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GENETIC DIVERSITY IN TRADITIONA AROMATIC RICE ACCESSIONS FROM MADHYA PRADESH

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Genetic diversity among 300 traditional aromatic rice accessions was worked out using non-hierarchical Euclidean cluster analysis. Based on genetic distance, these accessions were grouped into 16 different clusters, of which cluster II with 61 genotypes was the largest. The maximum intra-cluster distance was observed in cluster XII (D = 1.911) followed by cluster XI (D = 1.676) and cluster XV (D = 1.610). Cluster XII and XIII were identified as genetically the most divergent. The inter-cluster distances indicated the greater divergence between cluster XII and XIII followed by clusters XI and XII, clusters V and XII, clusters IX and XII, clusters I and XII. The average genetic distance for all possible pairs of combinations ranged from 1.165 (II, VI) to 6.475 (XII, XIII). The highly diverse and superior germplasm accessions viz., H:41 I, S:715, D:1017 and T:150 of cluster XII, A:367 II, W:48, B:801 and A:283 of cluster XIII, U:78 II, B:2354, C:340 and B:1209 of cluster XI, L:1238 II, B:1094 II, B:323 II, B:2604, B:1717 and B:2402 of cluster V, A:328 I, B:1693, B:323 I, B:2495 and C:751 of cluster IX, U:69 II, B:1322, B:1389, B:2461, B:2812 and V:9 of cluster I, were selected and appeared the most promising. These selected accessions may be utilized as donors in rice breeding programme for developing semidwarf, high yielding, early aromatic rices with good grain quality.

Key words : Rice, *Oryza sativa*, divergence, quality, yield

Genetic improvement mainly depends upon the amount of genetic variability present in a population. In any crop, germplasm serves as a valuable source of base population and provides scope for wide variability. Information on the nature and degree of genetic divergence would help the plant breeder in choosing the right type of parents for breeding programme (Vivekanandan and Subramanian, 1993).

In respect of the rice germplasm, Chhattisgarh, India can be considered as a centre of divergence where approximately at every 250 ha, the germplasm pattern changes (Richharia, 1979). With increase in rice production, greater emphasis is being given to aromatic rices with good grain quality and has been of major concern to rice breeding programme in recent years. The development of improved high yielding germplasm with superior grain qualities along with aroma is one of the most important objectives.

The spectrum of variability in segregating generations for grain yield and other traits depends on the genetic diversity of the combining parents. Hence, estimation of genetic diversity for grain yield and other traits among genotypes is important for planning the future crossing programmes. Characterization of genetic divergence for selection of suitable and diverse genotypes should be based on sound statistical procedures, such as D^2 statistic (Mahalanobis, 1936) and non-hierarchical

Euclidean cluster analysis (Beale, 1969; Spark, 1973). These potent tools for estimation of divergence has been emphasised by many workers (Murty and Arunachalam, 1966; Anand and Murty, 1968; Arunachalam, 1981; Rahaman *et al.* 1997; Mehetre *et al.* 1998; Sarawgi *et al.* 1998; Sharma *et al.* 1998; Soni *et al.* 1999). Understanding the genetic diversity for grain yield and other components in traditional rice accessions and its utilization for selection of desirable parents, either for exploitation of hybrid vigour or to get desirable recombinants is important for developing high yielding, aromatic, semidwarf, multiple resistant with good grain quality varieties.

In India, farmers mostly grow traditional aromatic rice varieties. Eventhough these varieties are well adapted to the local conditions, they are tall, scented and poor yielders (Sinha *et al.* 1991). The knowledge of available genetic diversity in traditional aromatic rice accessions pave the way to success for varietal improvement programme. The present investigation was carried out to ascertain magnitude of genetic diversity present in the traditional aromatic rice accessions with the objectives to develop high yielding export quality variety.

MATERIALS AND METHODS

The material for the study consisted of 300 geographically diverse aromatic accessions of *indica* rice collected from various places of Madhya Pradesh state in India (Table 1). The material was grown in a randomized complete block design with two replications. Direct seeded line sowing method was used for establishment of seedling. Each accession was grown in plots of four rows at a spacing of 20 cm between rows. The experiment was conducted during the wet season. The nutrients (N:P:K) were applied at the rate of 80, 50 and 30 Kg ha^{-1} asurea, super phosphate and muriate of potash, respectively. No plant protection measures were applied. Observations

Table 1. Details of rice accessions

S. No.	Accession Number	Area of collection (State Madhya Pradesh)		
		District	Block	Village
1.	B:372	Raipur	Kurud	Bhothli
2.	:996	Sarona	Devena	Dhunsing
3.	B:1589	Raipur	Dharsenwa	Banarsi
4.	B:2357	Raipur	Mainnpur	Idagaon
5.	B:13 II	Bastar	Bastar	Chiralpadar
6.	B:25	Bastar	Jagdalpur	Dhaniatur
7.	B:173 I	Bilaspur	Malharoda	Malkharoda
8.	B:173 II	Bilaspur	Malkharoda	Malkharoda
9.	B:173	Bilaspur	Malkharoda	Malkharoda
10.	B:189 III	Bilaspur	Pandaria	Pandaria
11.	B:497 II	Bastar	Jagdalpur	Kohkapal
12.	B:1049 III	Durg	Dhamda	Hirri
13.	M:1 A III	Raipur	Bilaigarh	Purgaon
14.	C:72 II	Bilaspur	Pandaria	
15.	C:395 B	Seoni	Kewlari	Ugli
16.	C:606	Bilaspur	Mungeli	Jamkor
17.	C:839	Raipur	Dharsinwa	Pawni
18.	D:812	Shahdol	Kotma	Kotma
19.	D:19 I	Raipur	Devbhog	Amlipatar
20.	D:202	Raipur	Balodabazar	Lavan
21.	D:297	Hoshangabad	Piparia	Nagpura
22.	D:339	Rajnandgaon	Bodla	Odekera
23.	D:378	Jabalpur	Patan	Barodaghidi
24.	D:452	Seoni	barghat	Sarekha
25.	D:459	Raipur	Tilda	Nagpura
26.	D:672	Durg	Saja	Ballootola
27.	D:675	Durg	Bemetara	Navagaon
28.	D:684	Sidhi	Sidhi	Jamodi
29.	D:691	Rajnandgaon	Chhuikhadan	Khurmudi
30.	D:692	Rajnandgaon	Chhuikhadan	Dhodra
31.	D:693	Durg	Dhamdha	Birjhapur
32.	D:699	Mandla	Bichhia	Ajania
33.	D:712	Raipur	Kasdol	Tundra
34.	D:725	Raipur	Devbhog	Kodobhanta
35.	D:727	Raipur	Devbhog	Sargimuda
36.	D:741	Shahdol	Pali	Ladera
37.	D:751	Mandla	Mandla	Patpara

38.	D:753	Mandla	Mainpur	Chichgaon
39.	D:762 I	Raipur	Tilda	Tarashiv
40.	D:773	Balaghat	Baihar	Kukurra
41.	D:776	Balaghat	Waraseoni	Koste
42.	D:777	Balaghat	Bissa	Nevargaon
43.	D:777 II	Balaghat	Bissa	Nevargaon
44.	D:809	Balaghat	Kirnapur	Hirg
45.	D:833	Bastar	Sarona	Danwarkhar
46.	D:864	Rajnandgaon	Rajnandgaon	Dharregaon
47.	D:874	Balaghat	Waraseoni	Tegawela
48.	D:875	Balaghat	Waraseoni	Tegawela
49.	D:889 I	Balaghat	Kirnapur	Kakodi
50.	D:893 II	Balaghat	Kirnapur	Seoni
51.	D:896 I	Balaghat	Kirnapur	Pathri
52.	D:904	Balaghat	Calbarra	Beori
53.	D:908 II	Bilaspur	Masturi	Nargoda
54.	D:914	Raipur	Fingeshwar	Sorip
55.	D:921 II	Raipur	Devbhog	Amlipadar
56.	D:929	Raipur	Devbhog	Kukhurd
57.	D:934	Raipur	Magarlod	Bhainsmudi
58.	D:939	Raipur	Magarlod	Dhaniabora
59.	D:940	Raipur	Magarlod	Bhainsmudi
60.	D:942	Raipur	Magarlod	Bhainsmudi
61.	D:951	Raipur	Bhatapara	Niyania
62.	D:952	Raipur	Bhatapara	Tikulia
63.	D:959	Raipur	Simga	Kesada
64.	D:968	Bilaspur	Mungeli	Karahi
65.	D:1017	Bastar	Kanker	Bevratti
66.	D:1020	Rajnandgaon	Kawardha	Jhalmala
67.	D:1024	Shahdol	Suhagpur	Chewani
68.	D:1024	Shahdol	Suhagpur	Chewani
69.	D:1071	Raigarh	Tapkara	Lawakera
70.	D:1075	Bilaspur	Pamgarh	Bhaisa
71.	D:1090	Raipur	Fingeshwar	Patseoni
72.	D:1098	Raipur	Saraipali	Banigirdol
73.	D:1100	Raigarh	Dharamgaigarh	Kadga
74.	D:1119	Bilaspur	Chanda	-
75.	D:1123	Raipur	Mahasamund	Sirpur
76.	D:1126	Raipur	Basna	Chhote temri
77.	D:1214	Raigarh	Tamnar	Bhuikurri
78.	D:1216	Raigarh	Tamnar	Darama
79.	D:1230	Raipur	Devbhog	Chichiya
80.	D:1246 II	Raipur	Devbhog	Dhanora
81.	D:1276	Bastar	Lohandiguda	Matwar
82.	D:1289	Bastar	Jagdalpur	Bademurma
83.	D:1284	Bastar	Kanker	Muddongori
84.	D:1293	Bastar	Antagarh	Bulawand
85.	D:1310	Bastar	Durgkondal	Pudomichgaon
86.	D:1348	Bastar	Narayanpur	Bakulbadi
87.	D:7 III	Raipur	Nagri	Sirsida
88.	B:2875	Raipur	Saraipali	Sagarpali
89.	B:2738	Bastar	Sarona	Danwarkhar
90.	B:2739	Baster	Sarona	Bhawlipara
91.	D:1173	Raigarh	Saranggarh	Dansara
92.	D:1041	Rajnandgaon	Dongargarh	Diwanbhedi
93.	D:1362	Bastar	Sarona	Simanpur
94.	D:1366	Bastar	Sarona	Dhanesara
95.	H:41 I	Raipur	Simga	Lanja
96.	M:576 I	Sarguja	Masturi	Ralila
97.	D:668 II	Bastar	Sarona	Sarona
98.	D:1404	Raipur	Mahasamund	Kosrangi
99.	D:839 I	Sarguja	Lakhanpur	Lahori
100.	G:1035	Rajnandgaon	Chowki	Metepar
101.	J:450	Raigarh	Gharghoda	Pulsada
102.	S:227	Bilaspur	Gorella	Bacharwar
103.	R:169 II	Raipur	Fingeshwar	Rajim
104.	R:171 IV	Raipur	Fingeshwar	Rajim
105.	D:1543	Raipur	Fingeshwar	Rajim
106.	T:102 I	Sargeya	Odagi	Kalamjan
107.	T:103	Raipur	Arang	Jugesar
108.	B:562	Durg	Bemetara	Mohtara
109.	C:539	Raigarh	Bagicha	Sanna
110.	G:583	Raigarh	Bahicha	Gaylunga
111.	M:873	Raipur	Fingeshwar	Kirwai
112.	B:728 I	Raipur	Gariyaband	Mohanda
113.	B:1380	Raipur	Dharsenwa	Banarsi
114.	C:43	Jabalpur	Badpara	Amdi
115.	C:56	Jabalpur	Sehora	Junnani
116.	C:195	Jabalpur	Shahpura	Surai
117.	C:265	Damoh	Jabera	Kariakheda
118.	C:389 I	Shahdol	Pali	Barkoda
119.	C:611	Bilaspur	Takhatpur	Sankri
120.	G:3	Raipur	Palari	Datan
121.	K:1295	Bhind	Mehgaon	Jugekapura
122.	K:2533	Bhind	Gohad	Dhimka
123.	L:88	Bastar	Makdi	Jarandi
124.	S:1250	Bilaspur	Masturi	Luthera

125.	S:1332	Bilaspur	Gorela	Ropanhand
126.	S:1072	Raigarh	Gharghida	Puri
127.	T:150	Durg	Dondi	Bharritola
128.	S:715	Shahdol	Sohagpur	Jodhpur
129.	T:186	Bastar	Kanker	Badebhata
130.	C:194	Jabalpur	Katni	Khirhani
131.	C:2671	Damoh	Jabera	Melithana
132.	C:808	Seoni	Barghat	Takhlakala
133.	K:216	Durg	Saja	Parasbod
134.	K:1374	Raipur	Simga	Kesada
135.	K:1890	Raipur	Mahasamund	Birkoni
136.	B:728	Raipur	Gariaband	Mohanda
137.	C:459	Bastar	Sarona	Saletola
138.	Bd:444	Gwalior	Dabra	Dabra
139.	Bd:153	Raipur	Basna	Basna
140.	Bd:384 A	Bilaspur	Jaijaipur	-
141.	Bd:8	Raipur	Arang	Arang
142.	A:319	Mandal	Bichhia	Bhua
143.	A:349	Balaghat	Baihar	Powdilar
144.	A:26	Bastar	Chhindgarh	Leda
145.	A:274	Bastar	Keshkal	Adega
146.	A:283	Bastar	Chhindgarh	Leva
147.	A:328 I	Bastar	Dantewara	Badped
148.	A:543	Raipur	Tilda	Kharora
149.	A:625	Bastar	Lohandiguda	Harikodar
150.	A:644	Bastar	Bastar	Nehrani
151.	A:367 II	Sarguja	Sitapur	Sontai
152.	A:593	Raigarh	Dharamjaigarh	Siyra
153.	B:480 II	Bastar	Baderajpur	Tenwsa
154.	B:1728	Bastar	Bastar	Mundagaon
155.	B:1689	Seoni	Barghat	Dharnakula
156.	B:1358	Bastar	Kanker	Bewarti
157.	B:361	Raipur	Arang	Umaria
158.	W:48	Sidhi	Majholi	Khadora
159.	B:1166	Raipur	Deobhog	Kodevan
160.	A:647	Bastar	Bastar	Selemata
161.	B:1209	Shahdol	Jaithari	Bargawan
162.	B:801	Bastar	Lokapal	Sonarpal
163.	B:42 I	Bastar	Bakawand	Dodiapal
164.	B:54 II	Raipur	Devbhog	Amlipadar
165.	B:54	Raipur	Devbhog	Amplipadar
166.	B:214 III	Durg	Durg	Tirga
167.	B:220	Durg	Dondi	Salhaitan
168.	B:220 II	Durg	Dondi	Salhaitan
169.	B:254	Raipur	Tilda	Chhatod
170.	B:323	Bastar	Gidam	Kasoli
171.	B:323 I	Bastar	Gidam	Kasoli
172.	B:323 II	Bastar	Gidam	Kasoli
173.	B:381	Raipur	Bhatapara	Mirgi
174.	B:381 II	Raipur	Bhatapara	Mirgi
175.	B:405	Bilaspur	Gorela	Dhanoli
176.	B:440 II	Raipur	Dharseva	Chirhuldih
177.	B:484	Bastar	Bakawand	Borpadar
178.	B:497	Bastar	Jagdalpur	Kohkapal
179.	B:528	Rajnandgaon	Kawardha	-
180.	B:562	Durg	Bemetara	Mohtara
181.	B:562 II	Durg	Bemetara	Mohtara
182.	B:799 I	Bastar	Tokapal	Mirga
183.	B:799 II	Bastar	Tokapal	Mirga
184.	B:973	Bastar	Geedam	Ronge
185.	B:1005	Bastar	Baderajpur	Madokikhargaon
186.	B:1010	Bastar	Baderajpur	Kargaon
187.	B:1209	Shahdol	Jaithari	Badgaon
188.	B:1307	Sarguja	Bharatpur	Janakpuri
189.	B:1322	Sarguja	Sitapur	Pratapgarh
190.	B:1340	Bastar	Narayanpur	Narayanpur
191.	B:1370	Bastar	Farargaon	Bade Dongar
192.	B:1389	Bastar	Narayanpur	Kodia
193.	B:1427	Rajnandgaon	rajnandgaon	Bharregaon
194.	B:1693	Bastar	Antagarh	Sarandi
195.	B:1727	Bastar	Bastar	Kalchur
196.	B:1731	Bastar	Bastar	Baniagaon
197.	B:2094	Bastar	Durgkondal	Chihro
198.	B:2297	Raipur	Pithora	-
199.	B:2354	Raipur	Devbhog	Usarijor
200.	B:2355	Raipur	Devbhog	Usarijor
201.	B:2402	Bastar	Bakawand	Bajabandh
202.	B:2461	Bastar	Abujmand	Ader
203.	B:2495	Bastar	Lohandiguda	Mardum
204.	B:2812	Bastar	Bakawand	-
205.	B:2814	Bastar	Lohandiguda	Kothiaguda
206.	B:1092	Durg	Gunderdehi	Arjunda
207.	B:1717	Bastar	lohandiguda	Taragaon
208.	B:2604	Bastar	Antagarh	Antagarh
209.	B:2669	Bastar	Lohandiguda	Taragaon
210.	B:380 II	Bastar	Pithora	Girna

211.	B:1094 II	Durg	Dhamda	Hirri
212.	B:1094 IV	Durg	Dhamda	Hirri
213.	L:1238 II	Raigarh	Kunkuri	Hastanpur
214.	R:509	Bastar	Baderajpur	Forgaon
215.	V:9	Bilaspur	Gorela	Tifarkala
216.	V:26 I	Sarguja	Bhaiyath	Sirsi
217.	B:525 III	rajnandgaon	Kawardha	-
218.	U:78 II	Jabalpur	Kargi	Dhanpuri
219.	U:69 II	Seoni	Barghat	Keshala
220.	C:165 II	Raigarh	Lelunga	Sarega
221.	C:30 II	Shahdol	Budhar	Pakariha
222.	C:340	Bastar	Bhanupratappur	Jampara
223.	C:236	Seoni	Barghat	Sajanwada
224.	C:334 I	Raipur	Dhamtari	Dhamtari
225.	C:392	Seoni	Barghat	Taklakhurd
226.	C:494 II	Balaghat	Waraseoni	Piparia
227.	C:604	Shahdol	Suhagpur	-
228.	C:828	Raipur	Mahasamund	-
229.	C:751	Bastar	Lohandiguda	Ermur
230.	C:705	Bastar	Bakawand	Bakawand
231.	D:625	Bastar	Jagdalpur	Bagbohar
232.	D:18	Raipur	Devbhog	Jakharpara
233.	D:18 I	Raipur	Devbhog	Jakharpara
234.	D: 18 II	Raipur	Devbhog	Jakharpara
235.	D:26	Raipur	Pallari	Ghotia
236.	D:27	Raipur	Pallari	Telasi
237.	D:33 A	Bastar	Bijapur	Ghanora
238.	D:76	Bastar	Kondagaon	Sukurpal
239.	D:80	Bastar	Charama	Haradula
240.	D:81	Bastar	Charama	Mahud
241.	D:90	Bilaspur	Baloda	Kamrid
242.	D:90 II	Bilaspur	Baloda	Kamrid
243.	D:119	Durg	Dongargarh	Sevtatola
244.	D:130	Durg	Durg	Karjabhilai
245.	D:136	Durg	Dondi	Solha
246.	D:137	Durg	Bhanpuri	Bawsa
247.	D:143	Durg	Dondilohara	Sanjari
248.	D:156	Balaghat	Lalbarra	Miregaon
249.	D:181	Raipur	Tilda	Tulsi
250.	D:181 II	Raipur	Tilda	Tulsi
251.	D:185 I	Raipur	Basna	Mithli
252.	D:191	Raipur	Basna	Rasoda
253.	D:194 I	Raipur	Bagbahara	Bhatgaon
254.	D:202	Raipur	Balodabazar	Lavan
255.	D:204	Raipur	Simga	Sankari
256.	D:1131	Bilaspur	Bilha	Madanpur
257.	D:1132	Raigarh	Lelunga	Madanpur
258.	D:1135	Bastar	Bastar	Ritaband
259.	D:226	Bastar	Tokapal	Bharkot
260.	D:268 II	Raipur	Arang	Nagpura
261.	D:297	Hoshangabad	Piparia	Simar
262.	D:311	Raipur	Dharsivan	Chirhuldih
263.	D:318	Raigarh	DHarmjaigarh	Shahpur
264.	D:320	Raigarh	Kausabel	Bagia
265.	D:329 I	Raigarh	Lelunga	Beskimuda
266.	D:329 II	Raigarh	Lelunga	Beskimuda
267.	D:360	Rajnandgaon	Dongargarh	Dhordah
268.	D:421	Rajnandgaon	Chhuikhadan	Borai
269.	D:423	Rajnandgaon	Chhuikhadan	Chakmar
270.	D:424	Rajnandgaon	Chhuikhadan. Bundeli	
271.	D:428	Rajnandgaon	Chhuria	Sitakasa
272.	D:433	Raipur	Devbhog	Amlipadar
273.	D:436	Mandla	Nainpur	Joharmau
274.	D:440	Raipur	Bhatapara	Maldi
275.	D:459	Raipur	Tilda	Nagpura
276.	D:482	Bilaspur	Jaijapur	Amgaon
277.	D:519	Raipur	Gariaband	Shobha
278.	D:610 II	Rajnandgaon	Dongargarh	Meregaon
279.	D:657 II	Bastar	Sukma	Sonakukanar
280.	D:659	Bastar	Koilibeda	Koylibeda
281.	D:665	Bastar	Durgkondal	Sukhai
282.	D:666 I	Bastar	Burgkondal	Kodekurse
283.	D:666 II	Bastar	Burgkondal	Kodekurse
284.	D:684	Sidhi	Sidhi	Jamodi
285.	D:731 I	Bastar	Usur	Usur
286.	D:734 II	Raipur	Chura	-
287.	D:742	Shahdol	Jaithari	Barbaspur
288.	D:749	Seoni	Kedari	Vimari
289.	D:750	Mandla	Mandla	Bapsa
290.	D:766	Rajnandgaon	Mohla	Mahewa
291.	D:780	Balaghat	Katangi	Lakhanwara
292.	D:781	Balaghat	Katangi	Agari
293.	D:806	Raipur	Kurud	Gogi

294. D:817	Bastar	Narayanpur	Narayanpur
295. D:819	Raipur	Nagri	Amgaon
296. D:828	Bastar	Keshkal	Gatka
297. D:843	Raipur	Bagbahara	Khamaria
298. D:862	Rajnandgaon	Manpur	Chhidivadi
299. D:875	Balaghat	Waraseoni	Tegabela
300. D:902	Balaghat	Lalbarra	Nilji

were recorded on five randomly selected plants from the central rows of each plot of each accession per replication except grain yield recorded on plot basis. The observations recorded on days to 50 per cent flowering, plant height, panicle length, hundred grain weight and spikelet sterility percentage. Ten whole milled kernels were used to measure kernel length and breadth. Then length:breadth ratio was calculated. The non-hierarchical Euclidean cluster analysis (Beale, 1969; Spark, 1973) was followed to estimate the intra- and inter-cluster distances and to group the genotypes into different clusters.

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences within the rice germplasm accessions for all the traits studied. Based on non-hierarchical Euclidean cluster analysis, the 300 cultivars were grouped into sixteen clusters (Table 2). The average genetic distance for all possible pairs of combinations ranged from 1.165 (II, VI) to 6.475 (XII, XIII) which indicated considerable amount of genetic diversity among the strains studied (Table 3). Amongst sixteen clusters, cluster II consisted of large number of cultivars (61) followed by cluster VI (45); XIV (33), V(26), I(23) and cluster X included 21 accessions. Minimum number of 4 cultivars accomodate in cluster XII. The maximum intra-cluster distance was observed in cluster XII (D = 1.911) followed by cluster XI (D = 1.676) and cluster XV (D = 1.610). The cluster XII consisted of 4 accessions, cluster XI of 7 accessions and cluster XV of 10 accessions. The above grouping indicates existence of wide

Table 2. Distribution pattern of 300 rice accessions into 16 clusters

Cluster No.	No. of genotypes	Accession numbers
I	23	B:1358, B:361, B:54, B:381 II, B:484, B:562 II, B:799 II, B : 973, B:1010, B:1209, B:1322, B:1340, B:1370, B:1389, B:1727, B:2297, B:2355, B:2461, B:2812, V:9, B:525 III, U:69 II, C:165 II
II	61	B:25, D:297, D:452, D:459, D:675, D:684, D:699, D:725, D:741, D:751, D:753, D:773, D:776, D:777, D:777 II, D:809, D:875, D:921 II, D:940, D:951, D:1024, D:1090, D:1126, D:1348, B:2875, B:2738, B:2739, B:2739, D:1362, D:1362, :576 I, D:668 II, D:1404, D:839 I, C:392, C:494 II, D:18, D:18 II, D:181 II, D:191, D:204, D:1131, D:1132, D:1135, D:297, D:423, D:424, D:436, D:436, D:440, D:610II, D:666 I, D:666 II, D:734 II, D:742, D:750, D:780, D:781, D:806, D:817, D:819, D:828, D:843, D:862
III	12	B:372, B:996, C:539, G:583, M:873, B:728 I, C:611, L:88, S:1250, S:1332, K:1890, BD:8
IV	9	B:562, C:43, C:56, C:389 I, C:194, C:808, C:459, Bd:444, Bd:384 A
V	26	B:1166, B:54 II, B:220, B:220 II, B:254, B:323, B:323 II, B:381, B:405, B:497, B:562, B:1005, B:1307, B:1427, B:2402, B:2814, B:1092, B:1717, :2604, B: 1094 II, L:1238 II, R:509, V:26 I, C:30 II, C:604, C:751
VI	45	B:1589, B:13 II, B:173 I, B:173 II, B:173, B:189 III, M:1A III, C:72 II, C:606, D:378, D:672, D:691, D:692, D:693, D:712, D:874, D:959, D:1020, D:1024, D:1075, D:1098, D:1100, D:1289, D:1293, G:1035, B:480 II, B:380 II, C:828, C:705, D:625, D:26, D:136, D:156, D:194 I, D:202, D:360, D:421, D:428, D:433, D:459, D:482, D:519, D:665, D:684, D:731I
VII	6	B:497 II, T:102 I, B:214 III, B:1094 IV, C:334 I, D:33A
VIII	7	B:2357, D:1230, S:227, D:1543, T:103, K:1374 II, B:728

IX	14	A:274, A:328 I, A:593, B:1728, B:42 I, B:3231, B:528, B:7991, B:1693, B:1731, B:2094, B:2495, B:2669, C:751
X	21	D:727, D:833, D:864, D:904, D:908 II, D:939, D:942, D:7 III, B:1689, D:27, D:76, D:80, D:81, D:90, D:119, D:130, D:137, D:239 II, D:749, D:875, D:902
XI	7	A:319, A:349, A:647, B:1209, B:2354, U:78 II, C:340
XII	4	D:1017, H:41 I, T:150, S:715
XIII	9	A:26, A:283, A:543, A:625, A:644, A:367 II, W:48, B:801, B:440 II
XIV	33	B:1094 III, C:395 B, D:812, D:191, D:202, D:339, D:762 I, D:889I, D:893 II, D:896 I, D:914, D:929, D:934, D:952, D:1071, D:119, D:1123, D:1310, D:1173, D:1041, C:236, D:18 I, D:90 II, D:143, D:181, D:185 I, D:226, D:268 II, D:311, D:318, D:329 I, D:659, D:766
XV	10	B:1380, C:195, C:265, G:3, K:1295, K:2533, S:1072, T:186, C:267 I, K:216
XVI	13	C:839, D:968, D:1214, D:1216, D:1246 II, D:1276, D:1284, D:1366, J:450, R:169 II, R:171 IV, Bd:153, D:320

genetic divergence among constituent genotypes. Such high degree of divergence was found in local collections (Rahaman *et al.* 1997; Sardana *et al.* 1997; Sarawgi *et al.* 1998; Soni *et al.* 1999) as well as in International collections (Usha Kumari and Rangaswamy, 1997). The minimum intra-cluster value (D = 1.000) exhibited by cluster II containing 61 acceesions, indicated limited genetic diversity among the constituent genotypes (Table 3). The unidirectiona selection practiced in the past might have resulted in uniform features with less divergence between these genotypes. The relative divergence of each cluster from other clusters (inter-cluster distances) indicated greater divergence between cluster XII and XIII followed by clusters XI and XII, clusters V and XII, clusters IX and XII, clusters I and XII (Table 3). In all the above inter-cluster distances, cluster XII was more distantly placed. It indicates that the accessions of cluster XII were genetically more diverged from accessions of rest of the clusters. Due emphasis for breeding programme should be given to four accessions of cluster XII: nine

Table 3. Mean intra-cluster (diagonal and bold) and inter-cluster distances among sixteen clusters

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI
I	**1.313**	3.956	3.671	4.703	1.493	3.732	3.837	3.992	1.508	4.460	2.596	6.164	2.841	4.489	5.056	4.735
II		**1.000**	3.904	4.094	4.169	1.165	3.683	3.431	4.374	1.535	5.523	4.043	5.004	1.639	4.992	2.723
III			**1.529**	2.256	4.261	3.911	3.792	1.910	4.270	4.013	3.847	4.495	4.377	4.147	3.000	4.568
IV				**1.363**	4.882	3.968	3.774	2.317	5.141	4.264	4.885	3.050	4.796	3.953	2.248	3.951
V					**1.198**	3.686	3.155	3.944	1.700	4.585	3.055	6.401	2.157	4.204	4.772	4.130
VI						**1.243**	2.925	3.096	4.275	2.407	5.548	4.494	4.641	1.625	4.766	1.933
VII							**1.530**	2.604	3.868	4.036	4.970	5.567	2.948	3.084	3.370	2.250
VIII								**1.545**	4.503	3.521	4.553	4.495	4.184	2.988	2.334	3.127
IX									**1.163**	5.524	2.351	6.381	1.959	4.690	5.070	4.967
X										**1.483**	5.383	3.890	5.051	1.632	4.691	3.239
XI											**1.676**	6.428	2.990	5.690	4.610	6.132
XII												**1.911**	6.475	4.053	4.430	4.632
XIII													**1.504**	4.795	4.115	4.582
XIV														**1.135**	4.241	1.720
XV															**1.610**	4.146
XVI																**1.406**

accessions of cluster XIII; seven accessions of cluster XI; twenty six accessions of cluster I. The selection of divergent genotypes from above clusters would produce a broad spectrum of variability for yield and other traits studied which may enable further selection and development of aromatic high yielding, good grain quality varieties. The hybrids developed from the selected genotypes within the limits of compatibility of these clusters may produce high magnitude of heterosis or desirable transgressive segregants which would be rewarding in varietal improvement programme. Bhatt (1973), Roy and Panwar (1993), Vivekanandan and Subramanian (1993), Rahaan *et al.* (1997), Sarawgi *et al.* (1998) and Soni *et al.* (1999) also found similar degree of diversity in rice.

The cluster mean values for all the traits under study are furnished in Table 4. There was a wide range of variation in the cluster mean values for all the characters under study. The maximum and minimum mean values for characters viz., days to 50 per cent flowering, 108.23 (XVI) and 94.89 (IV); plant height, 137-91 (XIII) and 107.90 (VI); panicle length 30.37 (XI) and 21.13 (II); hundred grain weight, 2.88 (XII) and 1.08 (V); grain yield, 632.90 (X) and 205.00 (VII); spikelet sterility %, 39.30 (XV) and 16.06 (I); kernel length, 6.78 (XII)and 4.34 (IX); length: breadth ratio, 3.14 (VIII) and 2.00 (XI), respectively were observed. This indicates that while planning hybridization programme to achieve early flowering germplasm accessions viz., C:56, C:194, C:808, C:459 and Bd:444 from cluster IV and C:195, C:265 and C:267 I from cluster XV should be included; for breeding dwarfness accessions C:72II, B: 1589, D : 519, D : 731, D : 380 II and B : 189 III from cluster VI hold promise; higher panicle length, germplasm accessions namely U: 78 II, C : 340, B : 1209 and A : 647 from cluster XI having longest panicle; for improvement in hundred grain weight, accessions T : 150, S : 715 and D : 1017 from

Table 4. Cluster means for different characters

Cluster	No. of genotypes included	Days to 50% fowering	Plant height (cm)	Panicle length (cm)	100-grain weight (g)	Grain yield (g/plot)	Spikelet sterility (%)	Kernel length (mm)	L : B ratio
I	23	103.00	120.07	25.31	1.10	286.09	**16.06**	4.53	2.22
II	61	107.92	111.81	**21.13**	1.74	471.98	17.84	5.96	2.97
III	12	97.50	124.83	28.56	1.50	326.83	17.27	6.23	3.08
IV	9	**94.89**	124.24	25.82	2.14	277.44	25.59	6.27	3.07
V	26	103.88	119.02	24.42	**1.08**	281.75	27.61	4.42	2.14
VI	45	107.97	**107.90**	21.37	1.65	360.20	23.18	5.87	2.94
VII	6	106.83	123.62	24.23	1.39	**205.00**	37.88	5.83	2.89
VIII	7	100.71	116.91	27.88	1.52	350.00	30.08	6.34	**3.14**
IX	14	105.50	132.09	25.14	1.13	337.71	20.02	**4.34**	2.09
X	21	107.38	119.81	21.99	1.74	**632.90**	21.10	5.98	3.03
XI	7	98.86	134.40	**30.37**	1.22	407.00	18.92	4.42	**2.00**
XII	4	99.00	122.58	23.30	**2.88**	510.00	20.03	**6.78**	2.83
XIII	9	105.78	**137.91**	26.68	1.27	240.44	32.93	4.53	2.23
XIV	33	107.11	112.46	21.49	1.76	519.11	30.59	6.05	3.01
XV	10	94.90	133.19	27.24	1.80	352.70	**39.30**	6.13	3.03
XVI	13	**108.23**	110.37	21.61	1.84	327.88	37.93	6.08	2.95

Bold figures indicate maximum and minimum cluster mean for a particular character

cluster XII hold promise; to minimise spikelet sterility, accessions B : 54; B : 799 II; B : 1209; B : 1727, B : 2297 and B : 2461 from cluster I should be included; for higher kernel length, accessions D : 1017; T : 150 and S : 715 from cluster XII hold promise; for length : breadth ratio accessions D : 1543; B : 728 and S : 227 from cluster VIII should be used; for improvement in grain yield accessions D : 875; D : 902, D : 904, D : 908 II; D : 864, D : 833 and D : 90 from cluster X should be used as donors in hybridization programme for improvement of individual traits.

The highest divergence between clusters are useful in heterosis as well as in recombination breeding since highly divergent genotypes would throw a wide spectrum of variability enabling further selection. The highly diverse and superior germplasm accessions viz., H : 41 I, S : 715, D : 1017 and T : 150 (XII), A : 367 II, W : 48, B : 801 and A : 283 (XIII), U : 78 II, B : 2354, C : 340 and B : 1209 (XI), L : 1238 II, B : 1094 II, B : 323 II, B : 2604, B : 1717 and B : 2402 (V), A : 328 (I), B : 1693, B : 323 (I), B : 2495 and C : 751 (IX), U : 69 (II), B : 1322, B : 1389, B : 2461, B : 2812 and V : 9 (I) were selected and appeared the most promising. These selected accessions may be utilized as donors in rice breeding programme for developing semidwarf, high yielding, early aromatic rices with good grain quality.

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