CHAPTER 4

RESULTS

4.0 RESULTS

4.1 F_1 Hybrids Seed Production and Germination Rates

In Table 4.1, the total number of F_1 seeds produced from 14 different crosses was ranged from 5 to 58 seeds. The lowest number of seed was produced from the cross between MR 219 and Entry 7, whilst the highest number of seeds was derived from the cross between MRQ 50 and Entry 7. The F_1 seeds collected were separated into curve shaped seed and non-curve shaped seed (Appendix 1.1) for each crosses, except F_1 of MRQ 50/ Rambir Basmati which is only produced curve shaped seeds. The number of seedlings and germination rates were calculated for each cross. F_1 of MRQ 50/ E 11 performed 100 % germination rate for both curve shaped seeds and non-curve shaped seeds.

4.2 Genotypic Characteristic for Fragrance (*fgr)* Gene in F_1 Hybrids

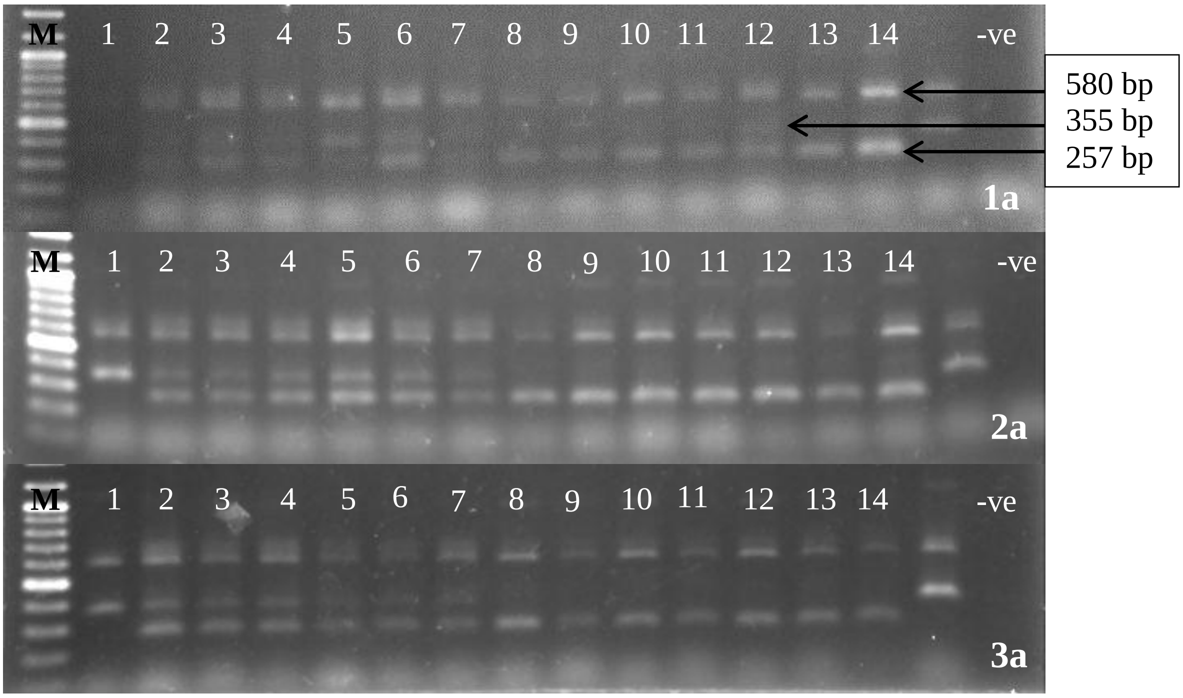
By using single tube Allele Specific Amplification PCR assay, PCR products were easily separated on an agarose gel. Four primers (ESP, EAP, INSP, IFAP) were used to identify the absence or presence of fragrance gene sequences in F_1 hybrids. A PCR product of approximately 580 bp was present in all fragrant (577 bp) and non-fragrant (585 bp) genotypes and serves as a positive control. The presence of a second PCR product of 355 bp identified as homozygous non-fragrant individuals. Whilst a second PCR product of 257 bp, identified individuals as homozygous fragrant. An individual that gives all three PCR products can be discriminated as heterozygous non-fragrant. In the present molecular screening the results are shown in figure 4.1. Of these, 38 individuals were observed as homozygous fragrant (**1, 2, 3(a):** Lane 8, 9, 10, 11, 13, 14; **2, 3(a):** Lane 12; **1, 2, 3(b)**: Lane 10, 11, 12, 13, 14; **1, 3(b):** Lane 9; **2(b):** Lane 7); 35 individuals were identified as heterozygous non-fragrant (**1, 2, 3(a):** Lane 2, 3, 4, 5, 6, 7; **1(a):** Lane 12; **1, 2, 3(b):** Lane 2, 3, 4, 6; **1(b):** Lane 5; **1, 3(b):** Lane 7; **2(b):** Lane 9) and 8 individuals were determined as homozygous non-fragrant (**1, 2, 3(a):** Lane 1; **1, 2, 3(b):** Lane 1; **2, 3(b):** Lane 5). Similar amplification pattern in fragrance (*fgr*) gene were observed in all of 3 F_1 individuals from each cross, except for F_1 hybrid MRQ 50/Entry 11 (a: Lane 12), MR 219/Rato Basmati (b: Lane 5), MR 219/Sadri (b: Lane 7) and MRQ 50/Rato Basmati (b: Lane 9) (Figure 4.1).

Table 4.1: The total F_1 seeds produced and germination rates in different crosses.

F_1 Hybirds	Total Seeds Produced	Number of Curve shaped seeds	Number of Seedlings	Germination Rates (%)		Number of Non-Curve shaped seeds	Number of Seedlings	Germination Rates (%)
MR219/GHARIB	40	20	15	75.0		20	5	25.0
MR219/E7	5	2	1	50.0		3	1	33.3
MR219/RMB	15	7	2	28.6		8	3	37.5
MR219/E13	30	22	12	54.5		8	6	75.0
MR219/RTB	35	21	12	57.1		14	2	14.3
MR219/E11	23	14	10	71.4		9	3	33.3
MR219/SADRI	47	23	20	87.0		24	12	50.0
MRQ50/RMB	7	7	3	42.9		-	-	-
MRQ50/RTB	22	15	11	73.3		7	1	14.3
MRQ50/SADRI	32	15	9	60.0		17	10	58.8
MRQ50/GHARIB	29	11	9	81.8		18	13	72.2
MRQ50/E11	43	20	20	100.0		23	23	100.0
MRQ50/E13	13	4	2	50.0		9	7	77.8
MRQ50/E7	58	26	18	69.2		32	22	68.8

(RMB= Rambir Basmati; RTB= Rato Basmati; E= Entry)

a. Curve seed



b. Non-curve seed

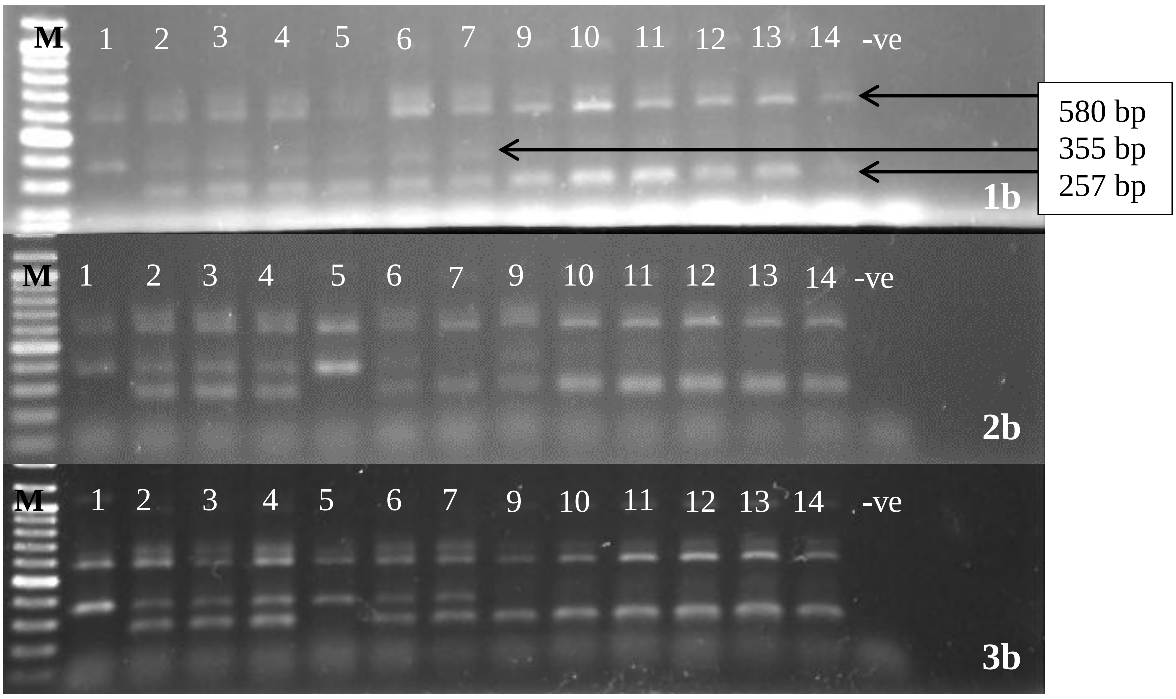


Figure 4.1: Six agarose gels showing individuals selected for fragrance analysis using single tube Allele Specific Amplification (ASA). Lanes 1-14 represent the F_1 individuals from 14 different crosses separated into curve and non-curve shaped seed with three replications (from three different seed). The band of approximately 580 bp corresponds to the positive control amplified by both external primers (ESP and EAP). The 355 bp band corresponds to a PCR product amplified from the non-fragrant allele by Internal Non-fragrant Sence Primer (INSP) and External Antisence Primer (EAP). The 257 bp band corresponds to a PCR product amplified from the fragrant allele by the

Internal Fragrant Antisence Primer (IFAP) and the External Sence Primer (ESP). –ve: Negative control (water). M: DNA ladder (100 bp, Vivantis) were used. (Lane 1-7:Gharib, Entry 7, Rambir Basmati, Entry 13, Rato Basmati, Entry 11 and Sadri crossed with MR 219 respectively; Lane 8-14: Rambir Basmati, Rato Basmati, Sadri, Gharib, Entry 11, Entry 13 and Entry 7 crossed with MRQ 50 respectively)

4.3 Aroma Evaluation in F_1 Hybrids

A total of 14 F_1 hybrids were used in aroma evaluation. They were separated into curve and non-curve shaped seeds.

4.3.1 Leaf Aromatic Test

From the leaf aromatic test, the highest mean aroma score was 3 while the lowest was 1 among F_1 hybrids. Within the curve shaped seed F_1 hybrids, five of them scored 3, nine individuals scored 2 and one of them scored 1. Within the non-curve shaped seeds F_1 hybrids, five of them scored 3 and the rest scored 2, as shown in Figure 4.2 (also see Appendix 2.1).

4.3.2 Grain Aromatic Test

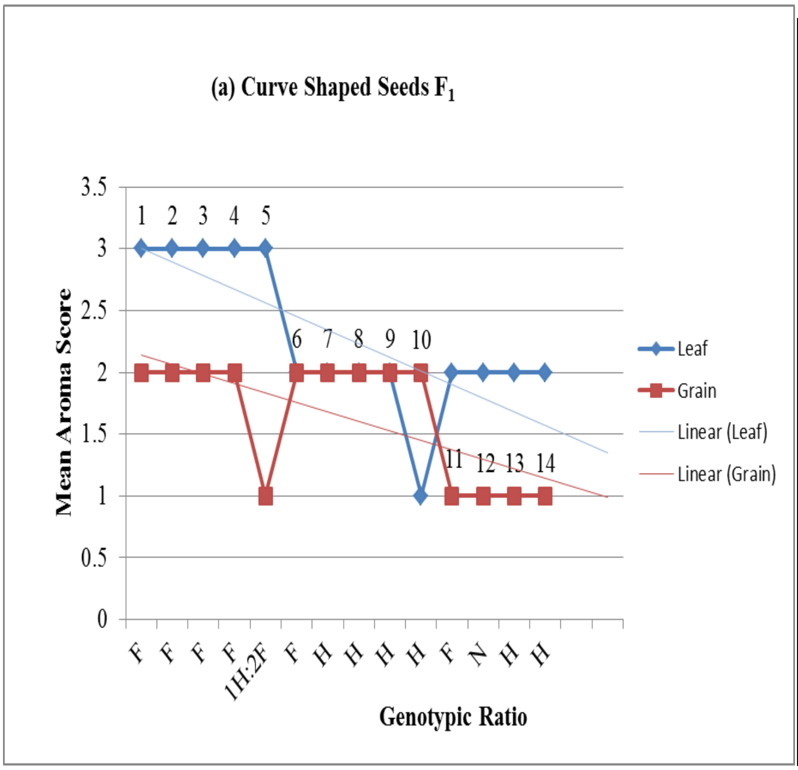
The highest scoring for grain aromatic test was 2 and the lowest was 1. F_1 hybrids from curve shaped seeds were evaluated and 9 of them perform with a score 2 and 6 of them scored 1. F_1 hybrids from non-curve seeds also were evaluated and 4 of them perform with a score of 2 and 9 of them scored 1 as shown in Figure 4.2 (also see Appendix 2.2).

4.3.3 Comparison of Mean Aroma Score from Both Methods

Comparing mean aroma scores from both methods, most of them produced a better leaf aroma score than the grain, except for the hybrids from MR 219/Rato Basmati in curve shaped seed. Most of them obtained a grain aroma score one grade lower than the leaf aroma score, except for the hybrids from MRQ 50/E 11 in curve shaped seed which was two grades lower. F_1s from MRQ 50/Gharib, MR 219/E 7, MR 219/Rambir Basmati, MR 219/Sadri in curve shaped seed and hybrids from MR 219/Rambir Basmati, MRQ 50/E 13 in non-curve shaped seed had the same aroma score in both leaf and grain. However, the trend for leaf aroma score was higher than the grain aroma score as shown in Figure 4.2.

4.4 Comparison of Genotypic and Phenotypic Aroma Analysis

From figure 4.2, genotypic analysis within F_1 hybrids, homozygous fragrant individuals were found to have a better mean aroma score in leaf and grain then both heterozygous non-fragrant individuals and homozygous non-fragrant individuals, except for F_1 from MRQ 50/E 11 (curve and non-curve), MRQ 50/Sadri (curve), MR 219/E 13 (non-curve), MR 219/Sadri (non-curve), MRQ 50/E 7 (non-curve). Through comparison of both genotypic and phenotypic characteristics of aroma in F_1 rice individuals, it was observed that aroma character from parents was successfully inherited in F_1 individuals derived from curve shaped seed compared to non-curved seeds.



1	MRQ50/E13
2	MRQ50/E7
3	MRQ50/RMB
4	MRQ50/RTB
5	MRQ50/E11
6	MRQ50/GHARIB
7	MR219/E7
8	MR219/RMB
9	MR219/SADRI
10	MR219/RTB
11	MRQ50/SADRI
12	MR219/GHARIB
13	MR219/E13
14	MR219/E11

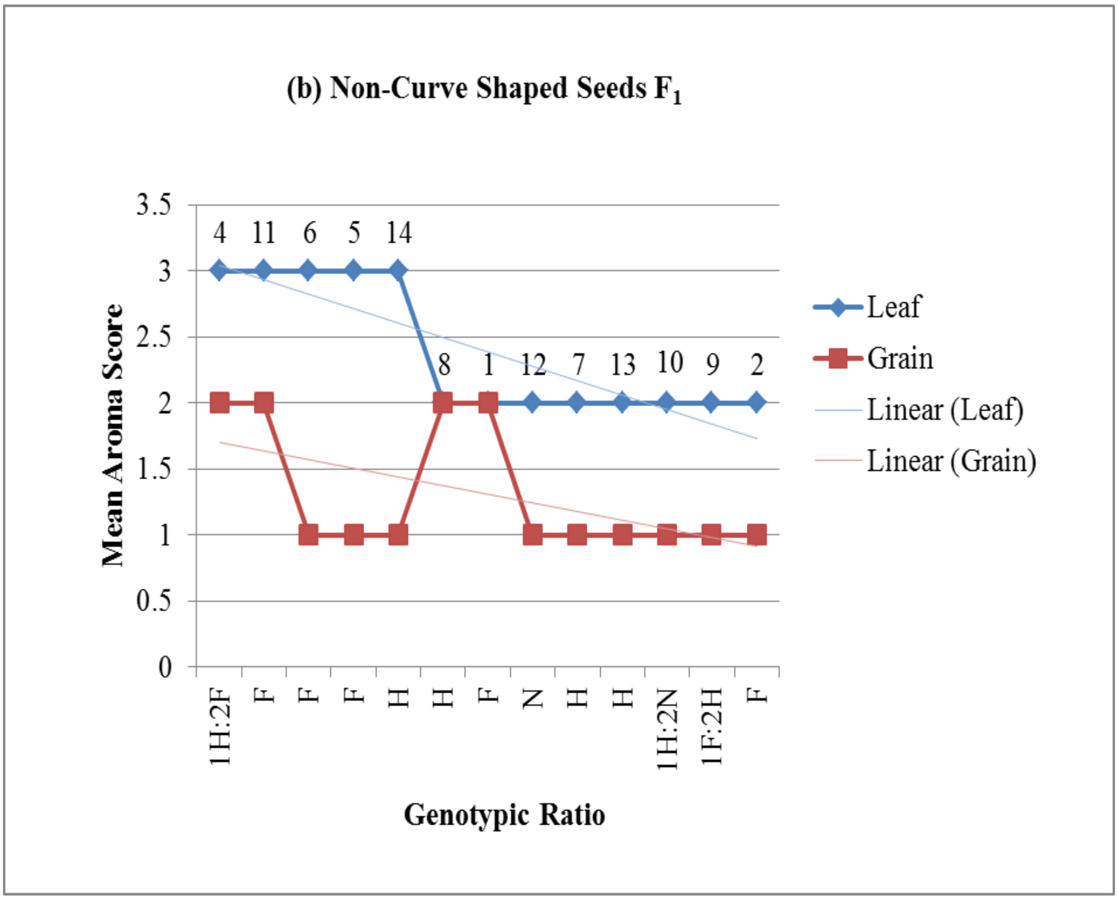


Figure 4.2: Comparison of aromatic performance for leaf and grain from F_1 hybrid rice and along with genotypic ratio for a) curve shaped seed and b) non-curve shaped seed. Mean aroma score were get from three individual plants. Linear lines were drawn for mean aroma score for leaf and grain. Genotypic ratio F, N and H represented homozygous fragrance, homozygous non-fragrance and heterozygous respectively. The

number 1 to 14 represented genotypes shown in right hand side column. (RMB=Rambir Basmati, RTB=Rato Basmati)

4.5 Agronomic and Yield Performance of Selected F_1 Hybrids

Analysis of variance (ANOVA) for yield related traits is presented in Table 4.2. Significant difference was observed in all traits among the F_1 hybrids at 1 % and 5 % level. The mean values for F_1 hybrid rice ranged from 79 to 108 days for days to heading (DH), 100 to 139 days to maturity (DM), 17 to 37 days for grain filling period (GFP), 64.0 to 102.33 cm for plant height (PH), 2.3 to 5.3 for number of tiller (NT), 1.0 to 4.3 for number of fertile tiller (NFT), 65.3 to 30.53 cm for panicle length (PL), 65.3 to 234.7 for grain per panicle (GP), 0.67 to 143.0 for fertile grain per panicle (FGP), 10.0 to 23.67 g for 1000-grain weight (TGW) and 0.05 to 9.30 g for grain yield per plant (GYP). Curve shaped seed F_1 from MRQ 50/ Sadri, MRQ 50/ E 11 and MRQ 50/ E 7 were not selected because they produced very low yield (not more than 10 F_2 seeds per plant). While, non-curve shaped seed F_1 of MR 219/ Sadri was selected because it produced high yield and better aroma.

From Table 4.2, the highest DH was in F_1 of MRQ 50/E 13 (104 days), followed by F_1 from MR 219/E 7 (102.7 days) and MRQ 50/Rambir Basmati (97 days). The lowest DH was in F_1 from MR 219/ Rato Basmati (79.3 days). The maximum DM was in F_1 of MR 219/E 7 (134 days) while the minimum was in F_1 from MR 219/ Rato Basmati (100.3 days). The highest GF was in F_1 from MRQ 50/ Gharib (37 days) while the lowest was in F_1 from MRQ 50/ Rato Basmati and MRQ 50/ E 13 (17.7 days). The highest PH was observed in F_1 of MRQ 50/ Rato Basmati (96 cm) whereas the lowest was observed in F_1 from MR 219/ E 13 (66.33 cm). Maximum NT was detected in F_1 from MRQ 50/ E 13 (5.3) while F_1 from three different crosses: MR 219/ E 7, MR 219/ Rambir Basmati and non-curve shaped MR 219/ Sadri had minimum NT (3.0). The highest NFT was found in MRQ 50/ E 13 (4.3) while the lowest was in MR 219/

Rambir Basmati (1.7). F_1 from MRQ 50/ E 13 was again found to have highest PL (28.0 cm) while the lowest was found in F_1 from MR 219/ E 13 (17.37 cm). The highest GP was also found in F_1 from MRQ 50/ E 13 (205) while the lowest was in F_1 of MRQ 50/ Gharib (74.3). F_1 of MRQ 50/ E 13 (101) was again performed highest FGP while the lowest was in F_1 from MRQ 50/ Gharib (0.67). The maximum TGW was in F_1 of MR 219/ Gharib (23.67 g) while the lowest in F_1 of MRQ 50/ Gharib (10.0 g). The highest GYP was again found in F_1 from MRQ 50/ E13 (9.30 g) while the lowest was in F_1 of MRQ 50/ Gharib (0.05 g). There are 3 F_1 scored 4 in the phenotypic acceptance (MRQ 50/ E 13, MRQ 50/ Gharib, and MR 219/ E 7). Two of the F_1 scored 3 in phenotypic acceptance (MR 219/ E 11 and MR 219/ E 13) while the rest scored 2 in phenotypic acceptance.

The comparison of grain yield/plant with aroma was shown in Figure 4.3. F_1 from MRQ 50/ E 13, MRQ 50/ Rato Basmati and MRQ 50/ Rambir Basmati showed top performance in leaf aromatic test. From these 3 F_1, MRQ 50/ E13 has the highest yield.

The comparison of yield and yield related traits such as TGW, FGP, PL and NFT are presented in Figures 4.4, 4.5, 4.6 and 4.7 respectively.

Table 4.2: Comparison of agronomic traits and grain yield performance between selected F1 hybrid rice by analysis of variance data

F_1 Hybrids	Agronomic traits and grain yield											
	DH	**DM**	**GFP**	**PH**	**NT**	**NFT**	**PL**	**GP**	**FGP**	**TGW**	**GYP**	**PAcp**
MR219/GHARIB	83.3ijk	102.3nm	19.0jkl	78.33fghij	4.3ab	4.0ab	23.47bcdefgh	110.7def	72.7bcdef	23.67a	7.26ab	2
MR219/E7	102.7b	134.0b	31.3bcd	83.67defg	3.0bc	2.3bcde	21.20fghij	137.3cdef	88.0bcd	20.67ab	3.96cdefg	4
MR219/RMB	94.0def	115.0hij	21.0hijkl	86.33bcdefg	3.0bc	1.7cde	21.10ghij	81.3def	75.0bcdef	18.67abc	1.58fghi	2
MR219/E13	91.3fg	120.0efg	28.7bcde	66.33kl	3.3bc	2.3bcde	17.37j	85.3def	49.0defgh	21.00ab	2.53efghi	3
MR219/RTB	79.3k	100.3n	21.0hijkl	75.67ghijk	4.3ab	4.0ab	26.30abcdefg	131.7def	76.0bcde	20.67ab	5.84bcd	2
MR219/E11	93.0def	111.7jk	18.7kl	75.33ghijk	3.3bc	3.3abc	21.60efghij	124.3def	92.7bcd	22.00ab	6.28bc	3
MR219/SADRI	84.7ijk	107.3l	22.7ghijk	86.33bcdefg	3.3bc	3.3abc	26.57abcde	134.7def	74.0bcdef	23.00a	5.59bcde	2
MR219/SADRI(n)	83.7ij	115.0hij	31.3bcd	80.00efghi	3.0bc	3.0abcd	24.87bcdefg	151.0bcd	88.7bcd	22.67a	5.69bcd	2
MRQ50/RMB	97.0cd	116.3ghi	19.3ijkl	83.00defgh	4.3ab	3.33abc	27.30abcd	133.0def	50.7defg	19.33ab	3.26cdefghi	2
MRQ50/RTB	96.7cd	114.3ij	17.7l	96.00abc	4.0abc	4.0ab	21.57efghij	84.7def	53.7cdef	17.67abc	3.39cdefgh	2
MRQ50/GHARIB	82.0ijk	119.0efgh	37.0a	86.00bcdefg	4.3ab	2.0cde	22.53cdefghi	74.3ef	0.67h	10.00c	0.05i	4
MRQ50/E13	104.0b	121.7def	17.7l	86.67bcdefg	5.3a	4.3a	28.00ab	205.0abc	101.0abc	22.00ab	9.30a	4
Average	91.5	117.3	25.8	81.89	3.8	2.5	23.55	121.1	52.2	19.06	2.85	
Range	**79.3-108.7**	**100.3-139.0**	**17.7-37.0**	**64.0-102.33**	**2.3-5.3**	**1.0-4.3**	**17.23-30.53**	**65.3-235.7**	**0.67-143.0**	**10.0-23.67**	**0.05-9.30**	
F test	32.49**	38.63**	13.18**	7.85**	1.98**	3.62**	4.56**	3.79**	7.03**	1.7*	7.36**	
CV%	2.41	1.99	9.56	7.32	22.2	35.69	11.23	30.58	47.73	23.41	56.63	

Means with the same letter within the same column are not statistically different.
*Significant at 5% Probability level; **Significant at 1% Probability level
DH=Days to heading; DM=Days to maturity; GFP=Grain filling period (days); PH=Plant height (cm); NT=No. of tiller; NFT=No. of fertile tiller, PL=panicle length (cm); GP=Grain/panicle; FGP=Fertile grain/panicle; TGW= thousand grain weight (g); GYP=Grain yield/plant (g); PAcp=Phenotypic Acceptance; (n) =non-curve shaped.

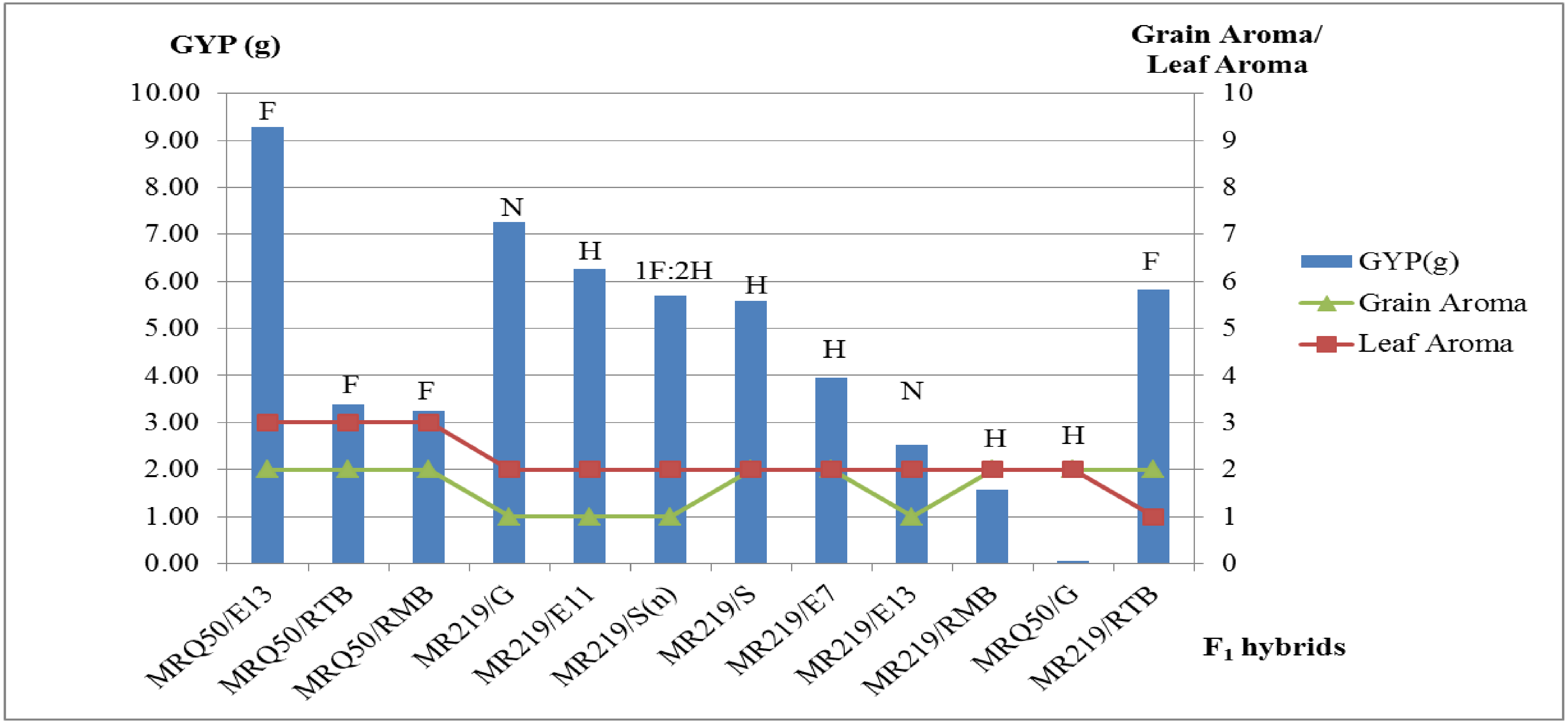


Figure 4.3: Relation between grain yield/plant (GYP) of F_1 hybrids selected with the mean aroma score (0-4) from leaf and grain. Genotypic ratio F, N and H represented homozygous fragrance, homozygous non-fragrance and heterozygous respectively. (RMB=Rambir Basmati, RTB=Rato Basmati, G=Gharib, S=Sadri, (n) =non-curve shaped).

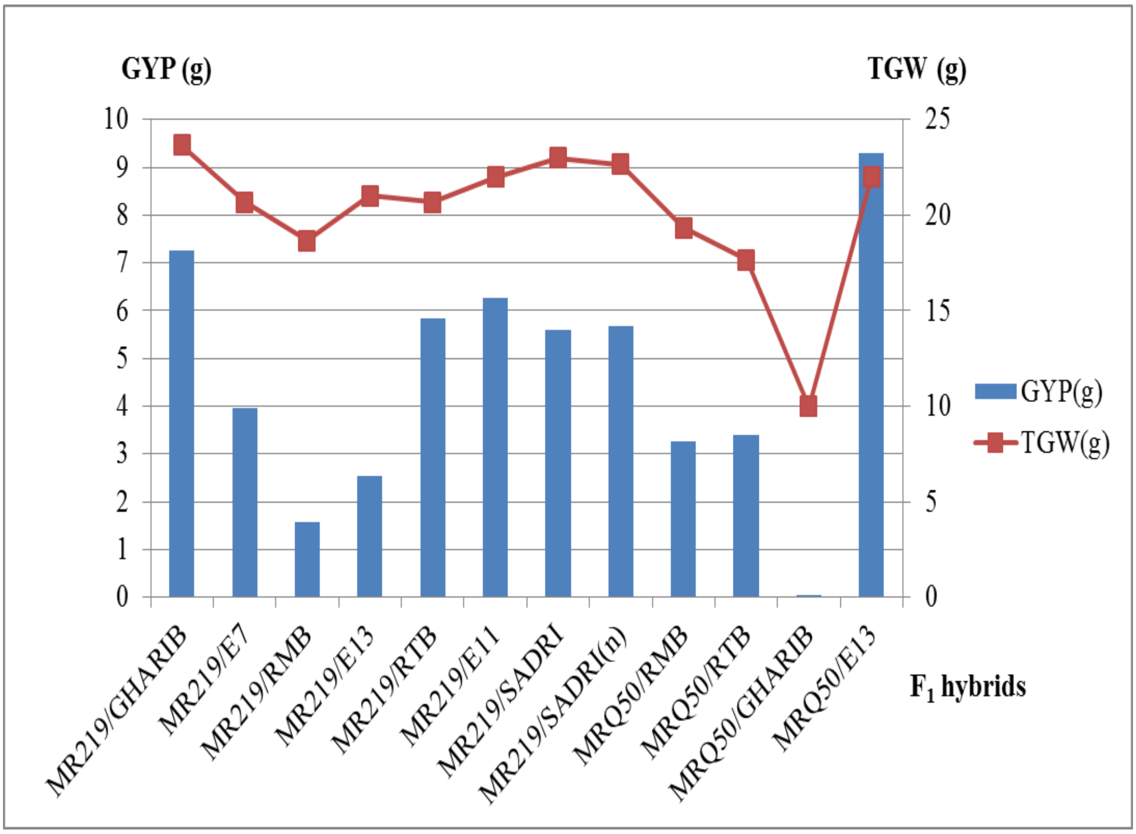


Figure 4.4: Relationship between grain yield per plant (GYP) (g) and thousand grain weight (TGW) (g) for selected F_1 hybrid rice.

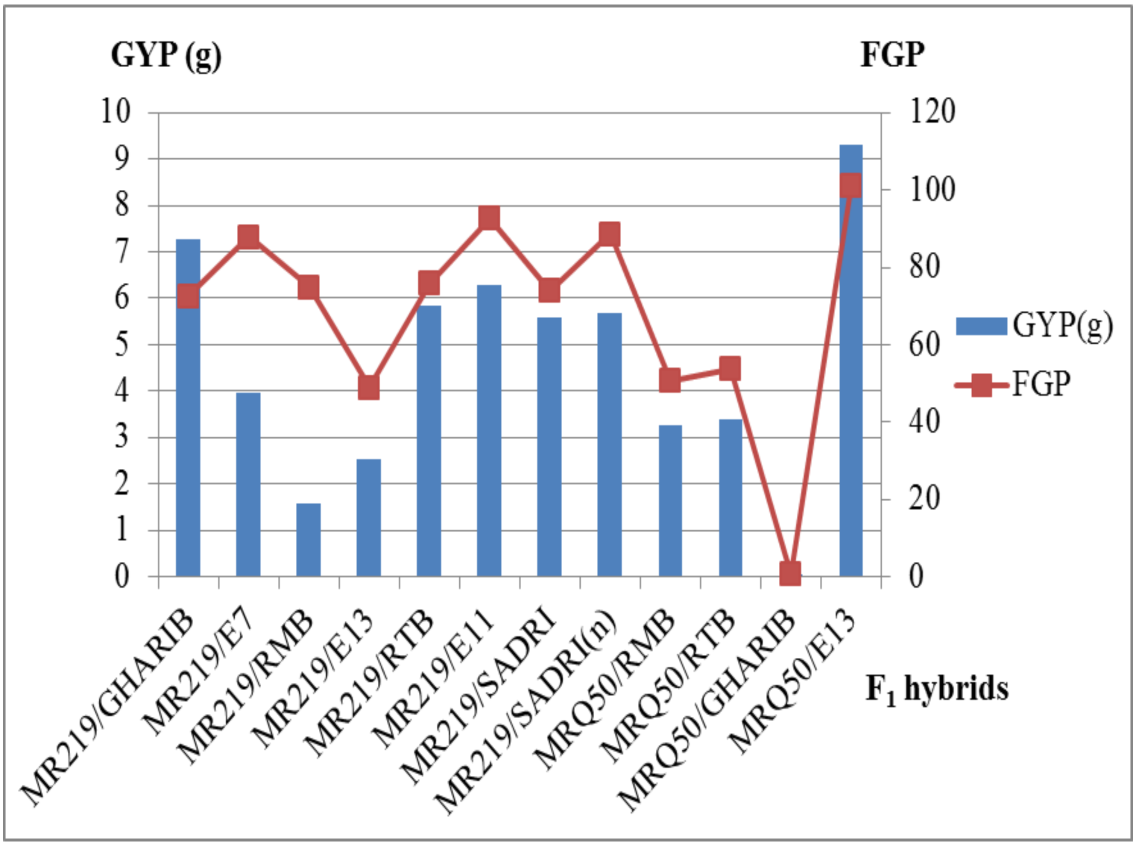


Figure 4.5: Relation between grain yield per plant (GYP) (g) and fertile grain per panicle (FGP) for selected F_1 hybrid rice.

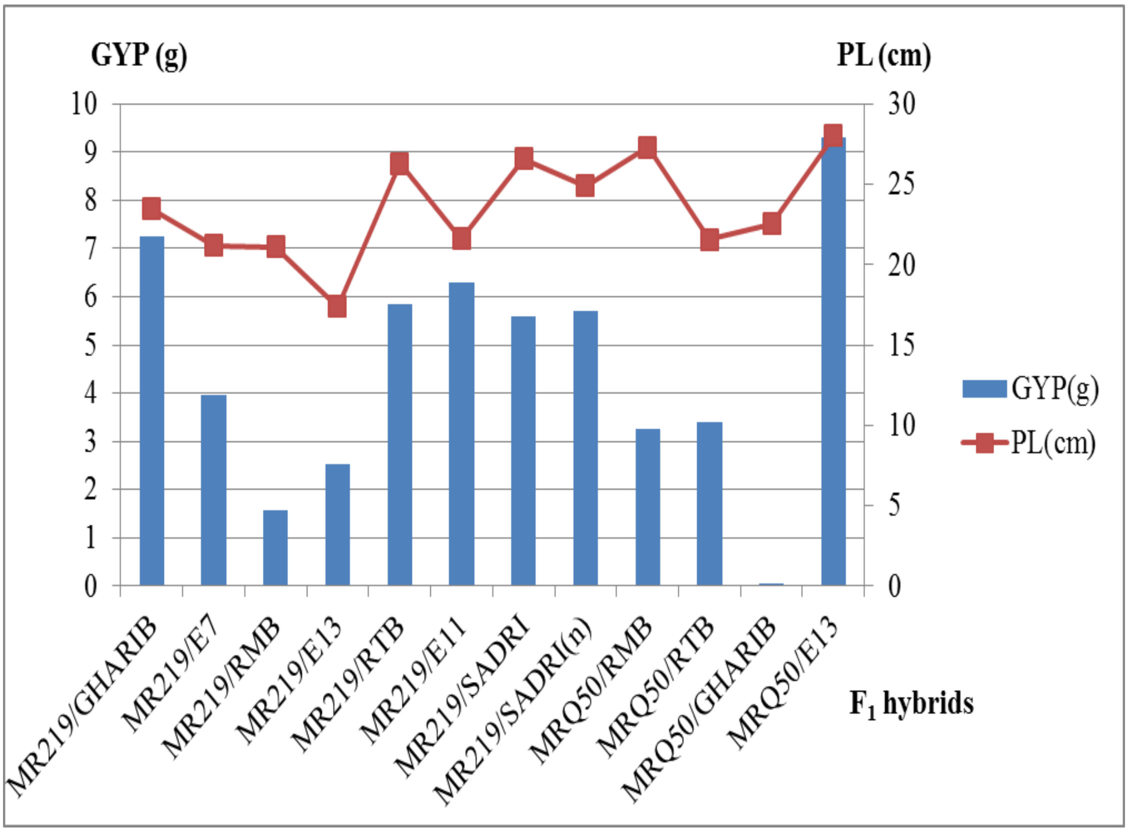


Figure 4.6: Relation between grain yield per plant (GYP) (g) and panicle length (PL) (cm) for selected F_1 hybrid rice.

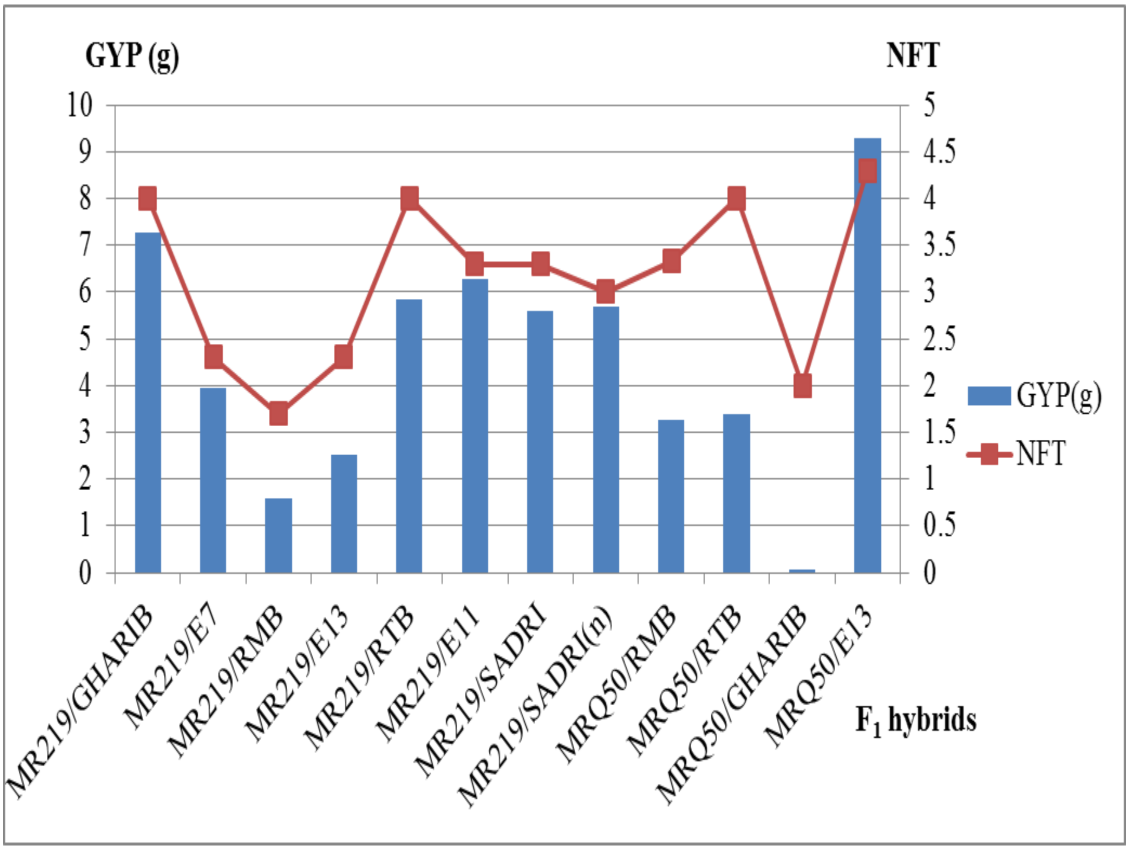


Figure 4.7: Relation between grain yield per plant (GYP) (g) and number of fertile tiller (NFT) for selected F_1 hybrid rice.

4.6 Comparison of Aroma and Yield Contributing Traits of Parental Materials along with their F_1 Hybrids

During leaf aromatic tests, most of the F_1s have the same aroma score as their female parent, except F_1 from MR 219/Rato Basmati. While comparing with the male parent, we observed 4 F_1 that have one grade lower, 4 F_1 two grade lower and 4 F_1 with the same grade as their male parent (Table 4.3).

During grain aromatic tests, most have the same aroma score as their female parent, except for 4 F_1 rice lines, which have one grade lower than their female parent. When comparing with their male parent, 3 of the F_1 have the same aroma score as their male parent, 4 of them scored one grade lower, 2 of them have two grades lower and 3 of them have three grades lower than their male parent (Table 4.3).

For molecular screening, homozygous non-aromatic female parents crossed with homozygous aromatic males produced heterozygous non-aromatic F_1, except for one MR 219/Sadri(n) produced 2 types: heterozygous non-aromatic and homozygous aromatic F_1. Homozygous non-aromatic female parents crossed with heterozygous non-aromatic male parents produced 2 different types of F_1: heterozygous non-aromatic F_1 (MR 219/E 11) and homozygous non-aromatic F_1 (MR 219/Gharib). When two homozygous aromatic parents were crossed they produced homozygous aromatic F_1 progeny. Homozygous aromatic female parents crossed with heterozygous non-aromatic male parents produced homozygous aromatic F_1 progeny (as presented in Table 4.3).

In Table 4.4, grain yield and yield contributing traits of the F_1s were compared together with their parents. The plant height of the F_1 MR 219/ E 7 performed better than both of the parents. F_1s that had plant height in between that of both their parents are MR 219/Rambir Basmati, MR 219/Sadri, MRQ 50/Rambir Basmati, MRQ 50/Rato Basmati, MRQ 50/Gharib, and MRQ 50/E 13. The other five of the F_1s have plant height lower than both of their parents. When considering the number of fertile tillers of F_1, 7 of them performed better than both of their parents (MR 219/Gharib, MR 219/Rato

Basmati, MR 219/Sadri, MR 219/Sadri(n), MRQ 50/Rambir Basmati, MRQ 50/Rato Basmati, MRQ 50/E 13). There is only MR 219/ E 11 that showed a number of fertile tillers between that of both of their parents and four had fewer than both of their parents. Most of the F_1s do not produce a better fertile grain per panicle than both of their parents, except 2 of them in between their parents (MR 219/Sadri curve and non-curve). The thousand grain weight of most of F_1 was lower than both of their parents, except 6 of them in between the parents (MR 219/Rato Basmati, MR 219/Sadri, MR 219/Sadri(n), MRQ 50/Rambir Basmati, MRQ 50/Rato Basmati and MRQ 50/E 13). The grain yield per plant was better than either parent in 4 of the F_1 (MR 219/Gharib, MR 219/Sadri, MR 219/Sadri(n), and MRQ 50/E 13). The other 3 showed grain yield per plant between that of their parents (MR 219/Rato Basmati, MR 219/E 11 and MRQ 50/Rambir Basmati).

4.7 Genetic Analysis of Agronomic and Yield Components in F_1 Hybrids

Genotypic and phenotypic variances, genotypic coefficient of variation (GCV), phenotypic coefficients of variation (PCV) and heritability of eleven agronomic traits of all F_1 hybrid rice were calculated and the results are shown in Table 4.5. GCV ranged from 7.063 to 82.587, grain yield per plant had the highest GCV followed by FGP, NFT and GP. Phenotypic coefficients of variation (PCV) ranged from 7.339 to 100.169. Phenotypic coefficients of variability were higher than genotypic coefficients of variability for all the traits. High heritability estimates were observed for DH, DM, GF, PH, PL, FGP and GYP, heritability was over 50% in all these characters.

4.8 Correlation of Agronomic Traits in F_1 Hybrids Rice

The association of grain yield per plant with other traits was estimated by correlation as shown in Table 4.6. Only three of the agronomic traits were negatively correlated with grain yield per plant (GYP). They are days to maturity (DM), grain filling period (GF) and plant height (PH). Highly positive correlation was observed between grain yield per plant (GYP) with grain per panicle (GP) and thousand grain weight (TGW) with fertile grain per panicle (FGP). Number of fertile tiller (NFT), panicle length (PL), fertile grain per panicle (FGP) and 1000-grain weight (TGW) exhibited positive direct effect on grain yield per plant (GYP). Positive correlation was also observed between days to heading (DH) with days to maturity (DM), number of tiller (NT) with number of fertile tiller (NFT) and panicle length (PL). Positive association of number of fertile tiller (NFT) with panicle length (PL) and grain per panicle (GP), panicle length (PL) with grain per panicle (GP) was also observed. There were also positive correlation between thousand grain weight (TGW) and fertile grain per panicle (FGP) with grain per panicle (GP).

Table 4.3: Differences of aroma score between parental and F_1 hybrids with their genotypic ratio.

F_1 Hybrids	Leaf Aroma			Grain Aroma			Genotypic		
	♀parent	♂parent	F_1	♀parent	♂parent	F_1	♀parent	♂parent	F_1
MR219/GHARIB	0	-1	2	0	-3	1	N	H	**N**
MR219/E7	0	-1	2	1	-1	2	N	F	**H**
MR219/RMB	0	-1	2	1	-1	2	N	F	**H**
MR219/E13	0	-1	2	0	-1	1	N	F	**H**
MR219/RTB	-1	-2	1	1	0	2	N	F	**H**
MR219/E11	0	-2	2	0	-3	1	N	H	**H**
MR219/SADRI	0	-2	2	1	-2	2	N	F	**H**
MR219/SADRI(n)	0	-2	2	0	-3	1	N	F	**1F:2H**
MRQ50/RMB	0	0	3	0	-1	2	F	F	**F**
MRQ50/RTB	0	0	3	0	0	2	F	F	**F**
MRQ50/GHARIB	0	0	2	0	-2	2	F	H	**F**
MRQ50/E13	0	0	3	0	0	2	F	F	**F**

- RMB=Rambir Basmati; RTB=Rato Basmati; (n) = non-curve shaped seed
- N= homozygous non-fragrance; H= heterozygous non-fragrance; F= homozygous fragrance
- The number represented the difference of aroma score of F_1 from parents: 0= no difference; -1= one score lower; -2= two score lower; -3= three score lower; 1= one score higher than parent.

Table 4.4: Comparison of yield contributing traits of parental materials along with their F_1 hybrids.

Genotypes	Comparison of Agronomic traits and grain yield between parental (planted Oct 2009) and F_1 (planted Dec 2010)					
	PH	**NFT**	**FGP**	**TGW**	**GYP**	**PAcp**
MR219/GHARIB	**78.33**	**4.0**	**72.7**	**23.67**	**7.26**	**2**
MR219	82.7	2.4	130.7	24.0	4.60	5
Gharib	101.7	2.7	87.0	25.3	4.54	2
MR219/E7	**83.67**	**2.3**	**88.0**	**20.67**	**3.96**	**4**
MR219	82.7	2.4	130.7	24.0	4.60	5
Entry 7	80.7	3.4	96.7	23.3	6.40	4
MR219/RMB	**86.33**	**1.7**	**75.0**	**18.67**	**1.58**	**2**
MR219	82.7	2.4	130.7	24.0	4.60	5
Rambir Basmati	105.7	2.0	123.0	20.0	1.86	3
MR219/E13	**66.33**	**2.3**	**49.0**	**21.00**	**2.53**	**3**
MR219	82.7	2.4	130.7	24.0	4.60	5
Entry 13	90.3	2.9	124.3	26.7	8.34	4
MR219/RTB	**75.67**	**4.0**	**76.0**	**20.67**	**5.84**	**2**
MR219	82.7	2.4	130.7	24.0	4.60	5
Rato Basmati	109.3	3.9	112.7	19.3	6.60	4
MR219/E11	**75.33**	**3.3**	**92.7**	**22.00**	**6.28**	**3**
MR219	82.7	2.4	130.7	24.0	4.60	5
Entry 11	80.0	3.5	105.0	24.7	7.26	4

Table 4.4 (Continued): Comparison of yield contributing traits of parental materials along with their F_1 hybrids.

Genotypes	Comparison of Agronomic traits and grain yield between parental (planted Oct 2009) and F_1 (planted Dec 2010)					
	PH	**NFT**	**FGP**	**TGW**	**GYP**	**PAcp**
MR219/SADRI	**86.33**	**3.3**	**74.0**	**23.00**	**5.59**	**2**
MR219	82.7	2.4	130.7	24.0	4.60	5
Sadri	104.3	1.8	33.3	22.0	2.60	2
MR219/SADRI(n)	**80.00**	**3.0**	**88.7**	**22.67**	**5.69**	**2**
MR219	82.7	2.4	130.7	24.0	4.60	5
Sadri	104.3	1.8	33.3	22.0	2.60	2
MRQ50/RMB	**83.00**	**3.3**	**50.7**	**19.33**	**3.26**	**2**
MRQ50	76.3	2.0	125.7	15.3	4.80	4
Rambir Basmati	105.7	2.0	123.0	20.0	1.86	3
MRQ50/RTB	**96.00**	**4.0**	**53.7**	**17.67**	**3.39**	**2**
MRQ50	76.3	2.0	125.7	15.3	4.80	4
Rato Basmati	109.3	3.9	112.7	19.3	6.60	4
MRQ50/GHARIB	**86.00**	**2.0**	**0.7**	**10.00**	**0.05**	**4**
MRQ50	76.3	2.0	125.7	15.3	4.80	4
Gharib	101.7	2.7	87.0	25.3	4.54	2
MRQ50/E13	**86.67**	**4.3**	**101.0**	**22.00**	**9.30**	**4**
MRQ50	76.3	2.0	125.7	15.3	4.80	4
Entry 13	90.3	2.9	124.3	26.7	8.34	4

Table 4.5: Heritability and coefficients of variability estimated for grain yield component in F_1 hybrids rice.

Traits	Error Variance	Genetic Variance	Phenotypic Variance	Genetic Advance (Gs)	GCV	PCV	Heritability(H)
DH	4.89	51.28	56.17	105.296	7.826	8.191	0.91
DM	5.47	68.63	74.10	141.960	7.063	7.339	0.93
GF	6.08	24.68	30.76	50.692	19.255	21.497	0.80
PH	35.98	82.2	118.18	170.415	11.071	13.275	0.70
NT	0.72	0.24	0.96	0.494	12.892	25.784	0.25
NFT	0.81	0.71	1.52	1.471	33.705	49.315	0.47
PL	6.99	8.31	15.30	17.019	12.241	16.609	0.54
GP	1371.44	1277.55	2648.99	2619.321	29.515	42.501	0.48
FGP	620.25	1247.05	1867.30	2577.247	67.651	82.782	0.67
TGW	19.89	4.66	24.55	9.608	11.326	25.996	0.19
GYP	2.61	5.54	8.15	11.416	82.587	100.169	0.68

GCV: Genetic coefficient of variability, PCV: Phenotypic coefficient of variability.

Table 4.6: Correlation between agronomic traits of F_1 hybrids rice.

Traits	DH	DM	GF	PH	NT	NFT	PL	GP	FGP	TGW	GYP
DH	1.000										
DM	0.740*	1.000									
GF	-0.282^{nc}	0.436^{nc}	1.000								
PH	0.121^{nc}	0.021^{nc}	-0.129^{nc}	1.000							
NT	0.138^{nc}	-0.123^{nc}	-0.361^{nc}	0.108^{nc}	1.000						
NFT	0.122^{nc}	-0.348^{nc}	-0.659^{nc}	-0.038^{nc}	0.648*	1.000					
PL	-0.062^{nc}	-0.296^{nc}	-0.339^{nc}	0.263^{nc}	0.554*	0.573*	1.000				
GP	0.344^{nc}	0.139^{nc}	-0.263^{nc}	-0.035^{nc}	0.367^{nc}	0.549*	0.711*	1.000			
FGP	0.307^{nc}	-0.036^{nc}	-0.463^{nc}	-0.075^{nc}	-0.154^{nc}	0.353^{nc}	0.264^{nc}	0.693*	1.000		
TGW	-0.002^{nc}	-0.314^{nc}	-0.446^{nc}	-0.187^{nc}	-0.218^{nc}	0.321^{nc}	0.194^{nc}	0.500*	0.814**	1.000	
GYP	0.152^{nc}	-0.232^{nc}	-0.535^{nc}	-0.171^{nc}	0.382^{nc}	0.786*	0.540*	0.815**	0.761*	0.683*	1.000

*= positive correlation, **=highly positive correlation, ^{nc} = no correlation

DH=Days to heading; DM=Days to maturity; GFP=Grain filling period (days); PH=Plant height (cm); NT=No. of tiller; NFT=No. of fertile tiller, PL=panicle length (cm); GP=Grain/panicle; FGP=Fertile grain/panicle; TGW= thousand grain weight (g); GYP=Grain yield/plant (g)