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PERFORMANCE OF AROMATIC RICE (*ORYZA SATIVA* L.) VARIETIES AND THEIR F_1 HYBRIDS UNDER LOWLAND AND UPLAND ENVIRONMENTS

A. D. Jarwar[1] and Q. D. Dela Cruz[2]

[1]Agriculture Research Sindh, Pakistan
[2] Department of Crop Science Institute of Graduate Studies,
Central Luzon State University Nueva Ecija Philippines

ABSTRACT

The performance of rice hybrids along with their parents was studied in two different environments i.e. lowland and upland. Statistically analyzed results showed significant differences among parents, hybrids and hybrids versus parents. The highest to lowest and medium values were observed under lowland, upland as well as in both the environments for parents and their F_1 hybrids. The highest mean value for days to 50% flowering was shown by hybrid Mehak x Vertin (90). In contrast, the lowest value was exhibited by hybrid LR2 x Pandan (61). Whereas for days to maturity, hybrid LR2 x Pandan and Sugdasi x Pandan were noted as early maturing with 97 and 98 days, respectively. On the contrary, Mehak x Vertin was found to be late maturing and took 124 days. Among the testers, Basmati 370 took 115 days to mature, followed by Pandan (114 days). Among the lines, Mehak took 113 days to mature. For plant height the lines Sugdasi and JJ77 were found to be tallest, while among the testers, Pandan was found tallest (103.69 cm). The plants of tester Basmati 370 were shortest (89.60 cm), followed by the line LR2 (91.77 cm). Highest number of productive tillers (20) was recorded in the hybrids DR 65 x Pandan and DR65 x Basmati 370.

Keywords: agronomic traits, aromatic rice, F_1 hybrids, lowland and upland environment

INTRODUCTION

Rice is second major exportable grain commodity of Pakistan. During 2012-2013, the area under cultivation, production and export figures indicates that the rice (aromatic and non-aromatic) was grown on 2.31 million hectares with production of 5.53 million tonnes and average yield of 2398 kg per hectare. The area in the same years under Basmati rice was 1.06 million hectares with the production of 1.87 million tonnes. The average per hectare yield of Basmati rice was 1765 kg (GoP, 2012). Fatema *et al*. (2011) reported significant variations during varieties for almost all the agronomic traits with high heritability. Mahmud *et al.* (2013) observed that rice cultivars differed significantly in all growth characters,

Corresponding author: adjarwar@yahoo.com

including plant height, number of tillers, chlorophyll content and dry weight of different plant parts, panicle length, filled grains, unfilled grains, filled grain percentage, 1000-grain weight, grain yield and straw yield. Number of seedlings per hill show remarkable influence on number of total tillers per hill and total dry matter production. Haque *et al.* (2015) observed that hybrid rice varieties have higher yield potential over inbred varieties, both hybrid varieties out yielded the inbred. However, the hybrids and inbred varieties exhibited statistically identical yield in late planting. Ahmed *et al*. (2015) conducted experiment on the performance of cultivars PAC 837, Arize 6444 and IR-64 and reported that these cultivars exhibited delayed panicle initiation, increased leaf area, leaf area index and leaf area duration under System of Rice Intensification (SRI) practice as compared to other two cultivation practices. There is a possibility of variation in environments, which affects the yield performance of aromatic rice cultivars (Haryanto *et al.,* 2008). The genotype by environment (GXE) interaction has an influence on yield and yield performance which may vary with genotypes (Suwarto and Nasrullah, 2011).

Basmati rice is grown in the traditional rice tracts of Punjab and at high altitude mountain valleys of Swat and other parts of tribal areas. It is estimated that about 96% of basmati rice is grown in Punjab as environment over there is suitable in maintaining its quality and aroma. Although, its yield is much lower than IRRI but the demand is high in the national and international markets. Majority of the farmers prefer to grow basmati rice despite low yield, high production cost and intense water requirement (Khan, 2011). The fine grain basmati varieties of rice are considered high quality and fetch a high price in the national and international trade.

However, yield per unit area of basmati rice is very low due to tall plant habit and late maturity. So, broadening the genetic base of rice is an essential requirement for rice improvement programme. The challenge of overcoming hunger, poverty and malnutrition in rice-consuming countries while maintaining productivity and protecting the environment will require a coordinated effort. The major focus of rice research in the next decade must be the development of high-yielding and early-maturing varieties in order to ensure the conservation and efficient use of natural resources (Swain, 2005). The performance of crop plants varies in different environments, which indicates their adoptability to specific environment or over wide areas. Thus, estimation of the interaction between genotype and environment for different agronomic and yield related characters is required to evaluate the adaptability and performance to express the genetic potential of the inbreds and hybrids. This paper reports the results of study conducted to evaluate the performance of F1 hybrids and their parents in two different environments.

MATERIALS AND METHODS

Research was carried out at the experimental area of the Research, Central Luzon State University, Science city of Munoz, Nueva Ecija, Philippines, during April-2010 to July-2011. Ten rice genotypes, viz: Local Roosi-2, Sugdasi, Mehak, JJ77, Rataria, DR65, and Bengalo originated from Pakistan, Pandan and Vertin from Philippines and Basmati 370 from India. Basmati 370 was used as check variety. All cultural practices were applied as per recommendations. Two

experiments were laid out for the evaluation of hybrids along with their parents and a check variety in two environmental conditions, as lowland and upland conditions in three replications. Lowland conditions were characterized by continuous presence of water during the growing period, while in the upland condition, the genotypes were grown under controlled irrigation. The varieties and hybrids were planted at a distance of 30 cm between rows and 20 cm between plants having 1 meter row length. Thirty- day- old rice seedlings were transplanted as one seedling per hill in the prepared plots. In the upland condition, irrigation was applied in the prepared plots at the time of transplanting. Harvesting was done when the plants reached at maturity. Five plants were selected randomly by cutting the stem close to the soil surface for determining the agronomic traits. Data on the following agronomic characters were recorded: days to flowering, days to maturity**,** plant height (cm) and number of productive and un-productive tillers per plant. Data were subjected to analysis of Duncans Multiple Range test for comparison of two means.

RESULTS AND DISCUSSION

Days to 50% flowering

The results revealed that the highest mean value was shown by hybrid Mehak x Vertin (90). In contrast, the lowest value was exhibited by hybrid LR2 x Pandan (61). Among the testers, Vertin took more (95) days, to flower and among the lines Variety JJ 77 took fewer (63) days to flower. The hybrid Bengalo x Vertin took 90 days to flower. In contrast, the hybrids LR2 x Pandan started flowering from 59 days after transplanting. This indicates the earliness in this hybrid than other hybrids by 10 days. On average of both the environments, the tester, parent Vertin was observed as the late parent and took 92 days to flower and the line parent JJ77 was found to be earlier and took only 61 days to flower.

In both the environments, hybrids Mehak x Vertin took 85 days and Bengalo x Vertin took 82 days to flower. In contrast, the crosses of LR2 x Pandan, Sugdasi x Pandan took 60 days and Rataria x Pandan, started flowering after 62 days of transplanting. Among the line parents, JJ77 was observed as early to flower and passed 62 days to flower, followed by Rataria with 63 days. Among the testers variety Vertin took 93 days, followed by check variety Basmati 370 (selection) which started flowering after 82 days (Table 1).

Days to maturity

In lowland environment, hybrids LR2 x Pandan and Sugdasi x Pandan were noted as early maturing with 97 and 98 days, respectively. On the contrary, Mehak x Vertin was late maturing (124 days). Among the tester parents, Basmati 370 was late to mature and took 115 days, followed by Pandan (114 days).

Table 1. Mean values of different agronomic characters under lowland and upland conditions

Crosses	Days to flowering (50%)			Day to maturity			Plant height (cm)		
	Lowland	Upland	Mean	Lowland	Upland	Mean	Lowland	Upland	Mean
LR2 x Pandan	61op	59q	60no	97v	110k-n	104k	93.34 k-n	93.28lmn	93.31ijk
LR2 x Basmati 370	66imn	63op	65j-m	103rst	110k-n	107ijk	98.51 i-l	63.69x	81.10op
LR2 x Vertin	76ef	72hij	74fg	114i-l	115f-j	114cd	91.52mno	68.88vw	80.20op
Sugdasi xPandan	62p	58q	60o	98uv	114h-k	106jk	95.39j-m	77.05tu	86.22mn
Sugdasi xBasmati 370	74fgh	80cde	77de	110imn	116e-i	113de	95.10j-m	87.38o-r	91.24jkl
Sugdasi x Vertin	67k-n	63nop	65jkl	104pqr	110k-n	107ij	112.25cd	92.10mno	102.18ef
Mehak x Pandan	69i-l	69jkl	69hi	108m-p	115f-j	112d-h	91.16m-p	67.58vwx	79.37p
Mehak x Basmati 370	70ijk	67klm	68hi	106opq	116e-i	111e-h	89.58nop	80.13st	84.86mno
Mehak x Vertin	90b	81cd	85b	124bc	126ab	125a	99.36ij	86.80o-r	93.08ijk
JJ 77 x Pandan	66imn	62op	64lm	100stu	119def	109f-i	110.91cde	94.13k-n	102.52ef
JJ 77 x Basmati 370	66imn	62op	64lm	102rst	109mno	106jk	103.84ghi	86.02pqr	94.93g-j
JJ 77 x Vertin	68klm	65mn	67ij	103rst	114h-k	108hij	106.07e-h	88.96n-q	97.52f-i
Rataria x Pandan	64no	61pq	62mn	102rst	115f-j	109g-j	122.30b	76.74tu	99.52efg
Rataria x Basmati 370	73ghi	77ef	75efg	109mno	111klm	110fgh	106.14e-h	68.01vwx	87.07lmn
Rataria x Vertin	65mno	64no	64lm	101stu	107n-q	104k	102.14hi	94.95klm	98.55fgh
Bengalo xPandan	72ghi	77def	75efg	107n-q	117d-i	112d-g	109.4c-f	82.56rs	95.98-j
Bengalo xBasmati 370	70ijk	64no	67ij	108m-p	120de	114de	108.88d-g	69.84vw	89.36klm
Bengalo x Vertin	75fgh	89b	82c	112j-m	114h-k	113def	114.61c	111.24cde	112.93bc
DR 65 x Pandan	68klm	64no	66jkl	103rst	104pqr	104k	104.72fgh	83.70qrs	94.21h-k
DR 65 x Basmati 370	72hij	75fgh	73g	106opq	120de	113de	104.96fgh	65.57wx	85.27mn
DR 65 x Vertin	77def	75fgh	76def	117d-i	111klm	114de	128.38a	108.40d-g	118.39a
LSD at 0.05	1.38	3.59	-	2.14	4.01	-	3.38	5.95	-

Table 1 continued

Parent	Days to flowering (50%)			Day to maturity			Plant height (cm)		
	Lowland	Upland	Mean	Lowland	Upland	Mean	Lowland	Upland	Mean
Lines (Males)									
LR2	71ij	68kl	70h	111klm	117d-i	114de	91.77mno	84.42qrs	88.10lmn
Sugdasi	69jkl	63nop	66jk	107nop	121cd	114de	128.26a	100.59hij	114.43ab
Mehak	80cde	77ef	78d	113i-l	124bc	119b	98.78ijk	93.68k-n	96.23ghi
JJ 77	63op	61op	62mn	97 v	103qrs	100l	128.06a	104.44fgh	116.25ab
Rataria	65mno	62op	63lm	99tuv	114h-k	107ijk	109.20c-f	98.79 ijk	103.99de
Bengalo	72hij	68klm	70h	107 n-q	117d-i	112d-g	127.90a	88.35opq	108.13cd
DR 65	68klm	65mno	66jk	105 o-r	113i-l	109ghi	92.30mno	82.97 rs	87.63lmn
LSD at 0.05	0.65	1.69	-	1.01	1.89	-	1.59	2.80	-
Testers (Females)									
Pandan	77def	76f	77de	114 h-k	116f-i	115cd	103.69ghi	85.73pqr	94.71g-j
Basmati370	76fg	74fgh	75efg	115f-j	121cd	118bc	89.60n-r	72.74uv	81.17op
Vertin	95a	92ab	93a	127ab	128a	128a	98.76ijk	69.37vw	84.06no
Bas.370 (check)	81c	83c	82c	118d-h	120de	119b	98.69ijk	95.39j-m	97.04ghi
LSD at 0.05	0.43	1.11	-	0.66	1.24	-	1.04	1.84	-

Means in a column followed by a common letter are not significantly different at 5% level (DMRT)

Among the lines, variety Mehak was also late to mature and took 113 days. In upland environment, hybrids DR65 x Pandan and Rataria x Vertin were noted as early maturing and took 104 and 107 days to mature, respectively. Hybrid Mehak x Vertin was observed as late maturing and took 126 days. Among the testers, variety Vertin matured late and took 128 days, followed by Basmati 370 and check both varieties matures in 121 and 120 days, respectively. Among the lines, parent namely Mehak took 124 days and JJ77 took 103 days to mature. The early maturing hybrids in both environments that took 104 days to mature were LR2 x Pandan, Rataria x Vertin and DR65 x Pandan. Whereas the late maturing hybrids were Mehak x Vertin took 125 days, followed by LR2 x Vertin, Bengalo x Basmati 370 and DR65 x Vertin, took 114 days to mature. Hybrids that are late maturing in lowland were also late maturing in upland. Similarly, parents that were late maturing in lowland were late maturing in upland.

Plant height (cm)

The highest value of height 128.38 cm was shown by hybrid DR 65 x Vertin, followed by 122.30 cm in Rataria x Pandan, while the lowest value for height was noted in Mehak x Pandan (91.16 cm), followed by LR2 x Vertin (91.52 cm). Generally, hybrids were shorter in height compared to their parents. The lines Sugdasi and JJ77 were the tallest, 128.26 and 128.06 cm, respectively, while among the testers, Pandan was found to be tallest (103.69 cm). The plants of tester Basmati 370 were shortest (89.60 cm), followed by the line LR2 (91.77 cm). Under upland condition the highest value of height (111.24) was shown by hybrid Bengalo x Vertin, followed by DR65 x Vertin (108.40). While the shortest plants were produced by hybrid LR2 x Basmati 370 (63.69 cm). Generally, hybrids were found to be shorter as compared to their parents. Among the line parents, JJ77 was the tallest (104.44cm), followed by Sugdasi (100.59), and DR65 was the smallest in height (82.97). While among the testers, the highest plant height was observed in Pandan (85.73) and lowest in Basmati 370 (72.74 cm).

From the results regarding plant height, it was observed that there was a significant change in the height of the hybrids and parents with the change in environment. Generally, height of genotypes was taller in lowland than in upland environment. The tallest plants were noted in the hybrid DR65 x Vertin with value of 118.39 cm, followed by Bengalo x Vertin (112.93 cm), JJ77 x Pandan (102.52 cm) and Sugdasi x Vertin (102.18 cm), while the smallest plants were of cross Mehak x Pandan (79.37 cm) in both environments. The highest value (116.25 cm) was observed in line JJ77, followed by Sugdasi, (114.43 cm); both lines showed tallest plants. Tester parent, Basmati 370 showed the lowest value (81.17 cm) with dwarf plants, followed by Vertin with height of 84.06 cm.

Table 2. Mean values of different agronomic characters under lowland and upland conditions

Crosses	Number of productive tillers (plant^{-1})			Number of un-productive tillers (plant^{-1})		
	Lowland	Upland	Mean	Lowland	Upland	Mean
LR2 x Pandan	12 gh	16 a-e	14efg	3	3	3bcd
LR2 x Basmati 370	13 fgh	15 c-f	14efg	3	4	4a-d
LR2 x Vertin	12 gh	15 c-f	14efg	3	4	4a-d
Sugdasi x Pandan	16 b-e	17 a-e	17a-e	4	4	4a-d
Sugdasi x Basmati 370	13 fgh	16 b-f	14efg	3	4	4a-d
Sugdasi x Vertin	15 c-g	17 a-e	16c-f	4	5	5a
Mehak x Pandan	17 a-e	15 c-f	16c-f	4	4	4a-d
Mehak x Basmati 370	17 a-e	17 a-e	17a-e	4	5	5a
Mehak x Vertin	13 fgh	16 b-f	15def	4	4	4a-d
JJ 77 x Pandan	15 c-g	15 c-f	15def	4	5	5a
JJ 77 x Basmati 370	17 a-e	15 c-g	16b-f	4	5	5a
JJ 77 x Vertin	16 b-e	17 a-e	16a-e	4	4	4a-d
Rataria x Pandan	19 ab	16 b-f	18a-d	4	5	5a
Rataria x Basmati 370	16 b-e	14 d-g	15def	4	4	4a-d
Rataria x Vertin	16 b-e	16 b-f	16b-f	4	4	4a-d
Bengalo x Pandan	19 ab	18 abc	18abc	4	4	4ad
Bengalo x Basmati 370	17 a-e	17 a-e	17a-e	4	4	4a-d
Bengalo x Vertin	19 ab	18 abc	18abc	3	4	3bcd
DR 65 x Pandan	20 a	15 c-g	17a-d	4	4	4a-d
DR 65 x Basmati 370	20 a	19 ab	19a	4	4	4a-d
DR 65 x Vertin	19 ab	18 abc	19a	4	5	5a
LSD at 0.05	1.26	1.67	-	-	-	-

Table 2 continued

Parents	Number of productive tillers (plant^{-1})			Number of un-productive tillers (plant^{-1})		
	Lowland	Upland	Mean	Lowland	Upland	Mean
Lines (Males)						
LR2	16 b-f	12 fgh	14efg	4	3	3.50a-d
Sugdasi	16 b-f	13 e-h	15def	3	3	3.16cd
Mehak	18 abc	13 e-h	16c-f	4	3	3.66a-d
J J 77	15 d-g	12 fgh	13fg	5	3	3.83a-d
Rataria	17 a-d	12 gh	15efg	4	3	3.50a-d
Bengalo	15 d-g	16 c-f	15efg	4	3	3.66a-d
DR 65	14 d-g	14 d-h	14efg	4	4	4.00abc
LSD at 0.05	1.06	1.40	-	-	-	-
Testers (Females)						
Pandan	16 b-f	14 d-h	15def	4	4	4.00abc
Basmati 370	10 h	13 e-h	12gh	4	3	3.50a-d
Vertin	11 h	10 h	11h	3	3	3.00d
Basmati 370 (check)	10 h	10 h	10h	4	3	3.50a-d
LSD. at 0.05	0.69	0.92	-	-	-	-

Means in a column followed by a common letter are not significantly different at 5% level (DMRT).

Number of productive tillers plant^{-1}

Hybrids DR 65 x Pandan and DR65 x Basmati 370 produced more productive tillers (20). This hybrid also produced 43 percent more tillers than its male parent. Whereas the lowest number of productive tillers was produced by the hybrids LR2 x Pandan and LR2 x Vertin (12). Mehak produced highest number of productive tillers plant^{-1} (18), followed by Rataria (17); whereas the lowest number of productive tillers was produced by testers Basmati 370 and Check (10). Under upland environment, hybrid DR65 x Basmati 370 produced highest number of productive tillers (19), followed by DR65 x Vertin, Bengalo x Vertin and Bengalo x Pandan (18), respectively. Whereas, the lowest number of productive tillers was produced by the hybrid Rataria x Basmati 370 (14). Among the lines, DR65, and among the testers, Pandan produced highest number of productive tillers (14), while the lowest was produced by Vertin and Basmati 370 (check) (10). Cross combinations, DR65 x Basmati 370 and DR65 x Vertin showed highest (19) number of productive tillers plant^{-1} under both environments. The lowest number of productive tillers per plant was observed in hybrids LR2 x Pandan, LR2 x Basmati 370, LR2 x Vertin and Sugdasi x Basmati 370 (14). Among the lines highest value (16) was noted for Mehak, followed by Sugdasi, Rataria, Bengalo and Pandan (15); whereas, less productive tillers plant^{-1} were observed by the tester Vertin (11). Also check Basmati 370 showed lowest value (10) for productive tillers.

Number of un-productive tillers plant^{-1}

Under lowland condition, difference between genotypes for this trait was not significant. Under upland condition the significant difference among genotypes was observed. The highest number of un-productive tillers was displayed by hybrids DR65 x Vertin, Rataria x Pandan, Sugdasi X Vertin, JJ77 x Pandan and JJ77 x Basmati 370 (5), whereas the lowest value was by hybrid LR2 x Pandan (3). Two parents each from lines DR65 and testers Pandan, produced un-productive tillers (4), all remaining parents produced less un-productive tillers (3).

The lowest number of un-productive tillers in both environments was in cross combinations LR2 x Pandan and Bengalo x Vertin (3), respectively.

CONCLUSION

From the results of the present study it is concluded that lowland and upland environments have significant impact for improving earliness and producing more productive tillers plant^{-1} in the F_1 hybrids as compared to their parents.

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