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Genetics of Quality and Yield Traits using Aromatic and Non Aromatic Genotypes through Generation Mean Analysis in Rice (*Oryza sativa* L.)

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A B S T R A C T

Generation mean analysis was carried out with 5 generations (P_1, P_2, F_1, F_2, and F_3) crossing 5 aromatic and 3 non-aromatic genotypes of rice for prime kernel quality characteristics and grain yield per plant. Besides main genetic effects (d and h), interaction effects (i and l) were also highly significant for quality traits, indicating the importance of epistasis exploitation in breeding for quality rices. Four crosses registered kernel length of more than 6.0 mm, two crosses (Improved Pusa Basmati x Basmati 370 and Sumathi x Improved Pusa Basmati) among these were identified as top ranking ones, as the genetic effects (d and i) were significant in desirable side. For kernel shape (L/B ratio), the genetic effects (d and i) were negative direction, epistasis was of duplicate nature, which indicated adoption of special breeding method for improvement. For overall quality improvement, Sumathi x Improved Pusa Basmati and Improved Pusa Basmati x Basmati 370 and for quality and yield NLR 145 x Sumathi, Akshyadhan x Pusa 1121 combinations were recommended for advancement. The main genetic and epistatic effects changed with change of cross and differed depending on quality trait in rice.

Introduction

In rice research, grain quality was initially over shadowed by the need for higher yields and greater pest-resistance. Food self-sufficiency for an expanding population was, necessarily, the primary goal. However, as many traditional rice importing countries achieved self-sufficiency, real rice prices declined in many Asian countries and in the world market over the last two decades and grain quality played an important role in fetching better market price. This renewed interest in grain quality in international and national research programmes. Although, aroma is an important quality characteristic in local requirements and trade, much progress in development of aromatic varieties has not been made so far, especially in Telangana State.

The small and medium-grained scented rices which are mostly grown for home consumption, while the long-grained basmati types constitute the bulk of the rice export from India. Some of the locally adapted and consumed small and medium grained scented rice cultivars possess excellent aroma, but are poor yielders. These could be used as excellent source of germplasm for improving quality in high yielding varieties. What is required, now, in Telangana state is to adopt proper breeding method to enhance the process of development high yielding, high quality short and long grained aromatic rice varieties. This background clearly necessitates studies on genetics of yield and quality traits involving aromatic short and long grained types. The present investigation is an attempt to know the genetics of grain characters and to develop aromatic high yielding rice varieties with exceptional quality possessed by Basmati rices in India.

Materials and Methods

The experimental material comprising of 5 generations (P_1, P_2, F_1, F_2, and F_3) was generated involving 4 Basmati varieties (Pusa 1121, Improved Pusa Basmati, Basmati 370 and Sumathi) and one non-basmati type aromatic variety (RNR 2354) as male parent and 3 non-basmati, high yielding varieties (BPT 5204, Akshyadhan and NLR 145) as female parents (Table 1). Basmati varieties were included in the crossing programme keeping in view the unique cooking qualities like highest elongation ratio and aroma. Among the female parents, BPT 5204 is well known for best cooking quality as on today after GEB 24 and commanding high premium in the market and the other two (NLR 145 and Akshyadhan) have high level of blast resistance. Parents and F_1s were planted in one row each, whereas F_2 and F_3 material was planted in 12 rows each replicating thrice in a Randomized Block Design during the post rainy season 2012-13. Observations were recorded on 10 competitive plants in case of P_1, P_2 and F_1's and 50 for F_2 and F_3 in each replication. Standard equipment of Satake make was used for milling and polishing (10 %) purposes and the data were generated as per the standard methods of Murthy and Govindaswamy (1967), Verghese (1950) and Murthy (1965). In addition to the scaling tests (C and D) of Mather (1949), joint scaling test as suggested by Calli (1952) was performed to test the validity of additive – dominance model using the mean values of 5 generations for 7 quality characteristics and grain yield per plant. In the event of presence of epistasis, perfect fit solution of 5 parameter was adopted to estimate the possible m, d, h, i and l components assuming digenic interactions as described by Hayman (1958).

Results and Discussion

An examination of the components with respect to head rice recovery revealed that, the estimates of 'm' were highly significant in all the crosses, while the highest quantum was noticed in the cross, Sumathi x Improved Pusa Basmati (Table 2). Poor recovery was registered in case of one cross, Akshyadhan x Pusa 1121. Both additive (d) and dominance (h) genetic effects were prevalent in both positive and negative sides. Additive and additive type (i) of epistasis which is most desirable was noticed in highest magnitudes in case of BPT 5204 x Pusa 1121 combination. Incidentally, 'd' was also positive and significant in this cross. In view of same results, breeding strategy to make use of both additive and dominance gene effects in effective manner was emphasized by Sreedhar *et al.*, (2005) to improve head rice recovery in rice.

Since long grained rice with good cooking qualities fetches high price in the market, breeders pay special attention for improvement of this trait by involving specific parents and adopting effective breeding procedures. Accordingly, in the present study, four crosses registered highly significant values of 'm' (> 6.00 mm) for kernel length and among them two crosses *viz.,* Sumathi x Improved Pusa Basmati and Improved Pusa Basmati x Basmati 370 were considered as top ranking ones due to preponderance of 'd' and 'i' effects in desirable direction.

In such crosses enhancement of kernel length is simple and straight forward through selections in early segregating generations itself. Interestingly, lower estimates of kernel breadth coupled with desirable side main genetic effects (d and h) and interaction effects (i) were observed in one of the two crosses mentioned *viz.,* Improved Pusa Basmati x Basmati 370. In addition, selections in crosses with BPT 5204 as female parent is also advisable due to presence of significant positive 'd' and 'i' effects for slenderness.

Kernel length / breadth ratio is the prime parameter in the national and international trade. A ratio of 3.0 and above is considered as slender. Four crosses registered higher mean values (> 3.70) while, the highest kernel length / breadth ratio was registered in the cross, Improved Pusa Basmati x Basmati 370. For this trait, the additive (d) and additive x additive (i) genetic effects were highly significant, but in negative side.

The components of 'h' and 'l' were significant in most of the crosses, but it was of unuseful duplicate nature (+ and -). However in one cross (BPT 5204 x Sumathi), the interaction was of complementary type (+ and +). Of the 10 crosses, one combination, Improved Pusa Basmati x Basmati 370 was regarded as top raking one, on the basis of preponderance of positive 'd' and 'i' genetic effects in association with high *per se* performance in F_2 which offers better scope for making pure lines through pedigree method in a quick process. Whereas for another promising cross (Sumathi x Improved Pusa Basmati), inter-mating in early generations to pool up plus genes followed by selection would be more profitable, on account of significance of both 'h' (non-fixable) and 'i' (fixable) components in desirable side. Mohan and Ganeshan (2003) reported significant main effects and interaction effects (except 'l') in negative direction, which is in accordance with present findings. Overall results revealed that, kernel shape was controlled equally by interaction effects and the pulling is towards negative undesirable side, the scope for improvement is very much limited especially for kernel length and kernel length/breadth ratio.

Mahalingam and Nadarajan (2010) reported negative 'd' effects and duplicate epistasis for kernel length after cooking as was observed in the present investigation. Among the crosses evaluated, Improved Pusa Basmati x Basmati 370 was found to be highly promising in view of registering 'm', 'd' and 'i' in higher magnitudes. In four crosses, 'h' and 'l' were significant indicating predominant role of complementary (+, +) type of interaction.

In addition to Improved Pusa Basmati x Basmati 370, the cross which recorded highest *per se* performance for the trait *viz.,* BPT 5204 x Pusa 1121 was considered as highly useful for simultaneous exploitation. Magnitudes of 'l' type of genetic effects were very high in comparison to others, thus certain crosses in which 'h' effects were also in appreciable levels could be profitably advanced after inter-mating among the selected genotypes in early segregating generations and breaking tight linkages.

For kernel elongation ratio, two promising cross combinations *viz.,* BPT 5204 x Akshyadhan and BPT 5204 x Pusa 1121 were identified for further use. In these specific crosses, apart from high mean performance, highly significant gene actions ('d', 'h' and 'i') were observed in the required direction.

Table.2 Genetic components of generation mean for yield and yield contributing characters

Cross	Scaling tests			Components				
	C	**D**	**χ^2 value of JST (3 parameter) at 2 d.f**	**m**	**d**	**h**	**i**	**l**
Kernel length								
BPT 5204 x Akshyadhan	0.12*± 0.07	0.64**± 0.09	54.53**	5.23**± 0.00	-0.33**± 0.03	-0.24**± 0.05	-1.06**± 0.07	0.69**± 0.10
BPT 5204 x Pusa 1121	-1.05**± 0.06	-2.25**± 0.07	1818.43**	5.76**± 0.00	-1.29**± 0.03	1.22**± 0.02	-1.25**± 0.06	-1.60**± 0.04
BPT 5204 x Sumathi	-3.38**± 0.08	-0.81**± 0.14	1723.82**	5.60**± 0.01	-1.04**± 0.03	1.22**± 0.09	-2.09**± 0.09	3.43**± 0.21
Akshyadhan x NLR 145	0.16± 0.10NS	0.82**± 0.09	98.46**	5.72**± 0.01	-1.02**± 0.03	-0.62**± 0.04	-2.56**± 0.08	0.88**± 0.14
Akshyadhan x Pusa 1121	-0.97**± 0.08	-0.10± 0.17NS	164.19**	6.27**± 0.00	-0.96**± 0.02	0.13± 0.11NS	-2.02**± 0.09	1.16**± 0.24
NLR 145 x Sumathi	-0.56**± 0.08	-1.60**± 0.06	1006.53**	6.20**± 0.02	-0.63**± 0.02	1.19**± 0.04	-0.29**± 0.06	-1.39**± 0.15
RNR 2354 x I.P Basmati	-2.04**± 0.06	-1.19**± 0.09	1432.27**	5.79**± 0.00	-0.58**± 0.03	0.54**± 0.04	-0.70**± 0.05	1.14**± 0.09
RNR 2354 x Basmati 370	-3.31**± 0.08	0.19± 0.13NS	1800.91**	5.22**± 0.01	-0.54**± 0.03	-1.03**± 0.09	-1.76**± 0.08	4.67**± 0.20
Sumathi x I.P Basmati	-0.94**± 0.06	-2.63**± 0.05	2869.70**	6.49**± 0.01	0.97**± 0.02	0.59**± 0.02	1.62**± 0.03	-2.25**± 0.08
I.P Basmati x Basmati	-1.69**± 0.07	-1.79**± 0.16	654.88**	6.16**± 0.01	0.52**± 0.03	0.49**± 0.10	0.98**± 0.09	-0.13± 0.20NS
Kernel breadth								
BPT 5204 x Akshyadhan	**0.04*± 0.02**	**-0.04**± 0.01**	**20.576****	**1.67**± 0.00**	**-0.05**± 0.00**	**0.18**± 0.01**	**-0.06**± 0.01**	**-0.11**± 0.03**
BPT 5204 x Pusa 1121	-0.48**± 0.01	-0.18**± 0.02	4321.233**	1.60**± 0.00	-0.09**± 0.00	0.22**± 0.01	-0.14**± 0.01	0.40**± 0.02
BPT 5204 x Sumathi	-0.21**± 0.01	-0.01± 0.01NS	477.581**	1.60**± 0.00	-0.04**± 0.00	0.13**± 0.00	-0.10**± 0.01	0.27**± 0.01
Akshyadhan x NLR 145	-0.99**± 0.05	-1.71**± 0.03	12771.870**	1.78**± 0.01	0.10**± 0.01	1.44**± 0.02	1.17**± 0.03	-0.96**± 0.09
Akshyadhan x Pusa 1121	-0.01± 0.01NS	0.27**± 0.01	835.523**	1.70**± 0.00	-0.05**± 0.00	-0.13**± 0.01	-0.27**± 0.01	0.37**± 0.02
NLR 145 x Sumathi	0.16**± 0.02	0.36**± 0.06	117.681**	1.70**± 0.00	0.09**± 0.01	-0.29**± 0.04	-0.03**± 0.03	0.27**± 0.08
RNR 2354 x I.P Basmati	0.33**± 0.03	-0.71**± 0.02	1795.696**	1.70**± 0.01	0.09**± 0.00	0.41**± 0.02	0.70**± 0.02	-1.39**± 0.06
RNR 2354 x Basmati 370	-0.49**± 0.01	-0.63**± 0.01	3119.239**	1.60**± 0.00	-0.04**± 0.01	0.19**± 0.00	0.27**± 0.01	-0.19**± 0.01
Sumathi x I.P Basmati	0.53**± 0.02	0.14**± 0.02	1254.289**	1.63**± 0.00	0.01**± 0.00	0.06**± 0.01	0.02**± 0.01	-0.53**± 0.04
I.P Basmati x Basmati	-0.51**± 0.02	-0.27**± 0.01	989.967**	1.53**± 0.00	-0.12**± 0.01	-0.01± 0.01NS	-0.15**± 0.01	0.32**± 0.03
Kernel L/B ratio								
BPT 5204 x Akshyadhan	**0.01± 0.04NS**	**0.48**± 0.06**	**80.13****	**3.14**± 0.01**	**-0.12**± 0.02**	**-0.47**± 0.03**	**-0.55**± 0.04**	**0.63**± 0.08**
BPT 5204 x Pusa 1121	0.23**± 0.03	-0.83**± 0.06	401.85**	3.56**± 0.00	-0.60**± 0.02	0.19**± 0.04	-0.61**± 0.04	-1.41**± 0.08
BPT 5204 x Sumathi	-1.34**± 0.05	-0.57**± 0.09	741.85**	3.22**± 0.01	-0.58**± 0.02	0.58**± 0.06	-1.01**± 0.06	1.02**± 0.13
Akshyadhan x NLR 145	0.65**± 0.08	0.98**± 0.07	213.59**	3.73**± 0.01	-0.60**± 0.03	-0.81**± 0.04	-1.74**± 0.06	0.44**± 0.12
Akshyadhan x Pusa 1121	-0.58**± 0.02	-0.58**± 0.11	774.22**	3.68**± 0.00	-0.48**± 0.00	0.31**± 0.07	-0.68**± 0.05	0.001± 0.15NS
NLR 145 x Sumathi	-0.49**± 0.06	-1.64**± 0.14	234.03**	3.73**± 0.01	-0.57**± 0.01	1.31**± 0.10	-0.12**± 0.07	-1.53**± 0.21
RNR 2354 x I.P Basmati	-1.88**± 0.07	0.73**± 0.08	855.30**	3.46**± 0.01	-0.53**± 0.02	-0.46**± 0.05	-1.86**± 0.05	3.48**± 0.13
RNR 2354 x Basmati 370	-1.05**± 0.07	1.52**± 0.09	607.10**	3.25**± 0.01	-0.23**± 0.02	-1.09**± 0.05	-1.66**± 0.05	3.43**± 0.14
Sumathi x I.P Basmati	-1.69**± 0.07	-1.95**± 0.06	1391.29**	3.99**± 0.01	-0.02± 0.02NS	0.23**± 0.03	0.98**± 0.04	-0.35**± 0.09
I.P Basmati x Basmati	0.03± 0.09NS	-0.51**± 0.11	-	4.01**± 0.01	0.30**± 0.03	0.34**± 0.07	0.94**± 0.08	-0.71**± 0.16

Table.2 Cont.,

Cross	Scaling tests			Components				
	C	D	χ^2 value of JST (3 parameter) at 2 d.f	m	d	h	i	l
Kernel length after cooking								
BPT 5204 x Akshyadhan	2.60**± 0.11	-3.17**± 0.13	1049.12**	8.85**± 0.02	-	1.34**± 0.09	2.54**± 0.09	-7.69**± 0.24
BPT 5204 x Pusa 1121	11.68**± 0.09	-6.87**± 0.15	23932.26**	11.87**± 0.01	-0.70**± 0.03	5.43**± 0.09	5.13**± 0.09	-24.74**± 0.20
BPT 5204 x Sumathi	-2.29**± 0.13	-3.35**± 0.11	1130.79**	8.98**± 0.00	-0.90**± 0.03	1.55**± 0.07	0.05± 0.08NS	-1.41**± 0.20
Akshyadhan x NLR 145	-10.09**± 0.12	-1.75**± 0.27	7453.83**	8.58**± 0.02	-0.30**± 0.02	3.49**± 0.19	-1.11**± 0.14	11.12**± 0.40
Akshyadhan x Pusa 1121	-0.69**± 0.08	2.45**± 0.54	93.29**	9.88**± 0.01	-0.70**± 0.03	-0.65± 0.36NS	-3.15**± 0.26	4.19**± 0.72
NLR 145 x Sumathi	-4.69**± 0.18	-1.25**± 0.11	1748.24**	8.63**± 0.04	-0.60**± 0.02	-0.35**± 0.10	-1.15**± 0.12	4.59**± 0.35
RNR 2354 x I.P Basmati	-8.50**± 0.10	-4.33**± 0.14	9161.98**	9.35**± 0.02	-2.25**± 0.02	0.92**± 0.10	-3.03**± 0.08	5.56**± 0.24
RNR 2354 x Basmati 370	-7.50**± 0.15	-0.40*± 0.15	2409.63**	8.65**± 0.00	-0.45**± 0.01	0.17**± 0.11	-1.88**± 0.09	9.47**± 0.29
Sumathi x I.P Basmati	-14.00**± 0.09	-3.67**± 0.12	24047.42**	9.58**± 0.01	-1.70**± 0.02	0.51**± 0.08	-3.29**± 0.07	13.78**± 0.19
I.P Basmati x Basmati	-5.09**± 0.13	-2.02**± 0.32	1603.97**	10.08**± 0.03	1.80**± 0.02	-1.20**± 0.22	4.10**± 0.17	4.10**± 0.49
Kernel elongation ratio								
BPT 5204 x Akshyadhan	**0.42**± 0.04**	**-0.86**± 0.03**	-	**1.69**± 0.00**	**0.12**± 0.02**	**0.35**± 0.01**	**0.87**± 0.04**	**-1.71**± 0.03**
BPT 5204 x Pusa 1121	2.19**± 0.04	-0.70**± 0.04	16255.11**	2.06**± 0.00	0.23**± 0.02	0.62**± 0.01	1.30**± 0.04	-3.86**± 0.03
BPT 5204 x Sumathi	0.35**± 0.04	-0.47**± 0.04	544.00**	1.60**± 0.00	0.15**± 0.02	0.01± 0.02NS	0.68**± 0.04	-1.09**± 0.05
Akshyadhan x NLR 145	1.57**± -0.02	0.30**± -0.02	-	1.50**± 0.00	0.03**± -0.01	-0.42**± 0.00	0.12**± -0.02	-1.70**± 0.00
Akshyadhan x Pusa 1121	0.08**± 0.02	0.38**± 0.05	59.29**	1.57**± 0.00	0.12**± 0.01	-0.14**± 0.03	0.01± 0.03NS	0.39**± 0.06
NLR 145 x Sumathi	-0.65**± 0.02	-0.01± 0.01NS	-	1.39**± 0.00	0.07**± 0.00	-0.23**± 0.01	0.03**± 0.01	0.85**± 0.03
RNR 2354 x I.P Basmati	-0.79**± 0.02	-0.29**± 0.05	1283.00**	1.62**± 0.00	-0.19**± 0.01	-0.03± 0.03NS	-0.31**± 0.03	0.67**± 0.07
RNR 2354 x Basmati 370	-0.36**± 0.03	-0.14**± 0.02	197.62**	1.66**± 0.01	0.07**± 0.01	0.31**± 0.01	0.17**± 0.02	0.29**± 0.04
Sumathi x I.P Basmati	-2.05**± 0.02	0.12**± 0.02	12014.30**	1.47**± 0.00	-0.25**± 0.01	-0.05**± 0.01	-0.93**± 0.01	2.90**± 0.03
I.P Basmati x Basmati	-0.35**± 0.02	0.20**± 0.02	403.97**	1.64**± 0.00	0.26**± 0.01	-0.34**± 0.01	0.32**± 0.02	0.73**± 0.04
Head rice recovery								
BPT 5204 x Akshyadhan	**-44.33**± 0.43**	**-19.00**± 0.43**	**11130.50****	**50.67**± 0.07**	**-2.17**± 0.14**	**-0.89**± 0.25**	**0.94**± 0.36**	**33.78**± 0.73**
BPT 5204 x Pusa 1121	-9.47**± 1.18	20.07**± 1.53	230.25**	47.30**± 0.11	10.00**± 0.12	-20.96**± 1.08	5.04**± 0.90	39.38**± 2.61
BPT 5204 x Sumathi	4.20**± 0.34	1.73**± 1.23	155.77**	53.30**± 0.02	4.83**± 0.14	-11.62**± 0.80	9.21**± 0.63	-3.29*± 1.62
Akshyadhan x NLR 145	-67.20**± 1.03	-13.40**± 1.28	4877.96**	44.70**± 0.20	5.00**± 0.11	-3.27**± 0.92	7.73**± 0.80	71.73**± 2.40
Akshyadhan x Pusa 1121	-100.73**± 0.45	48.87**± 0.93	52640.44**	26.73**± 0.07	12.17**± 0.09	-55.20**± 0.62	-25.03**± 0.50	199.47**± 1.38
NLR 145 x Sumathi	-17.20**± 0.71	-3.40**± 0.40	660.80**	52.70**± 0.07	2.00**± 0.11	3.40**± 0.32	3.40**± 0.37	18.40**± 1.08
RNR 2354 x I.P Basmati	-12.93**± 1.08	-19.53**± 0.82	593.36**	48.77**± 0.05	-4.00**± 0.27	0.87**± 0.51	2.87**± 0.61	-8.80**± 1.51
RNR 2354 x Basmati 370	-22.60**± 1.40	-64.87**± 1.42	3359.90**	44.60**± 0.33	-6.83**± 0.19	20.31**± 1.04	25.81**± 1.06	-56.36**± 3.13
Sumathi x I.P Basmati	18.80**± 3.79	-41.40**± 2.13	815.63**	57.70**± 0.94	-4.00**± 0.24	22.73**± 1.97	22.73**± 2.35	-80.27**± 7.60
I.P Basmati x Basmati	-50.60**± 1.22	-16.87**± 0.72	2428.45**	42.60**± 0.20	-2.83**± 0.26	-14.36**± 0.52	-2.86**± 0.78	44.98**± 1.94

Table.2 Cont.,

Cross	Scaling tests			Components				
	C	D	χ^2 value of JST (3 parameter) at 2 d.f	m	d	h	i	l
Grain yield/ plant								
BPT 5204 x Akshyadhan	**-42.38**± 0.57**	**4.27**± 0.15**	**7157.11****	**22.11**± 0.02**	**-5.98**± 0.07**	**10.27**± 0.19**	**-21.88**± 0.23**	**62.20**± 0.76**
BPT 5204 x Pusa 1121	-18.49**± 0.83	-0.01**± 0.54	490.95**	18.99**± 0.13	2.35**± 0.19	15.57**± 0.36	1.62**± 0.45	24.64**± 1.31
BPT 5204 x Sumathi	-14.67**± 0.35	5.93**± 0.75	1957.76**	20.97**± 0.03	-2.90**± 0.11	3.80**± 0.49	-12.20**± 0.38	27.47**± 1.04
Akshyadhan x NLR 145	-0.42± 0.07NS	-0.10**± 0.15	35.36**	25.40**± 0.01	-0.08**± 0.02	0.61**± 0.10	-0.16**± 0.08	0.43 ± 0.21NS
Akshyadhan x Pusa 1121	-21.52**± 1.00	-7.11**± 0.84	598.37**	18.69**± 0.19	8.33**± 0.20	8.75**± 0.59	17.82**± 0.63	19.22**± 1.86
NLR 145 x Sumathi	1.35**± 0.50	-15.51**± 0.31	2989.73**	24.30**± 0.03	-2.98**± 0.12	19.59**± 0.19	4.60**± 0.26	-22.48**± 0.65
RNR 2354 x I.P Basmati	-15.30**± 0.40	18.67**± 0.90	1693.56**	17.48**± 0.09	4.42**± 0.07	-2.22**± 0.61	-6.17**± 0.49	45.30**± 1.38
RNR 2354 x Basmati 370	-20.33**± 0.98	-3.69**± 0.65	715.95**	20.40**± 0.20	-2.72**± 0.08	5.93**± 0.55	-6.36**± 0.59	22.18**± 1.87
Sumathi x I.P Basmati	6.92**± 1.47	-7.20**± 0.50	209.13**	18.10**± 0.22	5.97**± 0.12	16.76**± 0.59	17.89**± 0.73	-18.83**± 2.34
I.P Basmati x Basmati	-39.39**± 0.79	5.08**± 1.18	2467.22**	14.03**± 0.11	-7.13**± 0.08	2.53**± 0.83	-24.22**± 0.66	59.29**± 1.97

*Significant at 5 % level, ** Significant at 1 % level

Table.3 Top ranking cross combinations for quality and yield

S. No	Quantitative trait	Promising crosses	Predominant gene action (desirable side)	Level of 'm'	Future strategy suggested
1.	Kernel length	Sumathi x Improved Pusa Basmati	d, i	High (+)	Simple pedigree method
		Improved Pusa Basmati x Basmati 370	d, i	High (+)	Simple pedigree method
2.	Kernel breadth	Improved Pusa Basmati x Basmati 370	d, i	Low (-)	Simple pedigree method
		BPT 5204 x Pusa 1121	d, i	Low (-)	Simple pedigree method
		BPT 5204 x Suamthi	d, i	Low (-)	Simple pedigree method
3.	Kernel length breadth ratio	Improved Pusa Basmati x Basmati 370	d, i	High	Simple pedigree method
		Sumathi x Improved Pusa Basmati	h, i	High	Bi-parental mating & selections in later generations
4.	Kernel length after cooking	Improved Pusa Basmati x Basmati 370	d, i, l	High	Pedigree method
		BPT 5204 x Pusa 1121	h, i	High	Bi-parental mating & selections in later generations
		Sumathi x Improved Pusa Basmati	h, l	High	Bi-parental mating & selections in later generations
		RNR 2354 x Improved Pusa Basmati	h, l	Medium	Bi-parental mating & selections in later generations
5.	Kernel elongation ratio	BPT 5204 x Pusa 1121	d, i, h	High	Pedigree method
		BPT 5204 x Akshyadhan	d, i, h	High	Pedigree method
		RNR 2354 x Basmati 370	d, i, h	High	Pedigree method
6.	Head rice recovery	BPT 5204 x Sumathi	d, i	High	Pedigree method
		Sumathi x Improved Pusa Basmati	h, i	Medium	Bi-parental mating & selections in later generations
		NLR 145 x Sumathi	d, h, i, l	Medium	Bi-parental mating & selections in later generations
7.	Grain Yield	NLR 145 x Sumathi	h, i	High	Bi-parental mating & selections in later generations
		Sumathi x Improved Pusa Basmati	d, i, h	Medium	Bi-parental mating & selections in later generations
		Akshyadhan x Pusa 1121	d, h, i, l	Medium	Bi-parental mating & selections in later generations

Table.1 Salient features of selected parents

S. No	GENOTYPE	PARENTAGE	SOURCE	SALIENT FEATURES
1	Samba Mahsuri (BPT 5204)	GEB – 24 / TN -1 // Mahsuri	RRU, Bapatla	**Long duration, medium slender, semi dwarf and good grain quality.**
2	Akshayadhan (DRR Dhan 35)	BR 827-35/SC 5109-2-2	DRR, Hyderabad	**Medium duration, long bold, high yielding, resistant to neck blast, tolerant to BPH**
3	Swarnamukhi (NLR 145)	CICA 4/IR 625-23-3-1//Tetep	ARS, Nellore	**Long slender, Straw glume, 135-140 days duration, Resistant to blast and tolerant to salinity**
4	PUSA 1121	Pusa 614-1-2 / Pusa 614-2-4-3	DRR, Hyderabad	**Strongly aromatic, extra-long slender grain, low GT, high cooked kernel elongation after cooking, 140-145 duration**
5	Shobhini (RNR 2354)	RNR M7 / RNR 19994	Rice Section, ARI, Hyderabad	**Short slender aromatic with medium duration**
6	Sumathi (RNR 18833)	Chandan / Pak. Basmati	Rice Section, ARI, Hyderabad	**Aromatic, extra-long slender grain, 135-140 days duration, resistant to blast.**
7	Improved Pusa Basmati	PB 1 // PB 1 / IRBB 55	DRR, Hyderabad	**Semi-dwarf, long duration, Aromatic, extra-long slender and translucent, awns present**
8	**Basmati 370**	**Pure line selection from local basmati land races**	**DRR, Hyderabad**	**Tall, extra-long slender, awns present**

Particularly, improvement through simple pedigree method is easy with respect to the cross combination, BPT 5204 x Sumathi, which registered maximum kernel elongation ratio of 2.06 with amenable gene effects.

As grain yield is the ultimate objective, genetic components were worked out for all these 10 crosses. Results indicated that, high yield was associated with higher magnitudes of dominant effects (h) on positive side especially in top most crosses (Akshyadhan x NLR 145, NLR 145 x Suamthi) and the corresponding poor yields in rest of the crosses were primarily due to negative additive effects (‘d’).

A mixed trend in epistasis was noticed for expression of grain yield potential. Higher magnitudes of both ‘i’ and ‘l’ types of interactions in comparison to the respective main effects were observed. Jinks (1954 and 1956) indicated through various experiments that F_1 generation of crosses, showing non-allelic interactions were in general superior in their performance as compared to F_1s of those crosses for which additive – dominance model was adequate.

Accordingly, in the present study also in F_1 generation, 7 crosses registered higher mean values, in which the 'l' type of interactions were highly significant and in 3 crosses (BPT 5204 x Akshyadhan, BPT 5204 x Sumathi and RNR 2354 x Basmati 370) 'm' was also found to be significantly high in F_2.

An overview of the results (Table 3) suggests that the best crosses to be picked up for improvement of overall quality are Sumathi x Improved Pusa Basmati and Improved Pusa Basmati x Basmati 370 and for achievement of simultaneous progress (quality and yield) NLR 145 x Sumathi and Akshyadhan x Pusa 1121 have to be advanced. One cross combination (BPT 5204 x Pusa 1121) was identified exclusively for improvement of kernel elongation ratio.

Nature of genetic effects changed with changing cross combination as well as the quality parameter. Although additive and additive x additive (fixable) effects were prevalent in few crosses for few traits, to achieve overall best quality especially high head rice recovery, higher kernel length and kernel elongation ratio coupled with grain yield, inter-mating of the promising genotypes in each segregating generations (F_2 and F_3) within and between crosses postponing selections to use dominance and epistatic gene actions is suggested. As this programme was basically designed for incorporating aroma and better quality traits of Basmati types in hybrids, adequate precaution needs to be taken to select only aromatic genotypes while handling material.

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