Journal of Asian Agriculture(Renamed as Indian Journal of AgriVet Research)
Volume 1, Issue 1, 2021, Pp. 17-27
Available online at https://aavpublisher.com
ISSN: XXX-XXX

ORIGINAL ARTICLE

Evaluation of rice germplasm –a quest for identification of high yielding iron rich rice

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Article Received: 14.01.2021 Article Published: 19.01.2021

ABSTRACT

A set of 92 rice genotypes were assessed for grain iron content using ICP-OES at CIF, OUAT, Bhubaneswar. Iron content in rice grains varied from 8.3ppm to as high as 52.15ppm. Some of the local land races Tikimahsuri, Jabaphulla and Kala Kusuna are rich in grain iron content with maximum in Tikimahsuri (52.15ppm). However, two mutants (P44 mutant Sel.-1 and ORCZ 75-3-1) had shown high yield potential along with acceptable grain quality and high iron content in brown rice. Above Fe-dense genotypes may serve as potential donors in Fe-biofortification programme in rice.

Key words: Grain iron content, grain quality traits, seed yield, rice (Oryza sativa L).

INTRODUCTION

Malnutrition continues to be a crucial problem particularly in developing countries where rice (*Oryza sativa* L.) is the major staple food. Rice is as such deficient in many micronutrients including Fe that limits growth and metabolism in plants and humans (Guerinot, 2001). Fe deficiency is the most widespread among the people causing anaemic problems, stunted growth, maternal mortality, preterm births, decreased immunity and increased placental weight during pregnancy (Rush, 2000). Globally more than 3 billion people are affected by Fe deficiency (Welch and Graham , 2004). In this context, brown rice and wild rice are most preferred healthier food stuff as they contain more nutrients and fibre compared to white polished rice. But, the lasting solution lies with breeding of high yielding nutrient rich quality rice to fight such hidden hunger and malnutrition among the common poor in developing countries. For this, rice breeding needs to be re-oriented to improve rice varieties nutritionally rich in micronutrients along with increased yield potential. Indeed, the task is challenging as most of the traits relating to quality and nutrient status in rice are complex. Success in Fe-biofortification lies with combining high iron density with high seed yield, retention of iron after processing and cooking; high bioavailability in our blood serum; and finally, popularization of the crop variety for large scale cultivation and consumption by the target population of the society (Howarth *et al.* 2009). Therefore, in this pursuit, an attempt has been taken to assess available genetic variation to identify iron rich rice genotypes with improved morpho-economic traits along with quality parameters.

MATERIALS AND METHODS

A set of 92 test genotypes including 53 local land races, 21 improved breeding lines and 18 released varieties were evaluated in a field trial following Randomized Block Design (RBD) with three replications to assess yield and ancillary traits. Observations were recorded for plant height(cm), panicle length(cm), number of ear bearing tillers/hill and grains per panicle, 1000-grain weight (g), days to maturity and seed yield (qtl/ha). Length and breadth of grains and kernels were measured by Dial micrometer to assess their dimension.in each genotype. L/B ratios for grain and kernel were calculated taking respective mean values. Basing on grain length and L/B ratio, rice genotypes were classified into seven grain types as per Govindaswamy (1985).

Grain iron (Fe) content was estimated by Inductive Coupled Plasma-Optical Emission Spectrophotometer (ICP-OES) at 238.2 nm wavelength at Central Instrumentation Facility (CIF), OUAT, Bhubaneswar following digestion of fine ground seed samples with di-acid mixture (Nitric acid: Perchloric acid in 3:2 ratio) as per Jahan *et al*.(2013) with minor modification The variation in replications for each sample did not exceed ± 1ppm. The mean of the three replicates were worked out to indicate Fe content of each genotype.

Routine statistical procedures were followed for analysis of variance and covariance as per Singh and Choudhury(1985) using sample means of various traits under study.

RESULTS AND DISCUSSION

There exists a wide array of genetic variation in maturity duration, plant types, yield potentiality and quality features. A quest for iron along with zinc dense genotype would help breeders to combine desirable specific morpho-economic features with high seed yield.

MEAN PERFORMANCE FOR AGRO-ECONOMIC TRAITS

The stable morphological traits are the priori for varietal identification. A systematic and meticulous effort was therefore, undertaken to assess all the relevant stable morphological traits. Mean performance of all 92 rice varieties for seed yield and its component traits have been shown in Table 1.

The mean performance of genotypes clearly spelt out the abundant scope for selection of valuable genotypes. Wide array of range variation in almost all characters further strengthens the probable effectiveness of selection. The best entries with regard to specific traits may be utilized as donors in future breeding programme.

Days to maturity ranged from 98 days in Parijat to153days in OR CZ 80-1 142days as compared to Swarna (145 days) (Table-1). Fe biofortification is targeted to breed mid-early to medium duration Fe rich rice genotypes. The 21 OUAT test entries included in this investigation, matured in around 125-130days. While the popular mega variety Pratikhya took 146days to attain physiological maturity. Semi-dwarf to intermediate plant types are needed to prevent the crop from lodging and to retain physical quality features. Plant height of the test entries ranged from extremely dwarf plant type as in Jagannath (80.2cm) to as tall as OR CZ 80-1(146cm).

Number of effective bearing tillers (EBT), grain number/panicle, panicle length, test weight and seed fertility status determine yield potential of a test genotype. In the present investigation, EBT/m^2 recorded maximum in Swarna Sub-1. Panicle length was even around 27.6cm in case of OR CZ 80-1 and Jayaphulla. Genotypes with good grain filling offers substantial contribution towards seed yield. Fe deficiency tolerant cultivars are expected to have better crop stand and favourable internal mechanism /condition for better grain filling. In the present investigation, ORCZ 80-1 recorded highest 1000-grain weight (30.0g) among the test genotypes.

Farmers are sceptic for realization of more produce from each penny invested so as to earn more profit per unit area of cultivation and to suffice their food requirement. Therefore, a biofortified crop variety must retain high yield potential besides being rich in micronutrient. In the present investigation, there was wide array of genetic variation(5.7 to 53.3q/ha) in seed yield. The mega variety "Pratikshya" recorded the highest seed yield (53.3q/ha) followed by Swarna (53.0q/ha). A few of the OUAT breeding lines e.g., ORCZ 76-2, ORCZ 84, OR(T) 31,ORCZ 48, ORCZ 75-3 yielded more than 40q/ha..

PHYSICAL QUALITY TRAITS

Length, Breadth and L/B ratio of grain and kernel are the measure of grain and kernel dimension. Length of grain and kernel varied greatly among the test genotypes with range variation of 5.42-10.5mm and 4.0-7.5mm respectively (Table-1). OR CZ 76-16 was identified to possess 10.5.0mm grain length and 8.0mm kernel length. In contrast, the local land race "Raghuse" had shown short bold grain. In the present investigation, the genotypes varied greatly in grain and kernel dimension. A few of the test genotypes e.g., OR CZ 75-3, Khandagiri-1, ORCZ 76-6, ORCZ 76-1, ORCZ 76-15, ORCZ 76-16, ORCZ 76-17, ORCZ 76-11 and ORCZ-76-4 recorded extra long grain length with grain length/breadth ratio more than 3.5. Among these breeding lines, ORCZ 76-15, ORCZ 76-6 and ORCZ 76-3 had good yield potential (≥40.0q/ha) which would have consumers preference and suitable as table rice.

In general, L/B ratio decreased due to more reduction in length compared to breadth after hulling. There was considerable difference between L/B ratio of grain and kernel in most of the test genotypes. This may be attributed either to the relative amount of air space between hull and kernel or hull thickness which directly influenced grain density in rice. Grain density reflects the degree of compactness of starch grains in the kernel and complete development of kernel, leaving no space between the kernel and hull. The L/B ratio of kernel and grain were observed to be almost equal in Chinamali and Pratikhsya indicating proportionate minimum decrease in length and breadth after hulling. Similar was the case in Sambalpuri, Budhamanda, Turikanhei, Jagannath, OR(T) 47 and Upahaar.

GRAIN FE CONTENT

Normally, brown rice contains 16 μg iron/g dry weight of kernel, but after milling, polishing and washing; it gets reduced to even less than 5 μg/g dry weight as Fe is stored in ample amount in aleurone layer of brown rice. Iron fertilization is not effective for biofortifcation (Sperotto *et al.*, 2012) as Fe in soil mostly occur in insoluble form (Fe^{+3}). Besides, parboiling of rice though reported to increase retention and bioavailability of Fe in rice based diet (Thai *et al*., 2011), but it seems to be practically not feasible. Transgenic approaches have shown the proof of the concept, but deregulation of the product is often challenged for general consumer's acceptance. Hence, there is need to identify donors for efficient adsorption, transport and loading of Fe in to the grains to improve yield and enrich nutrient status to address Fe deficiency. Iron content is reported to vary from 15.41 to 162.37 ppm in rice cultivars (Qui *et al*., 1995), while Ahmed et al. (1998) observed a variation in iron content ranging from 15.0 to 50.0 ppm with an average value of 32 ppm.

In the present study, grain Fe content varied from 8.3ppm in ORCZ 76-13 to as high as 52.15ppm in Tikimahsuri (Table 1). The top Fe dense(≥40ppm) genotypes identified were Tikimahsuri (52.15ppm), Jabaphulla (52.15ppm), Kala Kusuma(52.1ppm), OR CZ 75-3(51.95ppm), P 44 mutant Sel. (51.9ppm), CR 2327-23(51.4ppm), Budhidhan(51.15ppm), Kalamakhi(50.15ppm), Nikipankhia(47.2ppm), ORM 405-8(45.05ppm), Jadumani(42.75ppm), Basudha(41.45ppm), Malliphulajhuli(41.35ppm) and Tulasibasa(40.35ppm). P44 mutant Sel.-1 and ORCZ 75-3-1 were derived from cv. P44 (popular in Haryana) and Pusa Basmati-1 (popular aromatic rice) respectively following mutagenesis with EMS at 0.5%. These had good yield potential (44q/ha) with better adaptability over diverse environments. But, the top iron dense local land races e.g., Tikimahsuri (52.15ppm), Jabaphulla (52.15ppm), Kala Kusuma(52.1ppm), recorded very low yield potential(10.8-27.1q/ha) and these need to be improved by recombination breeding. Senadhira *et al*. (1998) reported variation of grain iron from 7.5ppm to 24ppm in a set of 939 IRRI germplasm lines. Brar *et al.* (2011) recorded wide variation in grain Fe (5.1-441.5 ppm) among 220 rice genotypes. Notably, Taraori Basmati and Palman 579 maintained high grain Fe (>180 ppm) concentration. Roy and Sharma (2014) analyzed Fe content of 84 landraces that varied from 0.25ppm to as high as 34.8ppm in cv. 'Swetonunia'. In general, Fe was reported to be high in wild rice genotypes and least in japonica (Anuradha *et al.,* 2012). However, the black rice genotypes are relatively rich in iron content (15.41ppm to 162.37 ppm) (Zhang *et al*., 2000). Jeng *et al*. (2012) recovered few high Fe (M-IR-75 and M-IR-58) and high Zn (M-IR-180, M-IR-49 and M-IR-175) mutants of rice cv IR64 following mutagenesis with sodium azide.

CONCLUSION

Iron is an important essential micronutrient required for normal metabolic function of animals and plants. Exploring iron dense genotypes among the available germplasm and using these as donors in biofortification breeding for product development can be a sustainable approach to address malnutrition.

ACKNOWLEDGEMENT

The authors highly acknowledge the Central Instrumentation Facility (CIF), OUAT for providing ICP-OES facility and IFPRI-CIAT for providing financial assistance to support the Harvest Plus Programme in collaboration with OUAT, Bhubaneswar (Odisha), INDIA.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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Table 2. performance of 92 selected rice genotypes for morpho-economic traits and their grain micronutrient status.

Sl. No.	Genotype	Days to maturity	Plant Height (cm)	Panicle length (cm)	EBT/hill	Grains/panicle	1000-GW (g)	GL (mm)	GB (mm)	GL/GB	Grain Type Score	KL (mm)	KB (mm)	KL/KB	Fe (ppm)	Seed Yield (q/ha)
1	**Tikimahsuri**	134.0	87.8	21.6	5.4	138.2	20.7	6.8	2.6	2.62	4	5.7	2.0	2.88	52.15	27.1
2	**Jabaphulla**	125.0	135.8	26.8	4.5	90.0	15.1	6.1	2	3.05	5	4.8	2.1	2.28	52.15	15.9
3	**Kala Kusuma**	130	125	22.5	3.6	92.0	19.8	6.1	2.2	2.77	4	5.0	2.0	2.50	52.1	10.8
4	**OR CZ 75-3-1**	130	106	24.0	5.0	144.0	22.8	10	2	5.0	6	7.0	1.9	3.70	51.95	43.8
5	**P 44 mutant sel.**	134	107.2	24.2	5.4	135	23.2	7.5	2.5	3.00	5	6.4	2.0	3.22	51.9	44.2
6	**CR 2327-23**	135.0	106.5	25.4	7.3	133.0	24.3	7.9	2.2	3.59	5	6.6	2.0	3.30	51.4	41.4
7	**Budhidhan**	130.5	120.1	23.4	5.5	78.5	24.4	5.8	2.5	2.32	2	5.8	2.7	2.12	51.15	9.5
8	**Kala makhi**	126.0	120.1	22.4	3.5	86.0	18.6	8.5	2.2	3.86	5	6.8	2.0	3.40	50.15	12.8
9	**Nikipankhia**	134.0	89.5	23.6	5.4	115.2	18.6	7.7	2.5	3.08	5	6.2	2.0	3.11	47.2	34.2
10	**ORM 405-8**	140	137	25.2	4.5	135.3	24.0	7.1	2.5	2.84	4	6.0	2.0	3.00	45.05	40.5
11	**Jadumani**	127.0	120	24.8	3.6	89.0	19.2	8.8	2	4.40	6	7.0	1.8	3.88	42.75	18.6
12	**Basudha**	133.0	92.5	21.0	6.2	128.0	16.8	6.7	2.2	3.05	5	5.5	2.0	2.75	41.45	27.9
13	**Malliphulajhuli**	125.5	103.3	24.6	4.7	125.9	18.2	7.8	2.5	3.12	5	6.9	1.8	3.78	41.35	20.2
14	**Tulasibasa**	134.5	140.3	27.2	6.6	120.0	16.7	7.9	2.6	3.03	5	6.3	2.4	2.62	40.35	25.6
15	**Manika**	142.0	91.4	22.0	7.2	123.5	22.0	6.9	2.5	2.71	4	5.9	2	2.96	39.4	38.3
16	**Swarna Sub-1**	142	88.0	22.2	9.8	130.0	23.0	7.2	2.5	2.88	4	6.0	2	3.00	37.7	40.0
17	**Jhaliamanju**	136.0	126.0	22.0	3.0	96.0	19.0	9	3	3	5	7.0	2.8	2.50	36.4	16.5
18	**LalJagannath**	135.5	114.8	20.8	6.7	125.2	21.9	7.02	2.6	2.7	4	5.0	2.2	2.27	33.15	29.4
19	**Prachi**	140.5	89.2	23.0	6.5	121.5	20.8	7.4	2.5	2.96	4	6.4	2	3.20	29.35	41.0
20	**Jaya phulla**	125.0	135.8	27.6	4.0	90.0	12.8	6	2.8	2.14	3.5	5.2	2	2.60	28.15	15.8

21	**Parijat**	98.0	82.0	20.0	8.5	70.4	21.6	8	2.8	2.85	4	7.0	2.6	2.69	27.45	25.8
22	**Mrunalini**	139.0	99.6	23.2	6.0	140.0	21.9	7.3	2.5	2.92	4	6.3	2	3.18	27.3	45.2
23	**Kalamugajai**	136.0	120.0	23.8	3.5	90.0	19.0	7	2.8	2.5	4	5.2	2.5	2.08	25.85	22.5
24	**Ranjit**	138	109	23.0	5.8	140	23.6	7.00	2.8	2.50	4	6.1	2.1	2.90	24.35	43.2
25	**Bhalusadi**	132	122.0	23.2	4.4	102	19.8	6	2	3	5	5.0	1.8	2.77	23.6	24.0
26	**Upahaar**	147.0	89.2	21.0	6.0	115.0	23.4	6.7	2.6	2.57	4	5.5	2.1	2.64	22.7	39.1
27	**Bhuvan**	130	99.2	23.3	6.0	120.0	23.2	7.7	3	2.56	4	5.6	2.6	2.16	20.05	34.0
28	**Padmavati**	130	109	22.2	4.6	89	20.2	6.6	2.5	2.64	4	5.2	2.2	2.36	19.7	20.0
29	**OR(T)-31**	138	90.2	23.2	9.0	120	24.0	9	2.5	3.6	5	6.5	2	3.30	19.4	44.0
30	**OR CZ 76-11**	130	102.2	23.6	5.4	138	23.8	10	2	5.0	6	7.0	1.8	3.90	18.7	41.2
31	**Jaygopal**	136.0	127.8	18.6	3.5	76.2	18.8	8.6	3	2.86	4	5.9	2.4	2.45	18.4	22.0
32	**Raghuse**	133.5	130.4	19.8	4.1	86.0	17.6	5.42	3	2.71	3	4.0	2.1	1.90	18.05	18.0
33	**Kathidhan**	130	120.2	19.8	3.5	89.0	16.8	8	3.2	2.5	4	6.0	3	2.00	17.6	20.0
34	**OR CZ 76-4**	129	104.5	23.6	6.6	140	24.0	10	2.0	5.0	6	7.0	2	3.50	17.3	40.0
35	**Basapatna**	133.0	107.8	22.4	3.4	100.0	20.0	6.0	2.0	3.0	5	5.0	2.8	1.80	16.6	18.8
36	**Chinamali**	136	119.6	22.4	3.0	96.0	18.8	9.0	2.5	3.6	5	7.5	2.1	3.59	16.5	16.8
37	**OR(T) 47**	119	138.4	25.3	4.5	138	24.2	8.0	2.9	2.8	4	6.1	2.3	2.70	15.9	40.5
38	**Jhilli**	127.5	112.1	22.4	6.0	122.0	20.7	8.0	2.5	3.2	5	6.0	2.0	3.00	15.7	26.8
39	**Birupa**	134	99.0	22.6	4.8	110	23.0	9.0	3.1	2.9	4	6.4	2.8	2.30	15.4	35.0
40	**Bhanja**	138	98.8	21.6	5.2	130	23.4	8.2	3.0	2.7	4	6.0	2.5	2.40	15.1	38.0
41	**Kharavela**	125	98.4	22.0	5.0	108	22.6	9.0	2.2	4.1	6	6.5	2.0	3.30	15.05	32.5
42	**Nilarpati**	135.0	117.8	24.4	6.2	124.8	27.6	7.0	2.6	2.69	4	6.1	3.0	2.00	14.7	29.0
43	**OR CZ 76-2**	134	112.0	24.0	6.5	145	23.8	10.0	2.0	5.0	5	7.0	1.8	3.90	14.15	45.4
44	**Buromal**	130	122.6	20.2	4.2	105	18.8	6.0	2.8	2.4	3.5	4.5	2.8	1.60	13.85	22.0
45	**ORCZ 84**	136	113.2	23.0	6.2	135	23.2	8.8	2.6	3.4	5	6.2	2.1	3.00	13.75	42.4
46	**Raghusai**	130	122	22.2	3.8	98	22.4	7.0	3.0	2.3	3.5	5.8	2.8	2.10	13.6	18.5

47	**Ispit**	129	136	21.0	3.3	106	23.0	7.8	2.8	2.8	4	5.8	2.4	2.40	13.4	16.2
48	**Kalkatti**	128	127.2	20.6	4.2	90	22.2	5.8	2.8	2.1	2	4.8	2.5	1.90	13.4	18.6
49	**Godikaveri**	127	126.8	22.0	3.8	94	22.6	7.5	2.2	3.4	5	6.1	2.0	3.10	13.2	19.2
50	**Gajapati**	134	109.2	23.2	6.0	143	23.6	9.8	2.7	3.6	5	6.5	2.3	2.80	13.2	42.8
51	**Boudachampa**	133	119.6	23.0	3.4	105	20.6	8.5	3.0	2.8	4	7.0	2.8	2.50	13.15	20.6
52	**Hiranmayee**	125.0	93.8	24.2	6.5	155.2	21.2	8.2	2.5	3.3	5	6.0	2.0	3.00	12.85	48.2
53	**OR CZ 83**	132	106.6	23.2	7.8	140	23.2	8.0	2.8	2.9	4	6.2	2.2	2.80	12.65	44.4
54	**OR CZ 76-3**	133	100.6	23.4	6.0	138	24.2	10.0	2.0	5.0	6	6.5	1.5	4.30	12.6	43.4
55	**Kantakarpur**	132.5	103.8	20.0	3.5	96.0	22.2	7.8	2.8	2.8	4	6.0	2.5	2.40	12.45	17.0
56	**Bhattadhana**	126.5	119.8	21.6	3.4	90.0	22.8	8.0	2.9	2.8	4	6.8	2.7	2.50	12.3	17.0
57	**ORCZ 80-1**	153.0	146.0	27.6	6.4	140.0	30.0	7.4	2.9	2.6	4	6.4	2.4	2.70	9.00	40.0
58	**OR CZ 76-5**	128	104.0	23.4	6.0	130	22.8	10.0	2.0	5.0	6	7.0	1.8	3.90	12.1	42.0
59	**Raja hansa**	130.5	122.8	21.0	4.2	86.0	19.6	9.0	2.5	3.6	5	7.5	2.2	3.40	12.1	18.0
60	**OR CZ 76-15**	133	102.6	23.5	5.8	136	23.8	9.5	1.9	5.0	6	6.8	1.7	4.00	12.0	45.4
61	**Labangalata**	134.0	123.6	22.6.	6.0	120.0	18.9	6.1	2.5	2.4	3.5	5.0	2.0	2.50	11.8	30.8
62	**Local Basumati**	130	109.4	20.6	2.6	98	22.0	6.0	2.5	2.4	3.5	5.0	2.0	2.50	11.75	16.6
63	**Kadalikandi**	132	124	21.0	2.8	90	20.8	7.5	3.0	2.5	4	6.5	2.6	2.60	11.7	18.8
64	**Kalialendi**	131	115.6	20.6	2.6	88	20.6	8.0	2.5	3.2	5	5.1	2.0	2.60	11.7	20.0
65	**OR CZ 76-16**	136	114.3	23.4	6.2	135	23.0	10.5	2.2	4.8	6	8.0	2.0	4.00	11.65	42.4
66	**Majhalijhuli**	130	109.0	22.6	2.8	98	19.6	8.0	2.2	3.6	5	6.0	2.0	3.00	11.65	18.6
67	**OR CZ 48**	126	104.3	24.7	6.6	146	22.4	8.0	2.2	3.6	5	6.0	2.0	3.00	11.3	46.6
68	**Sapurichudi**	129	107.6	22.2	3.5	88	19.4	8.0	2.5	3.2	5	6.0	2.0	3.00	10.9	19.6
69	**Dinkisiali**	134.5	134.1	20.6	6.5	70.0	21.0	9.0	3.2	2.8	4	7.0	2.8	2.50	10.85	16.4
70	**Bitisapari**	140	139.4	22.6	3.2	98	20.2	8.0	2.5	3.2	5	6.0	2.0	3.00	10.75	21.6
71	**Puagi**	134	134.2	21.6	3.6	95	21.0	9.0	2.1	4.3	6	7.0	2.0	3.50	10.55	21.6
72	**Jhulpa**	137	136.6	20.8	2.9	92	20.6	7.7	2.1	3.7	5	5.6	2.0	2.80	10.35	21.6
73	**Turikanhei**	136	129.6	23.8	3.8	96	22.0	8.0	3.0	2.7	4	6.8	2.4	2.80	10.35	21.6

74	**Mugudi**	136	128.6	21.8	2.8	102	21.2	8.2	2.2	3.7	5	6.5	2.0	3.30	10.15	21.6
75	**Karpuramati**	138	126.8	22.6	3.4	90	21.2	8.0	2.6	3.1	5	6.0	1.8	3.30	10.15	21.6
76	**Kalama**	123.0	121.8	22.8	5.5	66.8	19.4	7.5	3.0	2.5	4	5.2	2.6	2.00	10.0	5.7
77	**OR CZ 76-17**	133	106.3	24.8	6.2	140	23.2	10.0	2.1	4.8	6	7.0	1.8	3.90	9.75	42.4
78	**Geleikathi**	139	128.8	22.4	3.7	101	20.8	6.5	3.0	2.2	3.5	4.3	2.6	1.70	9.70	20.8
79	**Budhamanda**	138.0	142.8	24.2	5.0	114.8	27.5	6.6	3.3	2.0	3.5	5.6	3.0	1.90	9.50	30.6
80	**Thakurabhoga**	136	132.0	22.6	3.5	102	22.4	6.0	2.3	2.6	4	5.1	1.8	2.80	9.50	21.6
81	**Khandagiri -1**	106	112.0	23.6	7.2	132.5	22.2	9.5	2.2	4.3	6	7.0	1.9	3.70	9.45	40.5
82	**Kadalipenda**	134.0	126.4	20.6	5.2	119.0	21.5	6.5	3.2	2.0	3.5	5.5	3.0	1.80	9.40	27.4
83	**Jagannath**	136.0	80.2	22.8	5.4	135.7	20.4	6.6	3.3	2.0	3.5	5.5	2.9	1.90	9.40	36.8
84	**Tanmayee**	138.0	109.8	26.2	6.6	127.0	23.6	7.1	2.5	2.8	4	6.0	2.0	3.00	9.35	39.0
85	**Sakaribanki**	134.5	123.8	22.2	5.4	90.8	22.6	7.0	.3.0	2.3	3.5	6.0	2.3	2.60	12.2	17.0
86	**OR CZ 76-6**	136	110.4	24.0	6.0	142	23.6	10.0	2.2	4.5	6	7.5	1.8	4.20	8.95	43.4
87	**Pratikhya**	146.0	98.0	26.0	7.4	160.0	22.7	8.0	2.3	3.5	5	7.0	2.0	3.49	8.95	53.3
88	**Sambalpuri**	138	122.0	20.6	3.	100	20.8	8.0	2.2	3.6	5	7.0	2.0	3.50	8.85	20.6
89	**OR CZ 76-1**	133	109.6	22.0	5.4	130	23.8	9.5	2.1	4.5	6	6.5	1.6	4.10	8.85	40.4
90	**Dimapur**	138.0	96.8	21.6	6.2	135.3	20.0	7.1	2.1	3.3	5	6.0	1.9	3.10	8.50	31.5
91	**OR CZ 76-13**	134	108	24.0	6.2	132	23.2	10.5	2.9	3.6	5	8.0	2.0	4.00	8.30	40.4
92	**Swarna (Check)**	145.0	82.4	23.8	8.2	130.2	21.9	6.0	2.2	2.72	3	6.00	2.00	3.00	15.4	53.0
Mean		132.7	113.8	22.8	5.1	113.5	21.48	7.8	2.5	3.2	4.5	6.1	2.2	2.90	20.2	29.5
$CD_{0.05}$		9.20	12.8	2.20	0.85	15.4	0.48	1.20	0.15	0.08	0.6	1.10	0.12	0.06	8.20	12.8
		98 153	80.2 146	18.6 27.6	2.6 9.8	66.8 160	15.1 30.0	5.42 10.5	1.9 3.3	2 5	2 6	4 8	1.5 3	1.6 4.3	8.3 52.15	5.7 53.3