 282
GNY-405	= KS 282	= KS 282	<<< KS 282
GNY-406	< KS 282	= KS 282	< KS 282
Arize 403	< KS 282	< KS 282	= KS 282
KS-282 (Check)			

Source: Rice Research Institute, KSK

Table-8: Showing level of resistance against LF and WBPH

Hybrids	LF	WBPH
MK Hybrid-109	MS	MS
MK Hybrid-110	S	MS
MK Hybrid-111	MS	MR
MK Hybrid-117	S	S
PHB 71	HS	MS
27 P 72	MR	MS
H 8002	MS	S
RH 257	S	MS
GNY-401	MS	MR
GNY-402	S	S
GNY-403	HS	S
GNY-404	S	S
GNY-405	HS	MS
GNY-406	S	S
Arize 403	MS	MR
KS-282 (Check)	S	MS

Source: Rice Programme, NARC

R = Resistant HS = Highly susceptible
MR = Moderately resistant S = Susceptible
MS = Moderately susceptible

Table-9: Level of resistance against major diseases

Hybrids	Blast	Stem rot	BLB
MK Hybrid-109	MR	HS	MR
MK Hybrid-110	HS	HS	S
MK Hybrid-111	R	HS	MR
MK Hybrid-117	MS	HS	MS
PHB 71	MR	S	MS
27 P 72	MS	HS	MS
H 8002	MS	HS	MR
RH 257	MS	S	MR
GNY-401	MS	S	MR
GNY-402	MS	HS	MS
GNY-403	MS	HS	MS
GNY-404	MS	S	MS
GNY-405	S	S	S
GNY-406	MS	HS	MS
Arize 403	MS	S	MS
KS-282 (Check)	MS	S	S

Source: RRI, Kala Shah Kaku

R = Resistant HS = Highly susceptible
MR = Moderately resistant
S = Susceptible
MS = Moderately susceptible

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