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Evaluation of rice (*Oryza sativa* L.) hybrids for quality traits

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Abstract
Field Experiment was conducted to evaluate 22 rice hybrids for quality traits in Department of Genetics and Plant Breeding, SHUATS, Prayagaraj during *Kharif* 2018 in Randomized Block Design with three replications, received from AICRP Indian Institute of Rice Research (IIRR), Hyderabad. The data were recorded for 10 quality traits. The highest Hulling per cent was observed in the hybrid IHRT-E-3106 (74.23%), highest Head rice recovery (%) was observed in the hybrid IHRT-E-3106 (66.17). The present investigation revealed that the five hybrids *viz.*, IHRT-E-3102, IHRT-E-3116, IHRT-E-3114, IHRT-E-3108, and IHRT-E-3115 showed best cooking quality. Highest L/B ratio was observed in the hybrid IHRT-E-3114 (3.98), highest elongation ratio was observed in the hybrid IHRT-E-3106, highest Gel consistency (mm) was observed in the hybrid IHRT-E-3115(57.7 mm), Alkali spreading value 4 to 7 is preferred for quality rice hybrid IHRT-E-3101 (3.67).

Keywords: Quality trait, hybrid rice, hulling, gel consistency, alkali spreading value, head rice recovery

Introduction
Hybrid rice technology is the strongest tool, Most of the rice hybrids in the country and elsewhere in the world are developed by using the CGMS or the three line system. The CGMS system involves three lines, namely a cytoplasmic male sterile line (A line), a maintainer line (B line) and a restorer line, where restore line (R line) possesses dominant fertility restoring genes. India is still struggling to enhance its average under hybrid rice from the present level of 5% to more. Because of complicated seed production system, higher seed cost and poor grain quality of hybrids it could not cover much area under cultivation in India (Singh *et al*., 2011) [9]. Grain quality of rice plays an important role in consumer acceptability since rice is mainly consumed as whole grain especially in Asia (Seraj *et al*., 2013) Grain quality of rice is determined by the factors: The term rice quality encompasses Hulling, head rice recovery, cooking and eating quality of the grains, gel consistency, grain elongation, and Alkali spreading value. Hybrid rice technology is likely to play key role in increasing the rice production nearly 15-20% over the best pure line varieties. Development of high yielding hybrids with superior Hulling and cooking qualities is now one of the most important objectives in all hybrid rice improvement programmes.

Materials and Methods
The present investigation consists of 22 rice hybrids received from AICRP Indian Institute Rice Research (IIRR), Hyderabad. These were grown in Randomized Block Design with three replications during *Kharif* 2018 at Field Experimentation Centre, Department of Genetics and Plant Breeding, SHUATS, Prayagraj. Five representative plants for each hybrids in each replication were randomly selected and quality parameters record on Hulling (%), head rice recovery(%), Kernel length & kernel width before cooking, and Kernel length & kernel width after cooking, L/B Ratio, elongation ratio, Gel consistency and alkali spreading value evaluated for best performing quality rice hybrids.

Determination of Hulling & Head rice recovery values
Hulling determined from 100 grams Paddy was dehusked in a standard dehusker or Sheller. After cleaning the dehusked kernels (brown rice) were weighted and the percentage**.** Head rice recovery determined the milled samples were sieved to separate whole kernels from the broken ones; Small proportion of whole kernels which passed along with broken grains was separated by hand. Full rice and 3/4th kernels were taken as whole milled rice for computation.
Values were calculated using following formulas:

Values were calculated using following formulas

$$\text{Hulling (\%)} = \frac{\text{Weight of the dehusked grain}}{\text{Weight of the paddy}} \text{ x } 100$$

$$\text{HRR (\%)} = \frac{\text{Weight of whole polished rice (g)}}{\text{Weight of rough rice (g)}} \text{ x } 100$$

Determination of Physical attributes

The cooking quality preferences vary from region to region. Rice is one cereal that is consumed mainly as whole milled and boiled grain. The quality in rice will have to be considered from the view point Grain size, Grain shape, and appearance and cooking characteristics:

Grain size: 15 dehusked rice kernels of each hybrid were arranged lengthwise and width wise, cumulative measurement of length and width respectively in centimetres. Average length and width of the rice kernels was recorded as paddy grain length and width respectively.

Grain shape: Based on length width ratio, the shape of the milled rice is determined as slender (Over 3.0), medium (2.1-3.0), Bold (1.1-2.0) around (1.0 or less).The kernel length and width ratio was calculated using the following formula of Murthy and Govinda Swamy (1967) [7].

$$\text{L/B ratio} = \frac{\text{Mean length of kernels (mm)}}{\text{Mean width of kernel (mm)}}$$

Elongation ratio: Length & width

The length of rice kernel of each sample was measured before and after cooking and the kernel elongation ratio. The width of rice kernel of each sample was measured before and after cooking and the kernel elongation ratio.

Values were calculated using following formulas

$$\text{Elongation ratio} = \frac{\text{Kernel length after cooking (mm)}}{\text{Kernel length before cooking (mm)}}$$

$$\text{Elongation ratio} = \frac{\text{kernel width after cooking (mm)}}{\text{Kernel width before cooking (mm)}}$$

Determination of chemical attributes

To determine cooking quality following chemical attributes were determined:

Gel Consistency (GC)

Based on consistency of gel, rice hybrids are categorised as very flaky with hard gel of 40mm or less; flaky with medium gel of 41-60mm length and soft with gel length of 61mm or more. 100mg kernels flour of different rice samples were collected in thin and long test tubes. 5 ml of 95% ethyl alcohol, 2-3 drop of bromophenol blue and 2 ml of 0.2 MKOH solutions was added. Contents were mixed thoroughly, covered with glass marble and test tube were soaked in boiling water bath for 8 min until the height of all the sample reached 2/3 rd of the test tube. Test tubes were then removed and left to stand at room temperature for 5 min. after cooling in an ice water bath for 20 minutes, all the test tubes were laid horizontally on a graph paper and total length of gel was measured in mm (Cagampang *et al*., 1973) [1].

Alkali spreading (ASV) and Gelatinization temperature (GT)

Six whole milled grains per replication were spread evenly in transparent petridishes containing 10 ml of 1.7 per cent potassium hydroxide solution (KOH). These petridishes were kept undisturbed in an incubator at 27-30°C for 23 hours. The alkali spreading of kernels was noted on a 7 point scale and was expressed as average of six values. Scoring was done by following the method described by (Little *et al*. (1958). The GT of the rice varieties is known to vary between 50 ^{0}C to 79 ^{0} C and classified as low (55-69^0 C); Intermediate (70-74 ^{0}C) and high 75-79 ^{0}C (juliano, 1979).

Results and Discussion

The quality of rice is considered from view characters grain size, grain shape appearance and cooking characteristics determined to increase the acceptability to the consumer (Dela Cruz and Khush, 2000) [2]. The physicochemical traits include grain length(mm), grain width(mm), L/B ratio, Hulling (%), and Head rice recovery, The cooking qualities are Alkali spreading value, Gel Consistency, and Elongation ratio.

Hulling and Head rice recovery

Evaluation of hulling and head rice recovery value is one of the most important traits to know the quality of rice. It is determined the hulling per cent of all rice hybrids unit mass or weight of samples was found to decrease significantly for every level of processing by removal of husk and bran layer from paddy, respectively.

Table 1: Hulling & Head rice recovery values

S.no	Hybrids	Hulling %	HRR
1	IHRT-E-3101	64.2	53.35
2	IHRT-E-3102	67.27	57.23
3	IHRT-E-3103	68.57	50.67
4	IHRT-E-3104	71.38	61.2
5	IHRT-E-3105	63.37	51.27
6	IHRT-E-3106	74.23	66.17
7	IHRT-E-3107	64.11	58.12
8	IHRT-E-3108	69.53	56.9
9	IHRT-E-3109	72	61.13
10	IHRT-E-3110	68.61	53.07
11	IHRT-E-3111	67.53	65.69
12	IHRT-E-3112	72.4	65.47
13	IHRT-E-3113	72.4	68.3
14	IHRT-E-3114	73.4	60.4
15	IHRT-E-3115	71.62	59.73
16	IHRT-E-3116	70.91	61.43
17	IHRT-E-3117	61.4	50.57
18	IHRT-E-3118	72.06	57.73
19	IHRT-E-3119	70	64.07
20	IHRT-E-3120	70.46	64.68
21	IHRT-E-3121	69.42	53.16
22	IHRT-E-3122	70.84	49.96
TOTAL MEAN		69.41	58.75
SE.d		3.95	5
C.D		7.89	9.99
C.V		3.95	14.2
F-test		Sig	Sig

HRR = Head Rice Recovery

Table 1. Gives the Hulling & Head rice recovery value of the

hybrids. Highest & lowest hulling per cent was observed in the hybrid IHRT-E-3106 (74.23%), IHRT-E-3117 (61.4). Head rice recovery ranged from 49.96 to 66.17, in the present investigation, with maximum of 66.17% for IHRT-E-3106 and minimum of 49.96% for IHRT-E-3122. Head rice recovery of 65% or more is considered desirable traits, which in turn depends on the grain type, chalkiness, cultivation practices and drying condition (Dipti *et al*., 2003) [3].

Physical attributes

Grain length, shape, size and uniformity determine the consumer preference. Good rice should have kernel length of at least 6.0 mm. In the present investigation, kernel length was observed to range 6 (IHRT-E-3102) to 8(IHRT-E-3105) with a mean of 6.45 mm (Table 2). Further, the hybrids IHRT-E-3116(6.54), IHRT-E-3118(6) and IHRT-E-3122(7) had recorded more than 6.0 mm kernel length. Kernel breadth less than 2.0 mm is preferred in quality rice. In the present study, kernel breadth was noticed to range from 1.93 (IHRT-E-3102) to 2.7(IHRT-E-3106) (Table 2) further, hybrids IHRT-E-3116(2.2mm), IHRT-E-3118(2.3).It is one of the important physico-chemical characteristics that determine consumer preference. Kernel L/B ratio of 3.50 is preferred for quality rice. In the present study, kernel L/B ratio was however, observed to range from2.1mm (IHRT-E-3106) to 3.98(IHRT-E-3114) (Table2) with an Avg 2.93 further the hybrids IHRT-E-3105(3.68), IHRT-E-3122(3.43), in the present study were classified as slender (>3.0), medium (2.1-3.0), bold (1.1-2.0) and round (<1.0) based on the kernel L/B ratio.

During cooking, rice kernels absorb water and increase in volume through an increase in length or breadth. Length wise increase without increase in girth is desirable and is an important characteristic of high quality premium rice (Hossain *et al*. 2009). The character, kernel length after cooking in the present study ranged from 8.5mm (IHRT-E-3102) to 10.83mm (IHRT-E-3105) (Table 2).

The trait kernel elongation ratio is also considered to be one of the most important attributes for judging cooking quality of rice and an elongation ratio of 1.70 and above has been reported to be ideal for quality rice (Srivatsava *et al*. 2013) [10] In the present study, kernel elongation ratio ranged from1.2 mmto1.91mm with maximum of 1.91mm for IHRT-E-3115 and minimum of 1.2 mm for IHRT-E-3114 further, hybrids IHRT-E-3106 (1.81 mm),IHRT-E-3116 (1.75mm). The character kernel width after cooking ranged from 2.49mm (IHRT-E-3122) to 4.88mm (IHRT-E-3106) (Table 2).kernel width elongation ratio range from1.23mm to1.86mm (Table 2).

Table 2: Physical attributes values

S.no	Hybrids	KLBC	KWBC	KLAC	KWAC	L/B	KLER	KWER
1	IHRT-E-3101	6.00	2.37	9.53	3.83	2.48	1.61	1.53
2	IHRT-E-3102	6.63	1.93	8.50	2.28	2.60	1.66	1.48
3	IHRT-E-3103	6.11	2.07	8.43	4.71	2.81	1.42	1.57
4	IHRT-E-3104	7.01	2.15	9.63	4.88	3.28	1.36	1.54
5	IHRT-E-3105	8.00	2.18	10.83	3.66	3.68	1.38	1.81
6	IHRT-E-3106	5.21	2.70	9.00	4.80	2.10	1.81	1.35
7	IHRT-E-3107	6.33	2.30	8.40	3.27	2.24	1.69	1.25
8	IHRT-E-3108	6.00	2.12	10.20	4.01	3.31	1.46	1.57
9	IHRT-E-3109	6.21	2.25	9.93	3.01	2.56	1.65	1.53
10	IHRT-E-3110	8.00	2.28	8.20	3.58	2.55	1.35	1.43
11	IHRT-E-3111	7.04	2.14	10.50	2.63	3.73	1.33	1.85
12	IHRT-E-3112	7.01	2.16	10.47	3.14	3.27	1.46	1.57
13	IHRT-E-3113	8.00	2.18	10.33	3.41	3.26	1.42	1.76
14	IHRT-E-3114	5.01	2.04	9.63	2.99	3.98	1.20	1.73
15	IHRT-E-3115	6.05	2.23	9.40	3.33	2.17	1.99	1.77
16	IHRT-E-3116	6.54	2.20	10.43	4.61	2.72	1.75	1.86
17	IHRT-E-3117	7.01	2.25	8.83	3.61	2.22	1.74	1.45
18	IHRT-E-3118	6.00	2.30	10.53	3.48	3.15	1.52	1.63
19	IHRT-E-3119	6.00	2.22	9.80	4.36	2.71	1.65	1.75
20	IHRT-E-3120	7.01	2.60	8.50	3.53	2.31	1.42	1.23
21	IHRT-E-3121	7.01	2.17	10.13	4.56	3.27	1.45	1.84
22	IHRT-E-3122	7.00	2.04	10.00	2.49	3.43	1.50	1.85
TOTAL MEAN		6.45	2.22	9.66	3.66	2.98	1.53	1.62
SE.d		0.14	0.06	0.29	0.20	0.04	0.06	0.04
C.D		0.29	0.12	0.58	0.40	0.05	0.06	0.08
C.V		3.80	4.36	5.00	9.47	2.28	4.12	4.31
F-test		Sig	Sig	Sig	Sig	Sig	Sig	Sig

Table 3: Chemical attributes values

S.no	Hybrids	GC	ASV
1	IHRT-E-3101	45.07	3.67
2	IHRT-E-3102	53.37	5.33
3	IHRT-E-3103	43.57	4.67
4	IHRT-E-3104	49.5	6.33
5	IHRT-E-3105	52.2	7.4
6	IHRT-E-3106	56.8	5.67
7	IHRT-E-3107	36.8	4.33
8	IHRT-E-3108	40.67	4.67

9	IHRT-E-3109	30.98	4.69
10	IHRT-E-3110	43.33	4.33
11	IHRT-E-3111	31.17	3.67
12	IHRT-E-3112	43.23	6
13	IHRT-E-3113	44.47	5
14	IHRT-E-3114	40.7	4.67
15	IHRT-E-3115	57.7	4.67
16	IHRT-E-3116	50.27	6
17	IHRT-E-3117	36.13	4
18	IHRT-E-3118	43.4	5
19	IHRT-E-3119	53.4	4
20	IHRT-E-3120	49.43	5.67
21	IHRT-E-3121	44.23	4.67
22	IHRT-E-3122	52.23	3.67
TOTAL MEAN		45.76	4.78
SE.d		2.11	1.04
C.D		4.21	2.17
C.V		11.78	38.21
F-test		Sig	Sig

GC= gel consistency (mm), ASV = alkali spreading value.

Chemical attributes

The analysed values of various chemical characteristics; Gel consistency determines the softness of cooked rice which can be classified as very flaky rice with hard gel consistency (26-40 mm),flaky rice with medium gel consistency (41-60 mm) and soft rice with soft gel consistency (61-100 mm).In the present study, gel consistency ranged from 30.98mm (IHRT-E-3109) to 57.7mm (IHRT-E-3115) further, hybrids 53.4 mm (IHRT-E-3119), 53.37mm (IHRT-E-3102), Table (3).

Alkali spreading value of 4.0 to 7.0 is preferred for quality rice, studied in the present investigation had recorded alkali spreading value in the desired range of 4.0 to 7.0 (Table 3). However, IHRT-E-3101, IHRT-E-3111, IHRT-E-3122 had recorded alkali spreading value of 3.57 and the hybrids IHRT-E-3105, IHRT-E-3117, IHRT-E-3119, had recorded value of (4) Further, maximum alkali spreading value was recorded for IHRT-E-3116 (6.00) and minimum alkali spreading value of 3.67 was noticed for IHRT-E-3101 rice hybrids. The average alkali spreading value of the rice genotypes studied in the present investigation was 4.78.

Conclusion

The concluded rice hybrids cover wide range of characteristics with respect to highest observed hulling and head rice recovery values IHRT-E-3106 for the physical attributes revealed that the five hybrids *viz.*, IHRT-E-3102, IHRT-E-3116, IHRT-E-3114, IHRT-E-3108, and IHRT-E-3115 showed best cooking quality. Flaky rice with medium gel consistency (41-60 mm), 57.7mm (IHRT-E-3115). Alkali spreading value of 4.0 to 7.0 is preferred for quality rice IHRT-E-3105(4.00), IHRT-E-3116 (6.00).

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