Indian J. Genet., **66**(1): 13-15 (2006)

Variation for grain and quality characteristics in rice (*Oryza sativa* L.)

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(Received: August 2005; Revised: December 2005; Accepted: December 2005)

Abstract

Breeding for superior rice (*Oryza sativa* L.) genotypes having high yield potential coupled with desirable quality attributes should be the strategy for a successful breeding programme. The current investigation therefore evaluated the physico-chemical characters and cooking quality of 56 high yielding rice varieties from different eco-geographical areas *viz.*, Bangladesh, China, India, Indonesia, Malaysia, Pakistan, Philippines and Sri Lanka.

Key words: Rice, physico-chemical characters, cooking quality, amylase content, alkali spreading value

Introduction

Rice (*Oryza sativa* L.) being the primary product of consumption and commerce, processing and quality traits are crucial for evaluation. Hence performance testing of rice varieties, quality wise is an integral part of rice breeding programmes. Cooking quality in rice is primarily determined by water uptake, volume expansion, linear cooked kernel elongation and texture. Texture is influenced by amylose content and alkali spreading value. High amylose type varieties cook dry, flaky, and fluffy and have high volume expansion but harden rapidly on cooling. Rice with intermediate amylose content shows the fluffiness of high amylose content but remains soft after cooling. Varieties with low amylase content become sticky on cooking [1]. Breeding for superior genotypes having intermediate amylose content and high yield potential should be the strategy for a successful breeding programme suitable for South and South East Asia. Since intermediate amylose content (20%-25%) is preferred in India, genotypes having intermediate amylose content should be utilized for quality improvement in rice. In Kerala, since red rice is preferred to white rice, red kernelled rice with intermediate amylose content should be used for quality breeding. In the present study 56 high yielding rice varieties of diverse origin were evaluated for physico-chemical characters and cooking qualities and grouped accordingly.

Materials and methods

The materials of the study undertaken during 1995-2000 consisted of 56 high yielding rice genotypes representing various eco-geographical conditions prevailing in Bangladesh, China, India, Indonesia, Malaysia, Pakistan, Philippines and Sri-Lanka. Out of 56 genotypes, 27 genotypes are indigenous to India, recommended for cultivation in different ecological conditions of Kerala. Field trials were laid out at Agricultural Research Station, Mannuthy of Kerala Agricultural University. Plots were laid out in a randomized block design in three replications. All cultural operations were carried out as per the package of practice Recommendations of Kerala, 1993 [2]. Grain quality attributes that were evaluated include physico-chemical characters like grain length, grain breadth, L/B ratio of grain, hulling percentage, milling percentage, presence of awn, lemma palea pubescence, lemma palea colour and kernel colour and cooking qualities like amylose content, alkali spreading value, water uptake, volume expansion ratio and kernel elongation ratio. Amylose content and alkali value are the important characters in determining the cooking quality of rice [3]. Amylose content was estimated as per the method suggested by Sadasivam and Manikkam [4]. Alkali spreading value was scored according to the method of Little *et al.*, [5]. All other observations were taken as per the standard evaluation system suggested by Shouichi *et al.*, [6] and IRRI [7]. The details of genotypes evaluated and their source are given in Table 1.

Results and discussion

Mattatriveni and IR62030-18-2-2 had the highest grain yield followed by S 972B-22-1-3-1-1, Karthika, IR50 and AS25370. Grain length of IR60133-184-3-2-2 was the maximum followed by that of PK2480-7-31, PK2557-24-2-1 and IR56453-184-2-1-2. Maximum grain breadth was observed for HSICHU 64 followed by Vitally 2, Vitally 3, Vytilla 4 and Kachsuing Sen Yu 338. On the basis of grain dimensions (length and length /breadth) all IRRI genotypes, Pakistan genotypes, Malaysian genotypes, Indonesian genotypes evaluated

Table 1. Grain and quality characteristics of high yielding rice varieties

Genotype	Source	Grain yield (tonnes /ha)	Grain length (mm)	Grain breadth (mm)	L/B ratio	Hulling %	Milling %	Amy-lose content (%)	Alkali spread-ding	Water uptake	Volume expan-sion ratio	Kernel elonga-tion ratio
AT85-2	Srilanka	2.75	9.26	3.18	2.91	76.1	51.1	36.80	4.7	0.98	3.17	1.48
BR4676-72-2-4	Bangladesh	2.53	8.43	2.56	3.30	77.5	72.8	21.94	2.0	0.71	2.97	1.44
BR4689-17-1-5	Bangladesh	3.54	9.19	3.12	2.94	69.1	52.3	26.36	4.3	0.61	2.58	1.20
IR 53970-21-2-3-2	IRRI	3.49	9.61	2.79	3.45	75.5	71.7	20.74	2.0	0.55	2.07	1.13
IR 54883-152-3-3	IRRI	3.86	9.61	2.59	3.72	74.3	73.7	23.05	5.3	0.59	2.35	1.30
IR54550-181-2-1-2-3	IRRI	2.53	9.53	2.61	3.74	71.1	88.1	27.26	2.0	0.58	2.80	1.20
IR56453-184-2-1-2	IRRI	2.96	10.06	2.79	3.61	74.8	59.5	29.68	5.3	0.84	2.66	1.37
IR59682-132-1-1-2	IRRI	3.02	9.56	2.86	3.59	69.2	68.5	26.10	6.3	0.56	2.70	1.20
IR60133-184-3-2-2	IRRI	3.10	10.11	2.64	3.85	77.5	62.4	26.82	2.7	0.50	1.93	1.23
IR60832-187-2-2-2	IRRI	3.32	10.00	2.80	3.85	77.6	69.4	27.42	2.0	0.68	2.75	1.30
IR81006-37-2-1-2	IRRI	2.40	9.82	2.84	3.46	75.5	66.4	28.90	6.0	0.70	2.75	1.37
IR62030-18-2-2	IRRI	6.11	9.60	2.62	3.65	75.7	75.1	29.70	5.0	0.58	2.76	1.33
IR62164-14-2-2-2-3	IRRI	2.68	9.71	2.68	3.64	75.8	71.7	26.30	3.7	0.38	2.05	1.18
IR360 (International CHE)	IRRI	3.79	9.22	2.66	3.48	76.2	75.4	30.52	1.0	0.42	2.08	1.21
IR50 (International CHE)	IRRI	4.12	9.29	2.57	3.61	72.6	71.8	32.56	5.3	0.65	2.74	1.21
Kachsuing Sen Yu 338	Taiwan	3.02	8.81	3.45	2.56	68.9	57.8	19.04	3.0	0.66	2.31	1.13
HSICHU 64	Taiwan	1.17	7.35	3.76	1.95	78.0	66.3	26.57	3.3	0.57	2.78	1.80
MR 123	Malaysia	3.31	10.01	2.61	3.84	72.4	88.7	19.46	1.0	0.39	2.33	1.45
PK2480-7-31	Pakistan	2.53	10.10	2.73	3.70	76.6	76.8	30.00	5.0	0.51	2.06	1.36
PK2557-24-2-1	Pakistan	1.77	10.08	2.70	3.73	75.9	72.5	24.12	2.3	0.56	2.40	1.17
PK3355-5-1-4	Pakistan	1.39	9.81	3.09	3.23	78.2	67.7	31.03	5.3	0.49	1.93	1.29
S972B-22-1-3-1-1	Indonesia	3.07	9.15	2.60	3.51	77.5	80.3	32.47	1.0	0.63	2.61	1.22
S976B-PN-25-1	Indonesia	4.34	9.48	2.76	3.44	77.2	78.3	24.87	4.7	0.50	2.15	1.24
Asha	India (Kerala)	1.67	8.78	3.26	2.70	78.2	69.3	23.05	3.7	0.50	1.87	1.23
Athira	India (Kerala)	3.45	8.56	3.08	2.77	71.8	51.7	25.27	3.7	0.68	2.60	1.31
Bhadra	India (Kerala)	2.78	7.80	3.25	2.41	77.5	88.1	25.06	4.3	0.66	2.74	1.23
Bhagya	India (Kerala)	2.46	8.82	3.29	2.69	79.6	60.4	29.17	6.0	0.64	2.50	1.24
Hraswa	India (Kerala)	0.72	8.64	3.33	2.59	71.7	69.1	29.37	7.0	0.69	2.85	1.13
Jaya	India (Kerala)	2.12	9.20	3.17	2.90	78.3	87.5	23.77	2.0	0.42	2.04	1.22
Jayathi	India (Kerala)	3.47	8.77	2.99	2.94	67.3	57.8	23.52	2.7	0.60	2.34	1.33
Jyothi	India (Kerala)	3.32	9.73	3.13	3.11	76.0	64.2	25.67	4.7	0.57	2.38	1.20
Kanchana	India (Kerala)	2.25	8.91	3.11	2.87	71.5	64.9	29.01	4.3	0.61	2.39	1.32
Kanakam	India (Kerala)	2.30	8.49	3.24	2.63	78.9	69.3	29.45	4.3	0.59	2.42	1.23
Kairali	India (Kerala)	2.58	8.41	3.00	2.64	77.8	50.1	22.14	2.7	0.55	2.22	1.15
Karthika	India (Kerala)	4.33	9.83	3.22	2.65	76.5	60.4	31.40	7.0	0.66	2.75	1.24
Makam	India (Kerala)	2.73	8.59	3.39	2.54	77.2	57.1	29.11	3.3	0.49	2.00	1.28
Mahsuri	India (Kerala)	0.73	7.97	2.75	2.91	75.9	71.3	23.64	4.3	0.54	2.75	1.23
Mattatriveni	India (Kerala)	6.32	8.55	3.26	2.82	71.7	63.1	30.44	1.0	0.55	2.17	1.32
Onam	India (Kerala)	2.85	8.66	3.31	2.62	76.4	69.7	26.91	3.0	0.54	2.53	1.21
Pavizham	India (Kerala)	3.25	7.72	3.22	2.40	74.9	65.3	29.45	3.3	0.56	2.63	1.31
Ranjini	India (Kerala)	2.52	8.51	3.14	2.72	70.4	51.9	22.65	5.0	0.51	2.45	1.26
Remya	India (Kerala)	1.98	9.35	3.15	2.98	72.3	68.2	28.47	4.0	0.51	2.32	1.22
Sabari	India (Kerala)	1.89	9.88	3.48	2.87	72.7	68.6	25.99	6.0	0.60	2.48	1.50
Vytilla 2	India (Kerala)	1.63	9.09	3.63	2.53	77.2	52.2	31.07	2.3	0.47	2.33	1.20
Vytilla 3	India (Kerala)	2.44	8.84	3.65	2.48	76.6	70.7	30.28	3.3	0.59	2.55	1.36
Vytilla 4	India (Kerala)	1.99	9.16	3.48	2.63	75.1	71.1	30.70	2.3	0.57	2.52	1.45
AS25370	India	4.03	8.98	3.22	2.80	77.1	71.8	24.34	2.3	0.47	2.35	1.36
CCI 22-23-4-301	India	1.07	8.51	2.88	2.96	74.3	53.7	29.49	4.7	0.62	2.50	1.46
CCI38-11-8M14	India	0.52	9.04	2.82	3.20	75.3	56.7	31.20	5.7	0.59	2.71	1.16
CR 294-548	India	2.85	9.86	3.18	3.10	75.2	51.7	29.25	5.7	0.45	2.14	1.11
RAVI (RP 1864-1529-4254)	India	2.61	8.86	3.22	2.75	73.8	72.7	24.99	4.0	0.57	2.20	1.26
RP 1670-1418-2205-1585	India	3.12	9.61	2.68	3.62	75.4	71.1	20.15	3.7	0.53	2.17	1.24
CV (%)		24.34	3.02	3.01	3.04	0.62	1.23	3.76	28.68	1.72	4.35	2.65

and BR 4676-72-2-4 (from Bangladesh) were grouped under long slender category. All Indian varieties except CCI 38-11-6F-314, CR 294-548 and RP 1670-1418-2205-1585 and the varieties Kachsuing Sen Yu 338 (Taiwan) and BR4689-17-1-5 (Bangladesh) had long bold grains. The Thaiwan variety HSICHU 64 was of short bold grain type.

Most of the high yielding varieties evaluated lacked awn. The varieties Vytilla 2 and Vytilla 4 possessed long and fully awned grains while the varieties Vytilla 3 and Sabari had long and partly awned grains. The varieties AT85-2, PK2480-7-31, IR 36, Annapurna and Kanchana possessed short and partly awned grains.

Out of 56 rice genotypes evaluated, 25 genotypes were with straw apiculus colour, 20 were with grains having apiculus colour gold and gold furrows on straw back ground. Apiculus colour of six genotypes was brown spots on straw. Two genotypes each exhibited brown furrows on straw and brown apiculus colour respectively. All Indian genotypes that were evaluated except Mahsuri, Jaya, CCI 22-23-4-301 and CR 294-548 and the only Sri-Lankan variety evaluated were with red kernel. The kernel colour of the genotypes from IRRI, Taiwan, Bangladesh, Malaysia, Pakistan and Indonesia was white.

Hulling percentage was the maximum for the variety Bhaghya followed by Kanakam, Jaya, Asha, PK3355-5-1-4, HSICHU 64, Kairali and Ahalya. Hull content was the highest in the variety Jayathi with minimum hulling percentage 67.3 followed by Kachsuing Sen Yu 338 and IR59682-132-1-1-2 and BR4676-72-2-4. The variety Aruna exhibited the maximum milling percentage followed by S 976B-PN-25-1, PK2480-7-31.

Amylose content varied from 19.04-36.8 %. All IRRI genotypes that were evaluated had high amylose content (>25%) except in IR 53970-21-2-3-2 and IR 54883-152-3-3. Out of 33 Indian genotypes evaluated, 10 genotypes had intermediate amylose (20-25%) and the remaining had high amylose. One of the Taiwan varieties Kachsuittg Sen Yu 338 and the only Malaysian genotype MR 123 had low content of amylose (8-19%). The Sri-Lankan genotype AT85-2 possessed the highest amylose content followed by IR50, S 972B-22-1-3-1-1, Karthika, CCI 38-11-6F-314, Ahalyaand PK3355-5-1-4.

More pronounced alkali reaction for IR59682-132-1-1-2, Ahalya, Hraswa and Karthika are indicative of a low final gelatinization temperature. Twenty-four rice genotypes exhibited intermediate alkali reaction value indicative of an intermediate gelatinization temperature. Low alkali reaction value was seen for 16 rice genotypes showing high final gelatinization temperature. Twelve genotypes were of the type with high gelatinization temperature having alkali reaction value between 3-4.

When cooked, the kernel of Sri-Lankan variety absorbed more water followed by BR4676-72-2-4, IR61005-37-2-1-2, Hraswa, IR60832-187-2-2-2 and Kachsuing Sen Yu 338. Volume expansion ratio was the maximum for the Sri-Lankan variety, BR4676-72-2-4, followed by Hraswa, IR54550-181-2-1-2-3 and HSICHU 64. The genotypes Asha, PK3355-5-1-4, IR60133-184-3-2-2 and Makam expanded the least after cooking. The variety HSICHU 64 exhibited the maximum kernel elongation ratio after cooking followed by Sabari, AT85-2, CCI 22-23-4-301, MR 123 and Vytilla 4.

The present study evaluated the yield performance, physico-chemical characters and cooking quality traits of high yielding rice varieties representing different eco-geographical conditions prevailing in Bangladesh, China, India, Indonesia, Malaysia, Pakistan, Philippines and Sri-Lanka. This will be helpful in assessing the varietal characters for selecting parents for breeding programmes. Cooking quality requirement of varieties vary with consumer preference. The people of India prefer varieties with intermediate amylose content. The 56 rice genotypes evaluated were grouped as high, intermediate and low amylose types.

Acknowledgement

This paper forms a part of the Ph.D. thesis of the senior author submitted to the Kerala Agricultural University, Thrissur.

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