IJAS

International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 7, Issue 10, 2015, pp.-719-723.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

PHYSICO-CHEMICAL AND COOKING QUALITY CHARACTERISTICS OF HIGH YIELDING TWO LINE HYBRIDS IN RICE

DHIVYAPRIYA D.[1]* AND KALAIYARASI R.[2]

[1&2]Department of Rice (CPBG), Tamil Nadu Agricultural University, Coimbatore, India.
*Corresponding Author: Email: 89ddp06@gmail.com

Received: July 22, 2015; Revised: October 14, 2015; Accepted: October 29, 2015

Abstract- The physico- chemical characteristics of rice grains are important indicators of grain yield. Grain quality characteristics were studied for fifteen promising hybrids along with its parents. Hulling percent ranged between 68.75 % to 88.70 %. The hybrids namely TS09 22 X CO 43, TS09 22 X CB05/501, TS09 22 X T1408.10, TS09 410 X ADT 38 and TS09 410 X WGL 14 had the highest values of hulling, milling and head rice recovery percentage. Highest kernel length of 5.80 mm was observed in TS09 12 X CB05 911/884. The hybrids namely TS09 22 X T1408.10, TS09 28 X CO 43 categorized under the medium slender type. Cooking characters viz., Elongation ratio ranged from 1.24 to 1.57. Kernel length after cooking was high in the hybrid TS09 22 X G14. Among the parents, TGMS line TS09 22 had the medium slender type and G 14 had the highest L/B ratio and it falls under long slender type. Six hybrids namely TS09 22 X CO(R) 50, TS09 22 X CB05 /501, TS09 22 X T1408.10, TS09 22 X CB05 911/884, TS09 28 X CO 43 and TS09 410 X ADT 38 had the intermediate gelatinization temperature. Two hybrids exhibited soft gel consistency TS09 28 X CO 43 and TS09 410 X T360. GC ranged from 51.00 mm to 72.50 mm. Intermediate amylose content was seen in all hybrids. Rice hybrids with intermediate amylose content give soft and flaky rice. The hybrids TS09 22 X T1408.10, TS09 28 X CO 43, TS09 410 X ADT 38, TS09 22 X CB05 /501 had desirable quality parameters and appreciable grain yield.

Citation: Dhivyapriya D. and Kalaiyarasi R. (2015) Physico-Chemical and Cooking Quality Characteristics of High Yielding Two line Hybrids In Rice, International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 7, Issue 10, pp.-719-723.

Copyright: Copyright©2015 Dhivyapriya D. and Kalaiyarasi R., This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

Introduction

Rice is the staple food for the largest number of people on the earth. Global production has reached 800 million tones in the year 2006 from the present production to meet the future demand in 2025 [1]. Hybrids have shown 15-20 per cent higher yields than the best semi-dwarf inbred varieties, not only in China [2-4] but also on other countries [5]. Hybrid rice developed in China had a yield advantage of more than fifteen per cent over conventional pure line varieties. Heterosis breeding has been successfully utilized to enhance the productivity of rice crop. However, rice hybrids when introduced into other countries, were rejected due to their larger grain size, excessive chalkiness and low milling yield [6]. The emphasis on breeding for quality has assumed greater significance in recent years due to varied consumer preferences and the market demand for the quality rice. The physical grain characters that determine the appearance and market value of rice and non-chalkiness of endosperm and grain dimension. Hybrids must also have grain quality that is at least comparable, if not superior to that inbred check varieties grown by the farmers. However, limited offers have been made in the improvement of grain quality of hybrid rice. Quality is a complex phenomenon governed by physico-chemical properties of starch. It is difficult for breeders to improve rice grain yield and quality using conventional methods, due to a lack of discrete phenotypic segregation in the progeny. As rice quality is an endosperm trait, its inheritance can be more complicated because the genetic expression of an endosperm trait in cereal seeds is conditioned not only by the triploid endosperm genotype, but also by the diploid maternal genotype and any additional possible cytoplasmic differences [7-9]. In pure lines, all the individual kernels are more or less uniform with respect to different grain quality characteristics. In hybrids, seed borne on F_1 plants represent the F_2 seeds which are intermediate to the parents and uniform in shape but different in cooking quality characteristics. This affects the quality of cooked rice. Size and shape are important factor to farmer. Preference for grain size and shape vary from one group of consumers to others [10]. Rice grain quality includes the milling, appearance, cooking and nutritional qualities. Among these, people pay more attention to the appearance and cooking quality [11]. The amylose content of rice is considered as the main parameter of cooking and eating quality [12]. The present study aimed to analyze and evaluate the physico-chemical and cooking properties of some promising rice hybrids which were selected based on the criteria of grain yield per plant.

Materials and Methods

The laboratory experiment was carried out at rice quality lab, Department of Rice, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. The materials including fifteen hybrids and its parents were listed [Table-1,2] respectively. The methodology followed were standard evaluation system/methods were followed for scoring and evaluation.

Physical characters

Rice Technical Working Group [13] recommended ≥75 percent hulling percent, ≥ 65.1 percent for milled rice and ≥ 48 per cent for head rice recovery.

Kernel length measurement

On the basis of the average length, kernels were classified as follows

Size category	Scale
Extra long (more than 7.5 mm)	1
Long (6.61 to 7.5 mm)	3
Medium (5.51 to 6.60 mm)	5
Short (5.50 mm or less)	7

Kernel length/breadth ratio

The ratio of kernel length / breadth was worked out. Based on the ratio, the following categories were made for grain shape.

Scale	Shape	L/B ratio
1	Slender	over 3.0
3	Medium	2.1 - 3.0
5	Bold	1.1 – 2.0
9	Round	1.0 or less

Table-1. *List of hybrids selected for analysis of quality parameters*

S. No	Hybrids
1	TS09 12/CO 43
2	TS09 12/CB05 911/884
3	TS09 22/CO 43
4	TS09 22/CO(R)49
5	TS09 22/CO(R)50
6	TS09 22/CB05/501
7	TS09 22/IWP
8	TS09 22/WGL 14
9	TS09 22/G 14
10	TS09 22/T1408.10
11	TS09 22/CB05 911/884
12	TS09 28/CO 43
13	TS09 410/ADT 38
14	TS09 410/WGL 14
15	TS09 410/T360

Cooking qualities

Kernel length and breadth after cooking (KLAC and KBAC)
Kernel length and breadth after cooking were measured [14].

Linear elongation ratio
The ratio of mean length of cooked rice to mean length of milled rice was computed as linear elongation ratio [15].

Breadth wise expansion ratio
The ratio of average breadth of cooked rice grains to the average breadth of polished rice grains was computed as breadth wise expansion ratio [15].

Volume expansion
Volume of the milled rice was measured in a graduated measuring cylinder. Then the milled rice was cooked in boiling water bath in cloth bag upto its cooking time. The cooked rice was blotted free of water and final volume was measured. The ratio of the volume of cooked rice to the volume of milled rice was expressed as volume expansion.

Table-2. *Lines and Testers used in the Study*

S.No.	Parents
Lines	
1	TS09 12
2	TS09 22
3	TS09 28
4	TS09 410
Testers	
1	CO 43
2	CO(R) 49
3	CO(R) 50
4	CB05/501
5	ADT 38
6	IMPROVED WHITE PONNI
7	WGL 14
8	G 14
9	T 360
10	T1408.10
11	CB05 911/884

Chemical characters

Gelatinization Temperature
Gelatinization Temperature (GT) was based on the alkali spreading score of milled rice. Grain appearance and disintegration were visually rated after incubation and expressed in numerical scale [16].

Kernel with a score of 5.5-7.0 was classified as low gelatinization temperature (55-69 °C) ; 3.5-5.4 intermediate (69-74 °C) ; 2.6-3.4 intermediate to high and 1-2 high (>74 °C) .

Description	Score
Grain not affected	1
Grain Swollen	2
Grain Swollen, collar incomplete or narrow	3
Grain Swollen, collar complete and wide	4
Grain split or segmented, collar complete and wide	5
Grain dispersed, merging with collar	6
Grain completely dispersed and intermingled	7

Gel consistency
Gel consistency (GC) was analysed based on the method [17]. The test classified the rice into three categories.

1. Very flaky rice with hard gel consistency (length of hard consistency - < 40 mm)
2. Flaky rice with medium gel consistency (length of gel 40- 60 mm)
3. Soft rice with soft gel consistency (length of gel - > 60 mm)

Amylose content
Simplified procedure [13] was used for the estimation of amylose content. Based on the amylose content milled rice was classified as follows:

Waxy 1-2% amylose

Very low > 2-9% amylose

Low > 9-20% amylose

Intermediate > 20-25% amylose

High > 25-33% amylose

Results and Discussion

Physical parameters

The hulling percent ranged between 68.75 (TS09 410 X T 360) to 88.70 (TS09 22 X CB05/501) [Table-3]. The hybrid TS09 22 X CB05/501 had the highest hulling percent than the parents [Table-3]. Milling is the measure of rough rice recovery during milling. Milling recovery is one of the important criteria of rice quality especially from the standpoint of marketing. Milling recovery depends on grain shape and appearance, which has direct effect on the percentage of hulling, milling and head rice recovery. The hybrids namely TS09 22 X CO 43, TS09 22 X CB05/501, TS09 22 X T1408.10, TS09 410 X ADT 38 and TS09 410 X WGL 14 had the highest values of hulling, milling and head rice recovery percentage. The appearance of milled rice is important to the consumer, which in turn makes it important to the producer and the miller. Thus, grain size and shape are the first criteria for rice quality that the breeders consider in developing new varieties for releases of commercial production [18]. A quality rice variety should have head rice out-turn at least 48 %. Head rice out turn is the proportion of the whole grain in milled rice. Only one hybrid had about 70.96 (TS09 22 X CB05/501). Kernel length, shape, size and uniformity determine the consumer preference. Highest kernel length of 5.80mm was observed in TS09 12 X CB05 911/884. But in parents it had ranged from 7.40mm in case of G14 to 4.60mm (TS09 28). Among all the hybrids analysed, two hybrids TS09 12 X CB05 911/884 (5.80mm) and TS09 22 X T1408.10 (5.60mm) were seen with medium kernel length category. Out of fifteen hybrids observed, three hybrids were found with medium kernel breadth. In general, medium to long grains are preferred in the Indian subcontinent while the country is also replete with hundreds of short grain domestic types and long grain basmati types the latter commanding highest premium in both domestic and international markets. In the present study, the hybrids namely TS09 22 X T1408.10 (3.11mm), TS09 28 X CO 43 (3.25mm) categorized under the medium slender type. Among the parents, TGMS line TS09 22 had the medium slender type (3.11mm) and G 14 had the highest L/B ratio of 4.11 mm (long slender type).

Cooking characteristics

Elongation ratio is an important parameter for cooked rice. Rice with more expansion and less breadth wise ratio is preferred. If rice elongates more lengthwise it gives a finer appearance and it expands girth wise, it gives coarse look [19]. Elongation ratio ranged from 1.24 (TS09 12 X CB05 911/884) to 1.57 (TS09 22 X G 14) [Table-3]. Among the parents observed, the highest linear elongation ratio was seen in T 360(1.76). Kernel length after cooking ranged in the hybrids from 7.00 (TS09 12 X CO43) to 8.20 (TS09 22 X G14). Kernel length after cooking was higher than parents in TS09 22 X G 14, TS09 22 X CO(R) 49 and TS09 410 X T 360. The promising hybrids were shown [Fig-1,2]. Less than 2 mm kernel breadth after cooking is a desirable feature. None of the hybrids/parents exhibited <2 mm of breadth of cooked rice. The imbibitions ratio/volume expansion ratio was more than 4 and is considered particularly as a positive quality feature especially for the lower income community for whom quantity is important criteria. However, higher the volume expansion ratio of rice, lower will be the energy content per unit per volume or weight of cooked rice a they will have more water and less solid materials [19]. Similar results for volume expansion have been reported [20]. Volume expansion ranged from 3.90 (TS09 22 X CB05/501) to 4.70 (TS09 22 X C0 43 and TS09 22 X G14). In parents, it had ranged between 3.30 (T 360) and 5.50 (CO(R) 49).

Chemical characteristics of hybrids and parents

Gel consistency showing how stickiness the cooled paste of cooked rice flour is used as a criterion for evaluation of cooked rice texture. The varieties having the same amylose content can be differentiated for their tenderness of cooked rice by the gel consistency test [17]. Rice with high gelatinization temperature requires more water and time to cook than rice with low or intermediate gelatinization temperature.

Fig. 1. Kernel length and breadth after cooking of TS09 22 X T1408.10

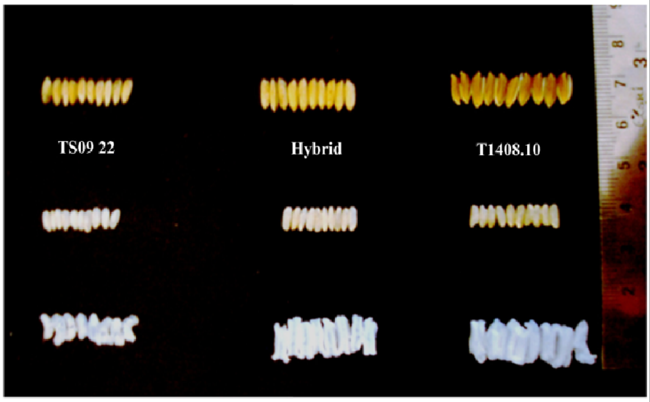
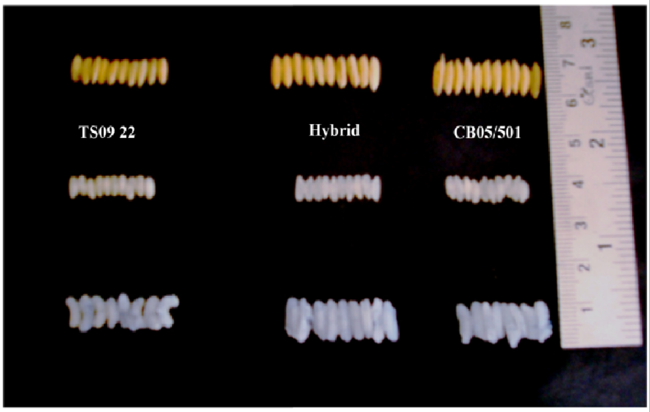


Fig. 2. Kernel length and breadth after cooking of TS09 22 X CB05/501



There seems to be distinct preference for rice with intermediate gelatinization temperature [10]. In the present study, six hybrids namely TS09 22 X CO(R) 50, TS09 22 X CB05 /501, TS09 22 X T1408.10, TS09 22 X CB05 911/884, TS09 28 X CO 43 and TS09 410 X ADT 38 had the intermediate gelatinization temperature [Table-3]. Among the lines, except for TS09 12, other TGMS lines had intermediate GC. Some of the promising hybrids are exhibited in [Fig-3,4]. The results indicate that most of the hybrids/parents required intermediate temperature (69-74 ºC). Gel consistency determines the softness or hardness of the cooked rice. The varieties having the same amylose content can be differentiated for their tenderness of cooked rice by the gel consistency test [17]. GC ranged from 51.00 (TS09 22 X CO(R) 50) to 72.50 (TS09 28 X CO 43). Only two hybrids exhibited soft gel consistency TS09 28 X CO 43 (72.50) and TS09 410 X T360 (65.00). Eleven parents exhibited soft gel consistency. These fall under the category of soft rice with soft gel consistency. A similar result of soft gel consistency was reported for varieties and hybrids in rice [19]. All other hybrids in [Table-3] indicate medium gel consistency. They fall under the category of flaky rice with medium gel consistency. None of the hybrids/ parents showed hard gel consistency. The amount of amylose in the grain determines how sticky the rice will be cooked. High amylose varieties cook dry, flaky, fluffy and have volume expansion but become hard after cooking intermediate amylose rice cook fluffy and remain soft on cooking whereas, low amylose varieties cook sticky. Amylose content is the major important factor for eating quality in rice. In India, intermediate amylose content is preferred. Intermediate amylose content (20-25%) was seen in all hybrids. Rice hybrids with intermediate amylose content give soft and flaky rice.

The present study revealed that out of fifteen hybrids along with its parents studied, 4 hybrids showed promising with desirable quality parameters.

Table-3 *Mean performance of selected hybrids and their hybrids for different quality characters*

Hybrids	Hulling percent	Milling percent	Head rice recovery	Kernel Length (mm)	Kernel Breadth (mm)	L / B ratio	KLAC (mm)	KBAC (mm)	LER	BER	VER	GT	GC	AC (%)
TS09 12/CO 43	72.33	56.33	45.00	5.00	2.00	2.50	7.00	3.00	1.40	1.50	4.20	7.00	59.00	22.70
TS09 12/CB05 911/884	77.02	58.10	47.29	5.80	2.60	2.23	7.20	2.80	1.24	1.07	4.40	6.00	55.00	22.60
TS09 22/CO 43	82.00	67.33	58.66	5.00	2.00	2.50	7.60	2.65	1.52	1.32	4.70	6.00	51.35	21.70
TS09 22/CO(R)49	82.97	64.89	38.29	5.50	2.00	2.75	8.00	2.60	1.45	1.30	4.50	6.00	51.25	24.90
TS09 22/CO(R)50	76.33	62.00	47.33	5.40	2.00	2.70	7.60	3.00	1.40	1.50	4.00	4.00	51.00	24.65
TS09 22/CB05/501	88.70	79.03	70.96	5.20	2.60	2.00	7.40	2.80	1.42	1.07	3.90	5.00	51.30	24.00
TS09 22/IWP	75.36	63.40	54.34	5.00	2.00	2.50	7.60	2.80	1.52	1.40	4.60	7.00	51.35	24.05
TS09 22/WGL 14	82.83	58.20	50.00	5.00	2.00	2.50	7.40	2.80	1.48	1.40	4.70	7.00	57.50	20.20
TS09 22/G 14	74.00	59.00	41.33	5.20	2.00	2.60	8.20	3.20	1.57	1.60	4.20	6.00	57.50	23.80
TS09 22/T1408.10	85.55	74.44	62.22	5.60	1.80	3.11	7.20	2.60	1.28	1.44	4.50	5.00	57.50	22.50
TS09 22/CB05 911/884	75.33	52.00	42.33	5.40	2.00	2.70	7.40	2.80	1.37	1.40	4.10	5.00	54.50	21.60
TS09 28/CO 43	76.02	64.38	54.10	5.20	1.60	3.25	7.20	3.00	1.38	1.87	4.30	5.00	72.50	23.10
TS09 410/ADT 38	83.82	69.11	58.82	5.00	2.00	2.50	7.60	3.00	1.52	1.50	4.10	5.00	60.00	22.10
TS09 410/WGL 14	76.96	69.66	59.55	5.30	2.30	2.30	7.20	2.80	1.35	1.21	4.50	7.00	57.50	20.60
TS09 410/T360	68.75	61.02	46.32	5.40	2.00	2.70	8.00	3.00	1.48	1.50	4.60	6.00	65.00	23.35
Parents	**Hulling percent**	**Milling percent**	**Head rice recovery**	**Kernel Length (mm)**	**Kernel Breadth (mm)**	**L / B ratio**	**KLAC (mm)**	**KBAC (mm)**	**LER**	**BER**	**VER**	**GT**	**GC**	**AC (%)**
TS09 12	75.00	61.50	47.50	5.00	2.10	2.38	7.40	3.00	1.48	1.42	4.90	3.00	70.00	23.50
TS09 22	73.00	59.33	44.00	5.60	1.80	3.11	8.00	2.60	1.42	1.44	5.00	5.00	60.5	21.50
TS09 28	68.83	46.57	34.58	4.60	2.30	2.00	7.00	2.80	1.52	1.21	5.20	5.00	62.50	24.30
TS09 410	70.00	50.00	33.33	5.00	2.00	2.50	7.20	3.20	1.44	1.60	4.80	5.00	61.00	22.30
CO 43	73.97	64.38	55.82	5.10	2.10	2.42	7.40	3.00	1.45	1.42	5.10	7.00	49.50	21.90
CO(R) 49	61.00	41.33	32.66	5.00	1.60	3.12	8.00	3.00	1.60	1.87	5.50	7.00	60.00	30.30
CO(R) 50	71.12	56.69	39.04	5.20	2.00	2.60	7.40	3.00	1.42	1.50	5.30	7.00	70.00	27.80
CB05/501	80.00	64.00	50.00	5.40	1.80	3.00	7.10	2.80	1.31	1.55	4.80	5.00	70.00	26.50
ADT 38	86.39	44.11	31.98	6.00	2.00	3.00	8.20	3.40	1.36	1.70	3.70	4.00	53.50	26.70
IWP	67.66	53.33	45.00	5.30	1.80	2.94	7.20	2.80	1.35	1.55	5.10	7.00	70.00	26.60
WGL 14	70.66	55.66	48.33	5.00	2.00	2.50	7.40	3.00	1.48	1.50	4.80	7.00	70.00	18.90
G 14	76.33	63.33	38.66	7.40	1.80	4.11	9.80	3.50	1.32	1.94	4.20	7.00	60.00	26.10
T 360	72.91	62.50	33.33	5.00	2.00	2.50	8.80	3.00	1.76	1.50	3.30	6.00	70.00	24.40
T1408.10	69.04	63.49	32.53	5.20	2.00	2.60	7.00	2.80	1.34	1.40	5.00	5.00	70.00	23.50
CB05 911/884	75.00	55.00	30.00	5.00	2.00	2.50	7.10	2.90	1.42	1.45	3.90	5.00	70.00	21.70

Fig. 3. Gelatinization temperature of TS09 22 X T1408.10

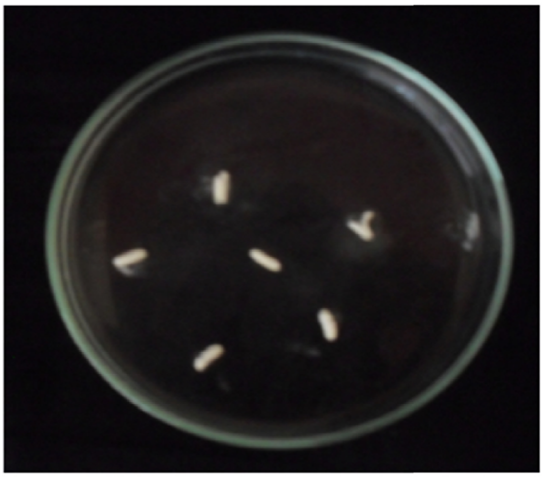
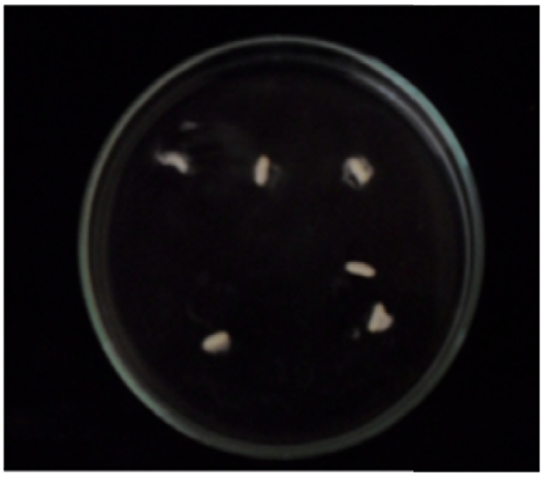


Fig. 4. Gelatinization temperature of TS09 22 X CB05/501



The hybrid, TS09 22 X T1408.10 had high hulling, milling and head rice recovery. The grains are medium slender with KLAC of 7.20 mm. The LER is also less than 2.00 (1.28), with intermediate GT, medium gel consistency and intermediate amylose content. The hybrids TS09 28 X CO 43(hulling, head rice recovery, medium slender grains, intermediate GT, soft gel consistency and intermediate amylose content), TS09 410 X ADT 38 and TS09 22 X CB05 /501 had desirable quality parameters.

It is now time to highlight the improvement of the productivity of rice including its quality. Thus, the knowledge may be utilized for quality improvements for developing high yielding hybrids.

Acknowledgements

The authors are grateful to Department of Biotechnology, Government of India for their financial assistance to undertake this investigation.

References

[1] Shukla S.K. & Pandey M.P. (2008) *Plant Bree,* 127(1), 28-32.
[2] Lin S.C. & Yuan L.P. (1980) IRRI, Manila, Philippines, pp. 33-51.
[3] Yuan L.P. (1994) IRRI, Manila, Philippines. pp 1–6.
[4] Yuan L.P., Yang Z.Y. & Yang J.B. (1994) IRRI, Manila, Philippines, pp 143-147.
[5] Virmani S.S. (1994) IRRI, Manila, Philippines. Pp.142-154.
[6] Virmani S.S. & Zaman. F.U. (1998) IRRI, Manila, Philippines, Pp.177-186.
[7] Pooni H.S., Kumar I. & Khush G.S. (1992) *Heredity,* 69(1), 166-174.
[8] Zhu J. & Weir B.S. (1994) *Theor. Appl. Genet.,* 89(1), 160–166.
[9] MO H.D. (1995) *Acta Genet Sinica,* 22(1), 126-132.
[10] Khush G.S., Poule C.M. & Dela Cruz N.M. (1979) IRRI, Manila, Philippines. pp.21-31.
[11] Huang F. S., Sun Z.X., Hu P.S. & Jang S.Q. (1998) *Chinese J. Rice Sci.,* 12(1), 172-176.
[12] Juliano B.O. (1972) IRRI, Manila, Philippines, pp.389-405.
[13] Rice Technical Working Group National Seed Industry Council (RTWG). (1997) Philippines.
[14] Azenz M.A. & Shafi M. (1996) *West Pakistan Tech. Bull.,* 13(1), 50.
[15] Juliano B.O. & Perez C.M. (1984) *J. Cereal Sci.,* 2(1), 281-292.
[16] Little R.R., Hilder G.D. & Dawson E.H. (1958) *Cereal Chem.,* (35), 111-126.
[17] Cagampang G.B., Perez C.M. & Juliano B.O. (1973) *J. Sci. Food Agric.,* 24, 1589-1594.
[18] Adair C.R., Beachell H.M., Jodon N.E., Johnston T.H., Thysell J.R., Green V.E., Webb B.D. & Atkins J.G. (1966) U.S. Dept. of Agriculture. pp. 19-64.
[19] Anonymous (1997) Bangladesh Rice Research Inst. Gazipur, pp: 24- 25.
[20] Dipti S.S., Hossain S.T., Bari G.H. & Kabir K.A. (2002) *Pak J. Nut.,* 1, 188-190.
[21] Asish K.B., Kalaiyarasi R., Thiyagarajan K. & Manonmani S. (2006b) *Indian J. Genet. & Plant Breed.,* 66 (2), 107-112.
[22] Adair C.R., Beachell H.M., Jodon N.E., Johnston T.H., Thysell J.R., Green V.E., Webb B.D. & Atkins J.G. (1966) U.S. Dept. of Agriculture. pp. 19-64.
[23] Anonymous. (1997) Bangladesh Rice Research Inst. Gazipur, pp: 24- 25.
[24] Dipti S.S., Hossain S.T. Bari G.H. & Kabir K.A. (2002) *Pak J. Nut*., 1, 188-190.
[25] Asish K.B., Kalaiyarasi R., Thiyagarajan K. & Manonmani S. (2006b) *Indian J. Genet. & Plant Breed*, 66 (2), 107-112.