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METROGLYPH ANALYSIS OF DIVERSITY IN SOME QUALITY COMPONENTS IN RAINFED RICE (*Oryza sativa* L)

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One hundred and six indigenous cultivars (mainly from plateau region of Bihar) of Oryza sativa *L. were evaluated to study the extent of variation in physico-chemical and cooking quality traits. The study revealed high variability for alkali digestion value and head rice recovery; moderate for grain shape and water uptake. About 50 per cent cultivars possessed short, bold and red kernels. Sixteen genotypes exhibited desirable combination of intermediate content of amylose and gelatinization temperature. Twenty five per cent cultivars also exhibited high water uptake (more than 300 ml). Metroglyph analysis indicated that 106 genotypes could be grouped into six complexes; the largest being I and II with 29 and 24 genotypes respectively. The cumulative index score (IS) varied from 6 (Bagri Black HRC 446) to 12 (Brown Gora, HRC 407). A few traditional cultivars possessed multiple desirable quality traits (IS 11).*

In rainfed based rice farming system of India, rich indigenous diversity still occurs since the modern varieties made very little impact so far. This valuable gene pool could perhaps become a very useful source in the cultivar development for rainfed ecosystem. Thus, an urgent need was felt for their collection, evaluation, conservation and utilization. In-depth study of indigenous cultivars was taken up for various agro-morphological and/or quality traits to identify potential donors for crop breeding.

MATERIALS AND METHODS

The experimental materials comprised 106 rainfed upland and lowland cultivars mostly from Chhotanagpur plateau (Bihar). The genotypes were direct seeded in 1986 (10 g/m^2) in augmented design in 3-row plots; 3 m long rows spaced 20 cm apart during wet season at Central Rainfed Upland Rice Research Station, Hazaribagh. The fertilizer N : P : K at the rate of 40 : 20 and 20 kg per ha was provided and healthy crop was raised. A composite random sample of 20 plants was chosen for observations and recording of data on various quality traits.

Representative sample (100 g) was hulled using Satake dehusker and the brown rice was milled in Kett T-2 polisher for 90 seconds (5% milling). The hulling, milling and head rice recovery were computed as reported earlier (Govindaswamy and Ghosh, 1969). Length and breadth were recorded on 10 whole milled rice kernels using dial micrometer (Mitutoyo, Japan). Standard analytical methods were employed for estimating amylose content (Juliano, 1971); alkali digestion value (Little *et al.*, 1958); water uptake and volume expansion (Beachell and

Stansel, 1963) and kernel elongation (Azeez and Shafi, 1966). Range, mean and coefficient of variation (CV, %) were computed to assess the magnitude of variability in different quality characters. Metroglyph and index score method was used to study the diversity in the experimental material (Anderson, 1957).

RESULTS AND DISCUSSION

The range, mean and coefficients of variation revealed considerable variability in the material for most of the quality traits (Table 1). The highest variability was recorded for alkali digestion value followed by head rice recovery and water uptake. The head rice yield ranged from 31.2 to 68.1 per cent with 17.92 per cent of the genotypes showing more than 60 per cent head rice recovery. High variation observed in head rice recovery is of great significance as it is the proportion of head rice rather than total milled out turn. The kernel shape (L : B ratio) ranged from 1.68 to 3.54 and exhibited moderate variability (Table 1). The remaining attributes had low variation. But for hulling, milling recovery and volume expansion, there was lack of inherent variation which was evidenced by their low CVs. This is in agreement with earlier reports (Jennings *et al.*, 1959; Chauhan and Nanda, 1983).

Kernel colour, size and shape varied widely. Among 106 cultivars, 53 possessed short bold and red kernels followed by 33 genotypes with short bold and white kernels. Only three cultivars (*Kalamdani*, HRC 212, *Brown Gora*, HRC 409 and *Sukhawel*, 20 HRC 490) exhibited long slender and white kernels. Predominance of short bold types with red or white kernels was evident (Table 2).

Amylose content and alkali digestion value (gelatinization temperature), the two major determinants of qualities of rice showed intermediate amylose content (20-25%). It ranged from 16.7 to 23.4% with (m 21.08 $\pm$ 0.13). However, wide range, 4.5 to 36.0% for this trait in collections from North Eastern Indian hills (Sadananda *et al.*, 1987) and a range of 16.3-28.1% for amylose content of indigenous upland rice cultivars (Hussain *et al.*, 1987) were reported. Since most of the collections in the present study represented a limited geographical area, with perhaps similar preference for rice quality, this might have resulted in restricted diversification. Only 16 of these cultivars had the most desirable combination of these two traits.

Good cooking quality rice is judged by the facts that it should have high water uptake, volume expansion and kernel elongation. Although, limited variation in volume expansion, water uptake and kernel elongation was observed in the present experimental material, twenty seven genotypes exhibited high water uptake (more than 300 ml); the highest being recorded in *Raria* (HRC 268). *Kalamdani* exhibited longest kernels after cooking yet the highest kernel elongation (20.3) was observed in *Sudha* (HRC 432). Seventeen cultivars had kernel elongation of 1.81 or more. Relatively low variation for volume expansion and kernel elongation was earlier reported (Hussain *et al.*, 1987).

Analysis of diversity using metroglyph analysis

Parental diversity plays a vital role in obtaining desirable segregants. This necessitates critical study of the diversity among the genotypes. The D^2 statistics helps in cluster analysis but often it is quite tedious while analysing large number

Table 1. Range, mean and coefficient of variability (%) for different quality traits

Character	Range	Mean ± SE	CV (%)
Hulling (%)	70.00 - 80.50	77.60 ± 0.25	3.4
Milling (%)	65.30 - 75.30	70.50 ± 0.25	3.6
Head rice recovery (%)	31.20 - 68.10	48.20 ± 1.05	22.4
Kernel length (mm)	4.21 - 7.02	5.63 ± 0.04	7.6
Kernel breadth (mm)	1.98 - 2.92	2.49 ± 0.02	7.3
L : B ratio	1.68 - 3.54	2.28 ± 0.03	12.6
Alkali digestion	2.50 - 5.50	3.22 ± 0.09	29.5
Amylose content (%)	16.70 - 23.40	21.08 ± 0.13	6.4
Water uptake (ml)	155.00 - 370.00	262.83 ± 5.04	19.8
Volume expansion	3.50 - 4.30	3.83 ± 0.02	4.7
Cooked kernel length (mm)	8.00 - 12.40	9.63 ± 0.08	8.6
Kernel elongation (mm)	1.49 - 2.03	1.71 ± 0.01	6.3

Table 2. Classification of genotypes based on kernel size, shape and colour

Type	Freqency		Genotypes
	No.	(%)	
Long bold, white	10	9.43	*Pakhiraj* (197). *Bhojani* (269) *Dhudhras* (271), *Br. Gora* (298), *White Gora* (322), *Black Gora* (364) *Rohini* (424B) *Laloo*-14 (4578), *Early Seetreall* (491), *Khao Vano Veri* (505)
Long bold, red	3	2.83	*Tilasar* (273), *Br. Gora* (378), *Br. Gora* (394)
Long slender, white	3	2.83	*Kalamdani* (212), Br. Gora (409), *Sukhawel* 20 (490)
Long slender, red	1	0.94	*Br. Gora* (407)
Medium slender, white	2	1.88	*Br. Gora* (316,410)
Medium slender, red	1	0.94	*Haskalma* (123)
Short bold, white	33	31.13	*Saro* (188), *Patiri* (205), *Dahia* (264), *Dahia* (266), *Raria* (268), *Nauhia* (287), CR 143-2-2 (297), *Whitie Gora* (303, 308, 310, 312, 313, 315, 317, 320, 321, 323, 325), *Br. Gora* (371), *Black Gora* (372, 373), *Br. Gora* (379, 380, 383, 386, 387, 388, 390), ARC 7046 (426B), *Sudha* (432), *Jhumlakhibiri* (518), *Lalki* (605), *Chandragrahi* (606)
Short bold, red	53	50.00	*Jonga white* (140), *Jonga* (157), *Black Gora* (159), *Br. Gora* (160), *Karhani* (173)_. *Tilasar* (190), *Jonga* (202), *Jhunasar* (211), *Karhani* (239), *Karhani* (240), *Br. Gora* (270), *Ramkel* (272), *Br. Gora* (274), *Damodar* (275), *Br. Gora* (280), *Karhani* (290, 299), *White Gora* (301, 302, 314, 318, 319, 324), *Black Gora* (358, 359, 361, 362, 363, 365, 366, 367, 368, 369, 370), *Br. Gora* (382), NCS-2 (416), *PTB*-10 (421), *Beali B*-76, (423), *Mettasannalu* (425), *Annapurna* (431), *Chakkula* (433, 433B), *Teenpathia* (441, 441B), *Bagri Black* (446, 446B), *Bagri white* (447), Aus 454 (465), *Rangpur* (466), *Cherannuni* (467), *Dharial* (468)

Within parentheses are the Hazaribagh Rice Collection (HRC) numbers for referring the seed source

of genotypes, metroglyph analysis was considered suitable for preliminary grouping of large number of germplasm (Chandra, 1977; Kotaiah *et al.*, 1987).

The head rice recovery and alkali digestion value were considered as the X and Y ordinates and all genotypes were plotted. Five other characters (Table 3) were denoted by rays at different positions of the glyph. The range in each attribute was divided into three classes (Table 3) and represented by different bars (Fig. 1b). The genotypes differed markedly for the various quality traits, in respect of pattern of rays and variability. The scatter diagram (Fig. 1 a,b) revealed that these rice genotypes could be assigned to six complexes.

Table 3. Index score values for some quality traits

Characters	Range	Index score		
		1 (<)	2	3 (>)
Kernel length (mm)	4.22 - 7.22	5.51	5.51 - 6.60	6.60
L : B ratio	1.68 - 3.54	2.00	2.00 - 3.00	3.00
Amylose content (%)	16.70 - 23.40	20.00	20.00 - 25.00	25.00
Water uptake (ml)	155.00 - 370.00	227.00	227.00 - 300.00	300.00
Kernel elongation (mm)	1.49 - 2.03	1.67	1.67 - 1.85	1.85

Group I: This is the largest complex with 29 genotypes with index score of 6 to 11 and mean value low (8.41) and scattered cluster with 1-2 bar pattern for different attributes (Fig. 1a). This group was characterised in intermediate-high gelatinisation temperature (low alkali score) and low head rice yields. The genotypes, in general, had short to medium grains ($\leq$ 6.60 mm).

Group II: Twenty four genotypes with intermediate gelatinisation temperature and moderate head rice recovery represented this group. This group had wide index-score-value range with the highest mean index score (Table 4).

Groups III, IV and V had cultivars with low alkali digestion value (high gelatinisation temperature) and moderate head rice yield; 5,5 and 6 genotypes respectively formed above three groups.

Group VI: This group comprised five genotypes having intermediate to low gelatinisation temperature and moderate head rice recovery (Fig. 1b). The index score values ranged from 7 to 10 and the mean index score was high (Table 4). The clustering of the genotypes as well as pattern of distribution of quality traits were irrespective of the ecotypic differences. This may probably be due to limited differentiation in quality attributes under two agro-ecological conditions.

Seventy four genotypes could be assigned to one or the other group but 32 genotypes did not belong to any group as they were widely scattered in relation to each other. The cultivars with low or intermediate gelatinisation temperature and high head rice yield were largely scattered (Fig. 1b).

The index score values ranged from 6 (Bagri Black, HRC 446 and HRC 446B) to 12 (Brown Gora HRC 407). The maximum number of genotypes (34) recorded the

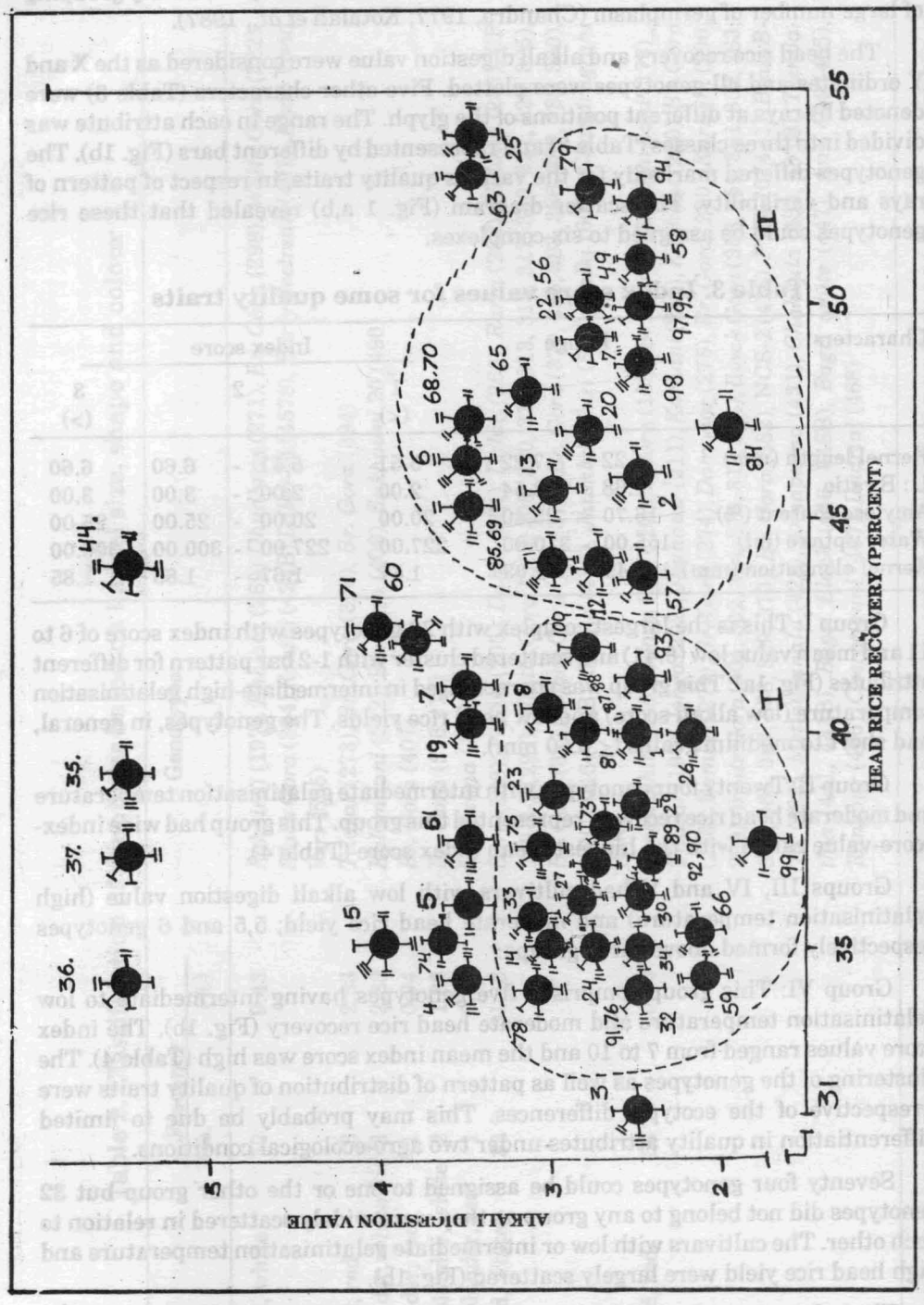

Fig. 1 (a). Scatter diagram of metroglyph analysis

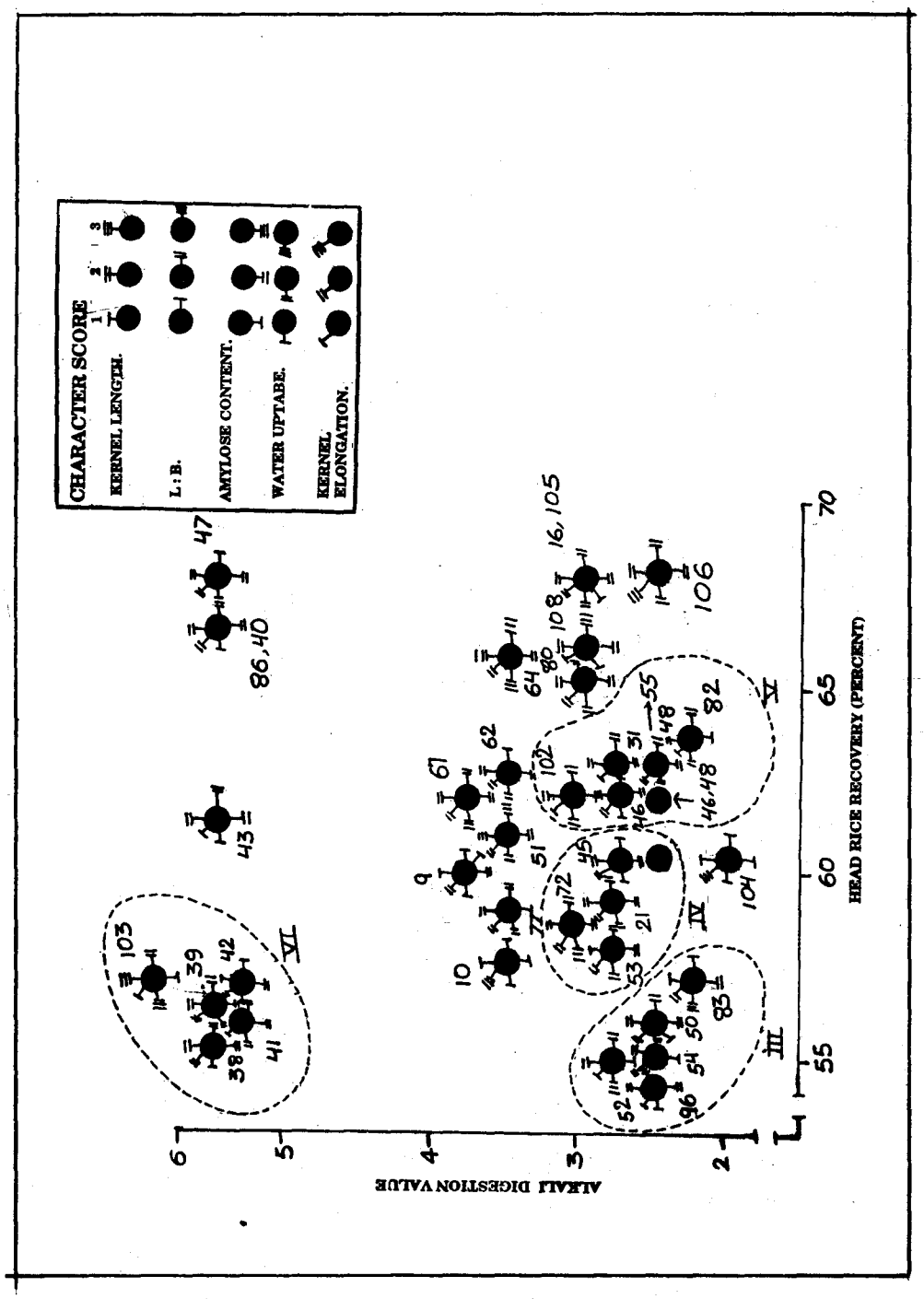

Fig. 1 (b). **Scatter diagram of metroglyph analysis.**

Table 4. Index score values and distribution of genotypes in different clusters

Cluster	Index score value Range	Mean	No. of genotypes	Genotypes
I	6.0 - 11.0	8.41	29	*Black Gora* (1), *White Gora* (8), *White Gora* (14,18, 23, 24), *Black Gora* (26, 27, 28, 29, 30, 32, 33, 34), *Tilasar* (59), *Karhani* (66), *Tilasar* (73), *Nauhia* (75) *Karhani* (76), *Karhani* (78), *Chakkula* (87), *Chakkula* (88, 89) *Parijat* (90), *Teenpathia* (91), *Teenpathia* (92), *Bagri Black* (93), *Cherannoni* (99). *Dharila*l (100)
II	6.0 - 11.0	9.33	24	*Br. Gora* (2.6), *White Gora* (7, 11, 12, 13, 20, 22), *Br.* Gora (49), *Jonga* (56), *Karhani* (57), *Saro* (58), *Karhani* (65), Dahia (68), *Raira* (69), *Bhojani* (70), *NCS*-2 (79), *Beali B*-76 (81), *ARC* 7046 (84), *Annapurna* (85), *Bagri Black* (94), *Bagri White* (95), *Aus* 454 (97), *Rangpur* (98)
III	8.0 - 9.0	8.80	5	*Br. Gora* (50, 52) *Haskalm*a (54), *Mettasannalu* (83), Laloo-14 (96)
IV	7.0 - 11.0	9.00	5	*White Gora* (21), *Br. Gora* (45, 53), *Ramke*l (72), *Jhul lakhibiri* (104)
V	7.0 - 9.0	8.50	6	*Black Gora* (31), *Br. Gora* (46), Br. Gora (48), *Jonga White* (55), Rohini (82), *Early Seetareall* (102)
VI	7.0 - 10.0	9.00	5	*Br. Gora* (38), *Black Gora* (39), *Br. Gora* (41, 42), *Khao Vano Veri* (106)

Within parentheses are the Serial no. corresponding to clustering in Fig. 1.

Table 5. Physico-chemical and cooking quality characteristics of some important rice landraces

Genotype	Index Score*	Head rice yield (%)	Kernel length (mm)	L : B ratio	Alkali value	Amylose content (%)	water uptake (ml)	Kernel elongation	Desirable traits
Br. Gora (HRC 160)	11	46.0	5.46	2.00	2.5	20.3	270	1.88	Kernel elongation
Kalamdani	11	65.9	7.02	3.54	3.5	22.1	340	1.77	High head rice yield, LS grains, intermediate amylose and GT, high water uptake
Dahia (HRC 264)	11	62.0	5.78	2.38	3.5	20.9	350	1.76	High water uptake
Raria (HRC 268)	11	45.3	5.88	2.10	3.5	20.9	370	1.77	High water uptake
Ramkel (HRC 272)	11	58.1	5.68	2.43	2.8	21.5	350	1.80	High water utpake, head rice yield
Br. Gora (HRC 298)	11	41.2	5.61	2.40	3.5	22.1	210	1.64	Intermediate GT and amylose content
White Gora (HRC 320)	11	47.1	5.82	2.27	2.8	22.8	245	1.92	High kernel elongation and intermediate amylose content
Black Gora (HRC 359)	11	40.0	5.29	2.44	2.5	20.9	330	1.62	High water uptake
Br. Gora (HRC 407)	12	61.0	6.89	3.17	3.5	23.0	240	1.64	High head rice yield, LS grains
Chandragrahi (HRC 606)	11	68.1	5.62	2.26	2.5	22.1	230	1.89	High head rice yield and kernel elongation

Within parentheses are the Hazaribagh Rice Collection (HRC) numbers to indicate seed source
* Cumulative

index score of 9 and 22 had score 10 but they were scattered in different complexes. Some of the important genotypes having cumulative index score of 11 or more out of the maximum score of 15, indicating multiple desirable quality traits (Table 5) could successfully be utilised in the rice quality improvement programme.

REFERENCES

Anderson, E. 1957. A semigraphical method for the analysis of complex problems. *Proc. Nat. Acad. Sci.* **43** : 923-927.

Azeez, M.H. and M. Shafi. 1966. Quality in rice. Tech. Bull. No. 13, Department of Agril., Govt. West Pakistan, pp. 50.

Beachell, H.M. and J.W. Stansel. 1963. Selecting rice for specific cooking characteristics in a breeding programme. *Rice Comm. Newsl.* **12** : 25-40.

Chandra, S. 1977. Comparison of Mahalanobis' method and metroglyph technique in the study of genetic divergence in *Linum usitatissimum* L. germplasm collection. *Euphytica* **26** : 141-148.

Chauhan, J.S. and J.S. Nanda. 1983. Genetic variability for physico-chemical characters of rice grain in segregating *Oryza sativa* L. *Oryza* **20** : 209-215.

Govindaswamy, S. and A.K. Ghosh, 1969. Time of harvest, moisture content and method of drying on milling quality of rice. *Oryza* **6** : 54-66.

Hussain, A.A., D.M. Maurya and C.P. Vaish. 1987. Studies on quality status of indigenous upland rice (*Oryza sativa* L.). *Indian J. Genet.* **47** (2) : 145-152.

Jennings, P.R., W.R. Coffman and H.E. Kauffman. 1979. Grain quality. *In* : Rice Improvement. IRRI, P.O. Box 933, Manila, Philippines.

Juliano, B.O. 1971. A simplified assay for milled rice amylose. *Cereal Science Today* **16** : 334-340.

Kotaiah, K.C., Rao, C.P., J.M. Reddy and M.V. Reddy. 1987. Comparison of Mahalanobis' D^2 and metroglyph analyses in long duration genotypes of rice. (*Oryza sativa* L). *Indian J. Genet.* **47** (1) : 55-60.

Little, R.R., G.B. Hilder and E.H. Dowson. 1958. Differential effect of dilute alkali on 25 varieties of milled white rice. *Cereal Chemistry* **35** : 111-126.

Sadananda, A.R., F.U. Zaman and E.A. Siddiq. 1987. Genetic variability for indices of major cooking and nutritive quality characters in rice (*Oryza sativa* L) collections from Northeast Indian hills. *Indian J. Genet.* **47** (3) : 249-255.