Journal of Tropical Agriculture 61(2): 218-226, 2023

Identification of superior exotic lines in rice (*Oryza Sativa* L) for yield and yield contributing characters

Maqsoodullah, Jiji Joseph*, Latha M. and Santhoshkumar A.V.

College of Agriculture, Kerala Agriculture University, Vellanikkara 680 656, Kerala, India

Received 06 January 2022; received in revised form 02 June 2023; accepted 10 October 2023

Abstract

The present research was conducted in the department of Plant Breeding and Genetics, College of Agriculture, Kerala Agricultural University during 2019. Eighty-nine exotic rice lines from IRRI Philippines were evaluated along with five check varieties (Jyothi, Jaya, Thulasi, Vaishak and Manurathna) in augmented design for yield and yield related traits. Observation on quantitative characters showed that seventeen accessions were having low height than the check varieties. Thirty-six accessions were having longer ligule, while, fifteen accessions were having longer leaf and accession EC 204863 had broader leaves. Thirty-three accessions were early to flower and 34 accessions were early to mature. Accessions EC 207747, EC 204863, EC 205042 and EC 205128 had high number of tillers. Accessions EC 207747, EC 204863, EC 205070 and EC 415401 had high number of productive tillers per plant. Accessions EC 204847, EC 205001, EC 205223, EC 205314, EC 415448 and EC 415452 had more number of spikelets. While, comparing with check varieties, eighteen accessions had longer panicles. Eight accessions had more grain number and nineteen accessions had longer grains. Majority of the accessions had grain yield on par with check varieties.

Key words: Exotic accessions, Quantitative traits, Rice, Yield

Introduction

Rice (*Oryza sativa* L.) is one of the oldest cultivated and major staple cereal crops, which is feeding the more than half of the world's population. Because of the rapidly growing global population, breeders are attempting to improve the staple crops like rice (Shivani et al., 2021 and Kumar et al., 2023).

The potential yield of available rice varieties has to be increased by 2020 to meet the present demand via using valuable yield genes and genes comprising resistance to biotic and abiotic stress. As a staple cereal crop, rice is one of the most essential components of the human diet in many regions of the world (Rawte and Saxena, 2018).

Hence, increase in production of rice plays a significant role in food security and mitigation of poverty. Breeding of high yielding varieties with wide adaptability is the ultimate aim of the plant breeders, and the knowledge on genetic variability for the characteristic under enhancement is of great significance for the success of any plant breeding programme (Kunta et al., 2021).

There are thousands of rice varieties, land races and wild species which vary based on plant and grain characteristics. Germplasm evaluation is essential for classification of the germplasm, maintenance of the diversity and identification of valuable genes. The only way to ensure food security for future generations is to exploit the present day genetic diversity and to identify the promising genotypes for breeding programs. The present work tries to understand the variability of yield related traits in exotic rice germplasm for use in breeding programmes.

* Author for correspondences: Phone: 9446153535, Email: jiji.joseph@kau.in

Materials and methods

The study was conducted in the Department of Plant Breeding and Genetics, College of Agriculture, Kerala Agricultural University and at the experimental farm of NBPGR Regional station, Thrissur, during 2019 - 2020. Eighty-nine exotic accessions of rice received from IRRI Philippines along with five check varieties (Jyothi, Jaya, Thulasi, Vaishak and Manurathna) were used in the study. Details of the accessions are given in the Table 1.

The experiment was set in augmented block design with 5 blocks. Each block contained 25 randomly allotted accessions including check varieties. Each plot was of $5m^2$ size with 1m isolation from surrounding field and plants were raised at a spacing of 20 cm x 15 cm. Eighty nine accessions grown to full maturity. Observations on quantitative characters were recorded as per the descriptor (Rani et al., 2006) from 10 randomly selected plants of each accession. Statistical analysis was done using Plant breeding package in R for augmented design.

Table 1. Details of exotic rice germplasm used in the study

Sl no	Acc no.	Sl no	Acc no.	Sl no	Acc no.
1	EC 207747	31	EC 415397	61	EC 415434
2	EC 204847	32	EC 415399	62	EC 415435
3	EC 204863	33	EC 415401	63	EC 415436
4	EC 204865	34	EC 415402	64	EC 415437
5	EC 204868	35	EC 415403	65	EC 415438
6	EC 204928	36	EC 415404	66	EC 415439
7	EC 204970	37	EC 415405	67	EC 415441
8	EC 204991	38	EC 415406	68	EC 415442
9	EC 204999	39	EC 415407	69	EC 415444
10	EC 205001	40	EC 415408	70	EC 415445
11	EC 205042	41	EC 415409	71	EC 415446
12	EC 205047	42	EC 415410	72	EC 415448
13	EC 205070	43	EC 415411	73	EC 415449
14	EC 205072	44	EC 415412	74	EC 415450
15	EC 205128	45	EC 415413	75	EC 415451
16	EC 205192	46	EC 415414	76	EC 415452
17	EC 205205	47	EC 415415	77	EC 415454
18	EC 205223	48	EC 415416	78	EC 415455
19	EC 205252	49	EC 415417	79	EC 415456
20	EC 205264	50	EC 415420	80	EC 415458
21	EC 205269	51	EC 415421	81	EC 415459
22	EC 205275	52	EC 415422	82	EC 415460
23	EC 205305	53	EC 415423	83	EC 415461
24	EC 205314	54	EC 415425	84	EC 415462
25	EC 205321	55	EC 415426	85	EC 415463
26	EC 205333	56	EC 415427	86	EC 415464
27	EC 415392	57	EC 415428	87	EC 415465
28	EC 415393	58	EC 415429	88	EC 415468
29	EC 415394	59	EC 415431	89	EC 415470
30	EC 415396	60	EC 415433		

Results and discussion

Observations showed wide variability in most of the vegetative, reproductive and grain characteristics. ANOVA is presented in Table 2 and data is presented in Table 3.

Plant height (cm)

Plant height of the accessions varied between 66 cm (EC 415414) to 153 cm (EC 204999) with an overall mean of 94.07 cm. As tall plants tend to lodge and dwarf plants will lead to insufficient growth and poor yield, semi dwarf genotypes will be more useful. Categorization by DUS criteria showed that 14 accessions and three check varieties were medium (110- 130 cm) in height while others were either short or tall (Fig.1).

Ligule length (mm)

Ligule, the thin outgrowth at the joint of leaf and leafstalk in family poaceae is present in all most all varieties of rice. Ligule length varied between 3.00 mm to 12 cm with a mean value of 7.07mm. Categorization of accessions showed that nine accessions had long (>10 mm) ligule (Fig.1). According to Chaffey (1985, and 2000), ligule is photosynthetic, and assumed to act in protecting the culm and leaves that it encloses from the entry of water, dust and harmful spores. Abraham et al. (2017) used ligule length as an indicator to distinguish between the yield patterns in the landraces. They concluded that plants with longer ligules are likely to produce more spikelets with low test weight. They also suggested that, ligule form a kind of support system for internodes at the node, and helps the culm to bear the weight of the

Table 2 ANOVA for augmented design

		Mean sum of square														
Source	DF	PH	LL	BL	LBW	TF	TM	NTP	NPTP	PL	NSP	NGP	GL	GW	TGW	GY
Genotypes	4	2050.50	6.00	261.40	0.01	1253.01	1325.60	4.93	6.77	7.83	595.0	1271.63	1.60	0.10	0.23	32.78
Block	4	210.99	0.20	109.42	0.08	185.30	95.63	2.56	0.38	1.94	170.02	180.97	0.26	0.14	0.11	11.24
Residual	16	146.47	0.68	19.56	0.01	256.30	265.30	2.01	0.24	2.58	262.30	242.82	0.26	0.22	0.03	9.97

PH- Plant height; LL- Ligule length; LBL- Leaf blade length; LBW- Leaf blade width; TF- Days to 50% flowering; TM- Days to maturity; NTP- Number of tillers per plant; NPTP- Number of productive tillers per plant; PL- Panicle length; NSP- Number of spikelets per panicle; NGP- Number of grains per panicle; GL- Grain length; GW- Grain width; TGW- 100 grain weight; GY- Grain yield

Table 3. Mean performance of exotic accessions of rice based on quantitative parameters

SL. No.	Accessions	PH (cm)	LL (mm)	LBL (cm)	LBW (cm)	TF days	TM days	NTP (no)	NPTP (no)	PL (cm)	NSP (no)	NGP (no)	GL (no)	GW (mm)	TGW (g)	GY (g)
1	EC 207747	130.00	12.00	69.00	1.00	83.00	113.00	9.00	8.00	22.00	119.00	97.00	8.00	2.90	1.62	9.65
2	EC 204847	97.00	4.20	64.00	0.60	102.00	131.00	3.40	3.40	16.00	136.00	114.00	9.12	2.40	1.21	6.05
3	EC 204863	133.00	5.00	70.00	1.14	84.00	112.00	9.00	6.00	21.00	100.00	78.00	7.86	2.90	1.91	10.80
4	EC 204865	85.00	4.00	47.00	0.60	98.00	131.00	4.00	3.00	15.00	99.00	75.00	8.00	3.00	1.50	7.50
5	EC 204868	78.00	3.00	39.00	0.50	102.00	131.00	3.00	3.00	17.00	107.00	89.00	8.20	3.12	2.01	5.95
6	EC 204928	124.00	7.00	52.00	1.00	76.00	103.00	8.00	5.00	18.00	97.00	79.00	6.86	2.20	2.05	5.90
7	EC 204970	118.00	5.00	70.00	1.00	80.00	108.00	6.00	4.00	21.00	112.00	90.00	6.84	2.18	1.91	8.73
8	EC 204991	120.00	4.00	57.00	0.98	79.00	107.00	6.00	3.00	21.00	81.00	67.00	8.26	2.82	1.98	9.90
9	EC 204999	153.00	8.00	59.00	1.04	79.00	105.00	8.00	4.00	23.00	90.00	70.00	7.00	1.58	1.78	9.53
10	EC 205001	84.00	5.00	55.00	1.10	81.00	109.00	7.00	4.00	16.00	143.00	127.00	8.86	2.96	2.08	7.52
11	EC 205042	111.00	11.00	63.00	0.96	76.00	101.00	9.00	4.00	20.00	85.00	71.00	6.94	3.00	2.24	11.20
12	EC 205047	126.00	6.00	67.00	0.94	79.00	111.00	6.00	5.00	24.00	95.00	77.00	8.52	2.78	1.79	5.61
13	EC 205070	129.00	4.00	65.00	0.96	87.00	121.00	5.00	6.00	20.00	115.00	95.00	8.72	2.96	1.95	9.65
14	EC 205072	119.00	5.00	61.00	0.82	98.00	130.00	7.00	3.00	18.00	92.00	68.00	8.46	3.12	1.69	8.45
15	EC 205128	132.00	5.00	63.00	0.94	106.00	131.00	9.00	4.00	21.00	84.00	62.00	8.22	2.66	1.71	8.71
16	EC 205192	128.00	8.00	65.00	1.00	81.00	111.00	5.00	3.00	20.00	105.00	81.00	8.46	3.10	2.17	10.80
17	EC 205205	87.00	6.00	49.00	1.20	75.00	108.00	4.00	3.00	20.00	85.00	71.00	7.70	3.18	2.19	7.07
18	EC 205223	116.00	12.00	58.00	0.90	81.00	112.00	8.00	4.00	22.00	193.00	171.00	6.12	2.38	2.08	16.20
19	EC 205252	124.00	6.00	55.00	0.70	74.00	104.00	8.00	6.00	21.00	109.00	91.00	7.26	2.20	2.02	15.30
20	EC 205264	106.00	5.00	67.00	0.90	80.00	111.00	6.00	4.00	20.00	79.00	59.00	8.18	3.26	1.95	5.74
21	EC 205269	118.00	4.00	59.00	0.90	78.00	110.00	5.00	4.00	22.00	93.00	75.00	7.04	2.44	2.25	15.60
22	EC 205275	97.00	3.00	67.00	0.80	81.00	111.00	8.00	4.00	17.00	129.00	107.00	8.26	2.88	2.09	9.10
23	EC 205305	108.00	4.00	59.00	1.00	79.00	109.00	5.00	3.00	23.00	71.00	49.00	7.00	3.00	1.35	6.41
24	EC 205314	139.00	5.00	58.00	1.10	101.00	128.00	5.00	4.00	21.00	212.00	186.00	8.44	2.94	1.55	6.62
25	EC 205321	133.00	6.00	69.00	1.10	81.00	111.00	4.00	4.00	22.00	116.00	94.00	9.44	2.96	1.93	13.90
26	EC 205333	132.00	5.00	62.00	0.70	79.00	109.00	5.00	4.00	21.00	94.00	74.00	8.04	1.66	2.19	10.60
27	EC 415392	74.00	6.00	45.00	0.90	82.00	111.00	4.00	4.00	16.00	88.00	70.00	10.76	2.32	2.06	12.40
28	EC 415393	87.00	8.00	54.00	0.70	82.00	111.00	4.00	4.00	19.00	91.00	71.00	8.72	1.88	2.43	9.24
29	EC 415394	82.00	6.00	43.00	0.70	80.00	110.00	4.00	3.00	16.00	75.00	53.00	10.94	1.96	1.25	8.90
30	EC 415396	87.00	7.00	44.00	0.90	71.00	101.00	5.00	3.00	11.00	86.00	70.00	10.74	2.28	2.38	16.40
31	EC 415397	84.00	11.00	50.00	0.70	101.00	131.00	5.00	4.00	20.00	98.00	76.00	8.78	1.50	1.85	10.10
32	EC 415399	80.00	10.00	44.00	1.00	80.00	111.00	6.00	3.00	15.00	86.00	70.00	8.88	2.12	2.28	15.90
33	EC 415401	129.00	8.00	58.00	0.90	93.00	121.00	8.00	8.00	22.00	94.00	72.00	10.04	2.90	2.45	17.60
34	EC 415402	88.00	6.00	47.00	0.80	83.00	115.00	5.00	4.00	16.00	83.00	63.00	10.54	2.18	1.94	8.74
35	EC 415403	89.00	10.00	46.00	1.00	77.00	108.00	5.00	4.00	17.00	89.00	71.00	9.38	2.46	1.88	9.04
36	EC 415404	104.00	5.00	43.00	1.00	81.00	111.00	4.00	4.00	16.00	55.00	50.00	8.92	1.78	2.13	10.60
37	EC 415405	93.00	9.00	43.00	1.00	88.00	118.00	7.00	4.00	21.00	75.00	57.00	10.90	2.30	2.19	17.40
38	EC 415406	94.00	10.00	42.00	1.00	88.00	117.00	5.00	3.00	20.00	70.00	54.00	9.04	1.82	2.44	11.40
39	EC 415407	94.00	7.00	50.00	1.00	78.00	108.00	6.00	4.00	19.00	91.00	73.00	9.44	1.72	2.48	9.08
40	EC 415408	93.00	9.00	54.00	1.00	83.00	111.00	4.00	3.00	20.00	86.00	72.00	10.38	2.58	2.36	14.10
41	EC 415409	73.00	8,8	41.00	0.80	87.00	117.00	5.00	3.00	20.00	83.00	65.00	9.50	2.64	2.09	7.23
42	EC 415410	77.00	7.00	38.00	0.70	79.00	111.00	5.00	3.00	21.00	67.00	57.00	9.04	1.54	2.25	10.80
43	EC 415411	79.00	6.00	41.00	0.90	76.00	105.00	6.00	4.00	17.00	90.00	70.00	10.20	2.34	1.77	10.40
44	EC 415412	90.00	11.00	42.00	0.80	80.00	110.00	4.80	3.80	17.00	97.00	77.00	10.76	2.38	1.80	6.75
45	EC 415413	77.00	5.80	45.00	0.86	74.00	102.00	4.40	3.60	22.00	112.00	88.00	10.42	2.40	2.07	10.30
46	EC 415414	66.00	6.40	43.00	0.80	75.00	106.00	4.80	4.20	17.00	85.00	61.00	9.74	2.84	2.01	10.50
47	EC 415415	105.00	9.00	47.00	0.70	71.00	101.00	6.00	4.00	22.00	119.00	99.00	9.08	3.04	1.87	7.47
48	EC 415416	75.00	11.00	42.00	1.00	81.00	111.00	4.20	3.20	18.00	100.00	80.00	9.46	2.52	2.09	10.40
49	EC 415417	87.00	6.40	47.00	1.10	78.00	109.00	5.80	3.80	19.00	101.00	79.00	8.64	1.74	2.16	7.65
50	EC 415420	77.00	10.00	49.00	0.50	78.00	106.00	4.80	4.40	17.00	99.00	83.00	10.50	2.20	2.32	12.70
51	EC 415421	82.00	10.00	45.00	0.80	80.00	110.00	5.40	4.60	21.00	71.00	53.00	9.06	1.80	2.10	6.59

SL. No.	Accessions	PH (cm)	LL (mm)	LBL (cm)	LBW (cm)	TF days	TM days	NTP (no)	NPTP (no)	PL (cm)	NSP (no)	NGP (no)	GL (no)	GW (mm)	TGW (g)	GY (g)
52	EC 415422	103.00	12.00	51.00	1.00	78.00	106.00	5.90	5.10	24.00	88.00	66.00	10.85	2.10	2.62	7.75
53	EC 415423	84.00	4.20	40.00	0.60	78.00	107.00	4.20	3.80	16.00	128.00	106.00	10.12	2.20	2.13	10.60
54	EC 415425	80.00	7.00	50.00	1.00	88.00	116.00	4.00	4.00	18.00	80.00	64.00	9.92	2.50	2.04	6.44
55	EC 415426	96.00	9.00	43.00	1.00	103.00	128.00	5.00	5.00	21.00	103.00	83.00	8.64	1.70	1.88	13.90
56	EC 415427	75.00	6.80	41.00	0.70	99.00	118.00	4.60	3.80	21.00	114.00	94.00	10.22	2.22	1.58	16.00
57	EC 415428	85.00	9.00	36.00	1.00	81.00	111.00	5.00	4.00	17.00	84.00	62.00	8.22	1.60	1.84	7.62
58	EC 415429	82.00	10.00	43.00	1.00	77.00	106.00	5.00	4.00	17.00	85.00	67.00	10.00	2.50	1.74	7.60
59	EC 415431	78.00	8.00	41.00	0.50	78.00	109.00	5.00	4.00	17.00	87.00	69.00	10.60	2.40	1.65	11.20
60	EC 415433	91.00	8.00	48.00	0.50	78.00	108.00	4.00	4.00	19.00	126.00	106.00	10.56	2.16	1.79	15.00
61	EC 415434	87.00	8.00	42.00	0.60	73.00	101.00	4.00	4.00	19.00	95.00	73.00	10.44	2.38	1.50	9.36
62	EC 415435	79.00	8.00	35.00	0.50	77.00	106.00	6.00	4.00	15.00	94.00	76.00	10.00	2.20	1.51	7.67
63	EC 415436	92.00	10.00	35.00	0.50	77.00	106.00	5.00	4.00	20.00	123.00	105.00	10.16	2.14	1.40	9.91
64	EC 415437	79.00	8.00	39.00	0.50	78.00	108.00	4.00	4.00	15.00	104.00	84.00	9.76	2.30	1.65	7.25
65	EC 415438	77.00	10.00	36.00	0.60	103.00	131.00	5.00	3.00	20.00	118.00	100.00	10.14	2.20	1.36	4.79
66	EC 415439	86.00	11.00	46.00	0.50	98.00	131.00	6.00	5.00	25.00	114.00	94.00	10.28	2.26	1.67	12.80
67	EC 415441	78.00	3.00	39.00	0.50	102.00	131.00	3.00	3.00	17.00	57.00	49.00	8.20	3.12	2.01	5.95
68	EC 415442	70.00	7.00	45.00	0.40	79.00	111.00	6.00	4.00	17.00	96.00	78.00	9.16	2.26	1.53	7.65
69	EC 415444	76.00	10.00	47.00	1.00	99.00	131.00	5.00	4.00	19.00	105.00	85.00	9.46	1.90	1.25	8.90
70	EC 415445	85.00	11.00	52.00	1.00	76.00	105.00	5.00	3.00	16.00	93.00	73.00	10.62	2.30	1.77	7.06
71	EC 415446	73.00	9.00	43.00	0.40	80.00	111.00	5.00	5.00	18.00	81.00	63.00	8.78	1.68	1.68	7.35
72	EC 415448	80.00	9.00	53.00	1.00	81.00	111.00	6.00	5.00	19.00	156.00	134.00	9.72	3.16	2.27	6.23
73	EC 415449	82.00	7.00	41.00	1.00	81.00	111.00	5.00	4.00	18.00	97.00	79.00	10.66	2.38	1.92	7.35
74	EC 415450	85.00	5.00	46.00	1.00	83.00	111.00	6.00	6.00	17.00	98.00	78.00	10.52	2.22	2.29	6.19
75	EC 415451	74.00	3.00	72.00	1.00	97.00	137.00	7.00	3.00	21.00	89.00	71.00	10.00	2.54	1.81	12.60
76	EC 415452	83.00	10.00	42.00	0.86	102.00	138.00	4.00	4.00	20.00	133.00	113.00	10.42	2.38	2.00	9.50
77	EC 415454	83.00	7.00	46.00	0.80	79.00	104.00	3.00	3.00	23.00	94.00	78.00	9.44	2.36	1.67	8.95
78	EC 415455	84.00	7.00	43.00	1.00	78.00	106.00	3.00	3.00	20.00	75.00	61.00	9.00	2.30	1.92	8.45
79	EC 415456	70.00	6.00	36.00	0.76	87.00	113.00	4.00	3.00	19.00	107.00	91.00	9.68	2.24	1.76	4.82
80	EC 415458	92.00	6.00	53.00	0.90	99.00	131.00	5.00	4.00	25.00	110.00	88.00	9.38	2.30	1.83	13.80
81	EC 415459	120.00	7.00	69.00	1.30	93.00	121.00	7.00	5.00	26.00	117.00	95.00	12.00	2.86	2.17	14.10
82	EC 415460	79.00	4.00	46.00	0.50	106.00	131.00	4.00	3.00	20.00	99.00	81.00	8.46	2.08	2.11	15.40
83	EC 415461	94.00	7.00	42.00	0.70	98.00	131.00	4.00	3.00	23.00	83.00	63.00	9.78	2.18	2.04	6.10
84	EC 415462	80.00	4.00	41.00	0.70	92.00	125.00	3.00	3.00	16.00	74.00	58.00	9.56	2.64	2.01	7.13
85	EC 415463	79.00	5.00	42.00	0.68	93.00	122.00	3.00	2.00	17.00	127.00	107.00	9.90	2.14	1.45	7.25
86	EC 415464	81.00	3.00	50.00	1.00	80.00	111.00	4.00	3.00	22.00	100.00	82.00	9.00	2.00	1.74	9.98
87	EC 415465	90.00	11.00	46.00	1.00	103.00	131.00	4.00	3.00	14.00	83.00	63.00	10.00	2.00	2.02	14.20
88	EC 415468	79.00	6.00	44.00	0.70	96.00	127.00	3.00	2.00	22.00	29.00	111.00	9.66	2.46	2.04	10.80
89	EC 415470	88.00	6.00	52.00	0.50	90.00	128.00	3.00	3.00	19.00	82.00	62.00	10.18	2.06	1.56	10.50
Check varieties																
	Jyothi	80.16	5.04	44.72	0.85	98.00	126.00	7.20	6.44	19.60	108.84	89.40	9.29	3.00	2.10	15.20
	Jaya	114.60	5.14	52.68	0.96	96.40	130.00	6.08	5.16	18.70	89.04	67.84	8.49	2.86	1.92	10.44
	Thulasi	110.10	6.60	53.28	0.86	78.00	107.00	4.96	3.32	17.90	82.12	63.56	8.42	2.99	2.22	9.34
	Vaisakh	127.40	3.80	59.08	0.90	78.00	108.00	4.76	4.00	19.00	110.88	90.40	8.28	3.17	2.41	11.96
	Manurathna	84.24	6.22	41.72	0.86	77.00	106.00	6.24	4.40	16.30	70.08	54.72	7.72	2.81	2.33	11.30
	Over all mean	94.07	7.07	49.75	0.84	85.01	114.72	5.23	3.91	19.25	98.43	80.48	9.25	2.38	1.92	9.80
	Minimum	66.00	3.00	35.00	0.40	71.00	102.00	3.00	2.00	11.00	29.00	49.00	6.12	1.50	1.21	4.82
	Maximum	153.00	12.00	72.00	1.30	106.00	138.00	9.00	8.00	26.00	212.00	186.00	12.00	3.26	2.62	17.40
	Mean of check vars	103.30	5.36	50.53	0.89	86.68	120.40	5.84	4.66	18.3	92.18	73.18	8.44	2.97	2.20	11.65
	CD	25.55	1.72	9.32	0.22	7.76	9.51	3.00	1.04	3.40	37.65	32.91	1.69	0.98	0.38	6.67

PH- Plant height; LL- Ligule length; LBL- Leaf blade length; LBW- Leaf blade width; TF- Days to 50 per cent flowering; TM- Days to maturity; NTP- Number of tillers per plant; NPTP- Number of productive tillers per plant; PL- Panicle length; NSP- Number of spikelets per panicle; NGP- Number of grains per panicle; GL- Grain length; GW- Grain width; TGW- 100 grain weight; GY- Grain yield/plant.

panicle. As it is observable at seedling stage they considered ligule length as selection criteria for early selection of high yielding plants. Based on these criteria the accessions EC 207747, EC 205042, EC 205223, EC 415397, EC 415412, EC 415416, EC 415422, EC 415439, and EC 415465 can be considered as high yielding.

Leaf blade length (cm)

Leaf blade length of the accessions was between 35 cm (EC 415435, EC 415436) to 72 cm (EC 415451) with a mean value of 49.75cm, while check varieties had a mean value of 50.53cm. According to Tafere and Irie (2019), the photosynthetic rate of plant is a function of canopy architecture and leaf

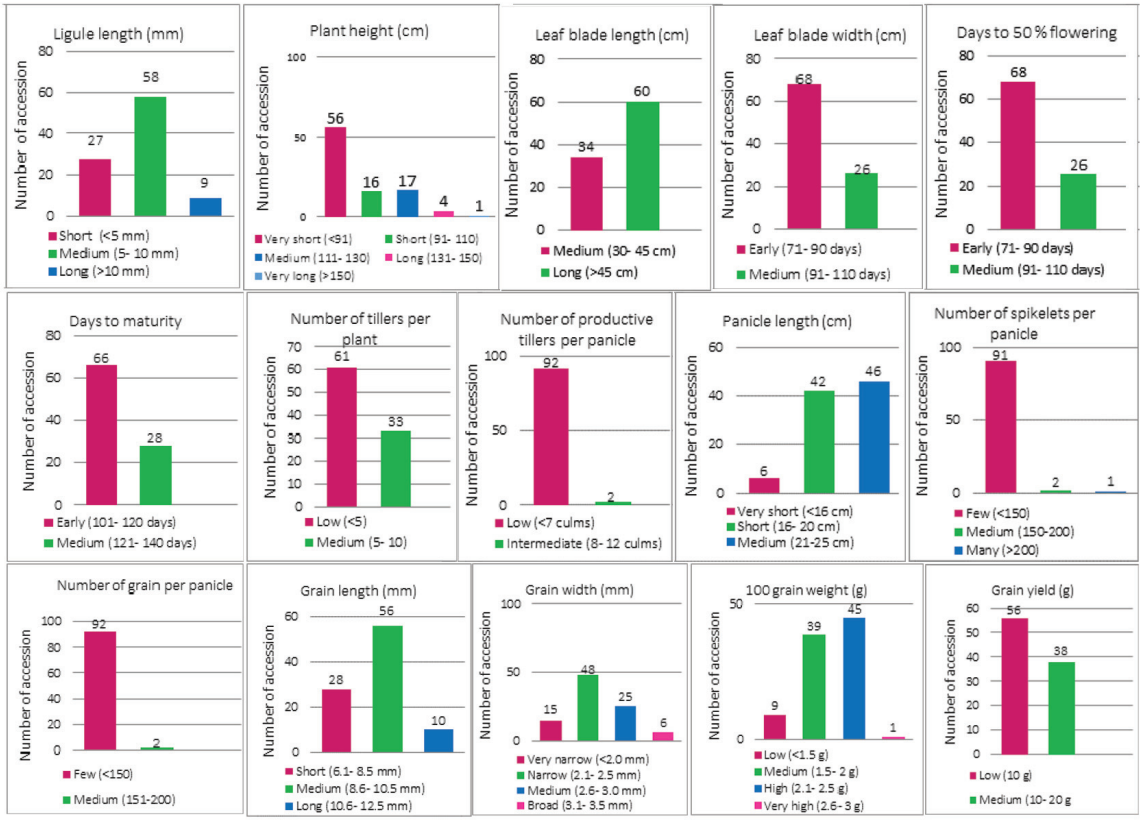

Figure 1. Categorization of exotic rice accessions based on quantitative characters.

area is one of the major canopy feature. According the DUS criteria 57 accessions and three check varieties recorded long leaf (>45 cm) (Fig. 1). Similar to the present study, Manjunatha et al. (2018b) also observed long leaves in 63 per cent of land races.

Leaf blade width (cm)

Leaf blade width of the accessions varied from 0.40cm (EC 415442) to 1.30 cm (EC 415459) with a mean value of 0.84cm. In check varieties range was between 0.85 cm (Jyothi) to 0.96 cm (Jaya) with a mean of 0.89cm. As an important part of canopy architecture leaf blade width also contribute to photosynthesis and yield. Only EC 204863 had broader leaves compared to check varieties. The accession EC 204863 had long and broad leaves, however, number of leaves and orientation of leaf also has to be considered while assessing the photosynthetic efficacy. Categorization of accessions showed that there was no accession with broad leaf (Fig.1). Studies by Manjunatha et al. (2018b) showed that majority of the local land races (77 %) had medium leaf width, while others had broad leaf. Hence, based on leaf area traditional land races of Kerala could be more photosynthetically efficient.

Days to 50 per cent flowering

The accessions had 50 per cent flowering between 71 days (EC 415396, EC 415415) to 106 days (EC 415460) with a mean value of 85.01 days. Among the check varieties range was between 78 days 98 days with mean of 86.68 days. Early flowering crop will help the plants to escape biotic and abiotic stress and also allow the farmer for multiple cropping. Grouping of the accessions showed that 65 accessions along with three check varieties were

early to flower, while, 24 accessions and two check varieties were medium (Fig.1). Manjunath et al. (2018b), observed only late or very late type indicating late flowering nature of traditional rice cultivars of Kerala.

Days to maturity

Days to maturity among the accessions was between 101 to 138 days with a mean value of 114.72. Duration of check varieties was between 107 to 130 days. On categorization, majority of the accessions along with Thulasi and Vaisakh showed early maturity (101- 120 days) and 25 accessions along with three check varieties exhibited medium duration of maturity (121- 140 days) as indicated in Figure1. Manjunatha et al. (2018b) observed only late (141-160 days) and very late type (>160) indicating the earliness of exotic accessions.

Number of tillers per plant

Number of tillers per plant ranged from three to nine with an average of 5.23. Check varieties had a mean value of 5.94. Four accessions had high number of tillers per plant (9) and all other accessions were on par with check varieties. Saini et al. (2013) observed high number of tillers per plant ranging from 9.5 to 29.6 among 160 short duration rice germplasm indicating less variability in the present population. Categorization of the accessions based DUS criteria showed that, 59 accessions and two check varieties had low (<5) and 30 accessions and three check varieties had medium (5- 10) number of tillers (Fig. 1).

Number of productive tillers per plant

Number of productive tillers per plant ranged from two (EC 415468) to eight (EC 207747, EC 415401). Check varieties had a mean value of 4.66. Saini et al. (2013) observed a wider range of 5.5 to 25.60. Classification of the number of productive tillers per plant as per DUS criteria showed that 87 accessions along with five check varieties had low (<7) and two accessions had intermediate number of productive tillers (8-12) as indicated in Figure 1. Similar to our studies Manjunatha et al. (2018a) also observed 88 per cent of landraces having few number of productive tillers and only 12 per cent landraces were of medium type.

Panicle length (cm)

Length of the panicle ranged from 11 cm of EC 415396 to 26 cm of EC 415459 and the mean value was 19.25 cm. Panicle length in the check varieties was between 17.90 cm of Thulasi to 19.60 cm of Jyothi and the mean value was 18.30 cm. Categorization showed that 46 accessions had medium long panicle (21- 25 cm) while others were short (Fig. 1). Manjunatha et al. (2018a) observed long panicles in majority of landraces. This indicate that in general exotic germplasm had short panicles.

Number of spikelets per panicle

Among the exotic accessions the number of spikelets per panicle was between 29 (EC 415468) to 212 (EC 205314) with a mean value of 98.43. Number of spikelets in check varieties was between 70.08 of Manurathna to 110.88 of Vaisakh with a mean value of 92.19. According to Saini et al. (2013), number of spikelets panicle in short duration germplasm was between 73 to 281.60 indicating wider variability of the germplasm they evaluated compared to the present study. Categorisation of accessions showed that 85 accessions and all check varieties had few (<150) and two accessions had medium (150- 200) spikelets per panicle and only one accession had many number of spikelets per panicles as presented in Fig. 1.

Number of grain per panicle

Number of grains per panicle was between 49 (EC 415441) to 186 (EC 205314) with a mean value of 80.48. Among the check varieties range was between 54.72 of Manurathna to 90.40 of Vaisakh. Eight accessions had grain number more than that of check varieties. Saini et al. (2013), observed the range for number of grains per panicle as 9.42 to 223.20 indicating wide variability in the germplasm. Majority of accessions along with check varieties showed low (<150) grain per panicle as indicated in Fig. 1.

Grain length (mm)

Grain length was observed between 6.12 mm (EC 205223) to 12.00 mm (EC 415459) with a mean value of 9.25mm. Among the check varieties it varied from 7.72 mm to 8.29 mm with mean value of 8.44 mm. Only EC 205223 had short grain, while 19 accessions had long grains. All other entries were on par with check varieties. Grain length of 160 short duration rice germplasm was found between 4.29 mm to 9.25mm (Saini et al. 2013). However, in the present study grains were longer. Based on grain length, 24 accessions along with four check varieties were grouped as short (6.1- 8.5 mm), 55 accessions and one check variety as medium (8.6-10.5 mm) and 10 accessions as long (10.6 - 12.5 mm) as presented in Fig.1. Based on grain length, Manjunatha et al. (2018a) classified land-races of Kerala as very short (6.67%), short (75%), medium (16.67%) and long (1.67 %).

Grain width (mm)

Among the exotic accessions grain width was found between 1.50 mm (EC 415397) to 3.26mm (EC 205264) and the mean value was 2.38. Check varieties had a mean of 2.97mm. Majority of exotic accessions were either very narrow or narrow as indicated in Fig. 1. Saini et al. (2013) observed grain width ranging from 0.22mm to 2.48mm indicating wide variability in the population. Compared to the studies of Manjunatha et al. (2018a) where they could get more of broader grains, in the present study majority of accessions had narrow grains.

100 grain weight (g)

Among the exotic accessions 100 grain weight ranged between 1.21g to 2.62g with a mean value of 1.92. Among the check varieties it ranged from 1.2 g of Jaya to 2.41 g of Vaisakh with a mean value of 2.20g. Saini et al. (2013) observed that the 100 grain weight of the genotypes they studied was between 2.14 g to 2.36 g showing a narrow range for the trait. However, in the present study the accessions showed a wider range of 1.21g to 2.62 g. Categorization of accessions showed that nine accessions had low (> 1.5 g) and 38 accessions along with check variety Jaya possessed medium (1.5 - 2.0 g) grain weight as presented in Fig. 1. Forty one accessions and check varieties, Jyothi, Thulasi, Vaisakh and Manurathna had high test weight ranging between 2.05 to 2.62 g. EC 415422 had high test weight of more than 2.5 g. Manjunatha et al. (2018) observed low test weight in 10 per cent of land races they evaluated. And the other classes were medium (18.33%), high (28.33%) and very high (43.33%). This also is a clear indication of the difference in the grain type of the exotic lines and land races of Kerala which are shorter, broader and heavier compared to exotic accessions.

Grain yield (g)

Grain yield of the accessions raged between 4.79g (EC 415438) to 17.40g (EC 415405) with a mean value of 9.80 g. Among the check varieties range was between 9.34g of Thulasi to 15.20g of Jyothi with a mean value of 11.65 g. Two accessions had lower yield, while other 87 accessions were having grain yield on par with check varieties. Grain yield is the most important aspect of any plant of commercial interest. It is highly influenced by many factors most important being its genetic potential. Being exotic collections, which are not aclimatised in the present environment the exact potential of the plant might not have expressed. As per the study of Saini et al. (2013) the grain yield per plant was observed between 8 g to 46.96 g. indicating a wide range for the trait which was not observed in the present study. Based on DUS criteria grain yield in 54 accessions and two check varieties was low (<10 g) and 35 accessions and three check varieties was medium (10- 20 g) (Fig. 1).

Conclusion

Accessions were scored for each character in comparison with check varieties. Number of characters better than the check varieties was noted for each accession. Accessions EC 207747, EC 204863, EC 204970, EC 204999, EC 205042, EC 205047, EC 415413, EC 415420, EC 415422, EC 415431, EC 415433, EC 415434, EC 415436 and

Table 4. Exotic rice accessions identified as superior with respect to quantitative characters

Accessions	PH	LL	LBL	LBW	DF	DM	NTP	NPT	PL	NSP	GP	GL	GW	TW	GY	TS
EC 207747		✓	✓			✓	✓	✓	✓							6
EC 204863			✓	✓		✓	✓	✓								5
EC 204970			✓		✓	✓			✓							4
EC 204999		✓			✓	✓			✓							4
EC 205042		✓	✓		✓	✓	✓									5
EC 205047			✓		✓	✓			✓							4
EC 415413	✓				✓	✓			✓			✓				5
EC 415420	✓	✓			✓	✓										4
EC 415422		✓			✓	✓						✓				4
EC 415431	✓	✓			✓	✓										4
EC 415433		✓			✓	✓						✓				4
EC 415434		✓			✓	✓						✓				4
EC 415436		✓			✓	✓						✓				4
EC 415445		✓			✓	✓						✓				4

PH- Plant height; LL- Ligule length; LBL- Leaf blade length; LBW- Leaf blade width; TF- Days to 50 per cent flowering; TM- Days to maturity; NTP- Number of tillers per plant; NPTP- Number of productive tillers per plant; PL- Panicle length; NSP- Number of spikelets per panicle; NGP- Number of grains per panicle; GL- Grain length; GW- Grain width; TGW- 100 grain weight; GY- Grain yield. TS -Total score.

EC 415445, having total score more than 4 in comparison with check varieties were identified as superior with respect to quantitative traits as given in Table 4. These accessions, can be further studied to confirm their superiority to use in breeding programmes.

References

Abraham, O. G., Chinyere, C. N., Richard, O. A. and Julius, O. F. 2017. Screening for yield related characters in some landrace accessions of *Oryza sativa* linn. J. Plant Sci. 12(2): 52-58.

Chaffey, N. J. 1985. Structure and function in the grass ligule: presence of veined and membranous ligules on the same culm of British grasses. New phytologist, 101(4): 613- 621.

Chaffey, N. 2000. Physiological anatomy and function of the membranous grass ligule. New Phytologist, 146(1): 5- 21.

Kumar, A., Satyendra, M. K., Sinha, S., Singh, S. P., Singh, D., RahulSingh, S., & Singh, D. P. K. (2023). Characterization of rice genotypes having indigenous and exotic origin for grain quality traits. Journal of Pharma Innovation. 12(11): 722-727

Mounika, K., Shivani, D., Jabeen, F., Chaitanya, K., Chiranjeevi, M., Sundaram, R. M., and Fiyaz, A. (2022). Multivariate analysis and character association for agro-morphological traits in elite rice germplasm. Journal of Cereal Research, 13(3).

Manjunatha, G. A., Elsy, C. R., Rajendran, P., Joseph, J., Francies, R. M., and Krishnan,S. 2018a. Agro-morphological characterization of rice (*Oryza sativa* L.) landraces of Wayanad, Kerala. J. Pharmacognosy and Phytochemistry, 7(2): 1409-1414.

Manjunatha, G. A., Elsy, C. R., Rajendran, P., Joseph, J., Francies, R. M. and Krishnan, S., 2018b. DUS Characterization of rice (*Oryza sativa* L.) landraces of Wayanad, Kerala. Elec. J. Plant Breed. 9(2): 617-630.

Rani, S. N., Rao S. L.V. and Viraktamath, B.C. (2006), 'National guidelines for the conduct of tests for distinctness, uniformity and stability: rice *(Oryza sativa* L) – Zero Draft', Directorate of Rice Research, Rajendranagar, Hyderabad, Andhra Pradesh.

Rawte, S., and Saxena, R. R. (2018). Morphological characterization of selected rice (*Oryza sativa* L.) from core germplasm group of Chhattisgarh using DUS descriptors. Int. J. Curr. Microbiol. App. Sci, 7(10), 350-357.

Saini, P., Francies, R. M., Joseph, J., Bastian, D. and Vigneshwaran, V. 2013. Genetic assessment of core set developed from short duration rice accessions held by Kerala Agricultural University. *J. Trop. Agric. 51*(1): 126- 131.

Shivani, D., Jabeen, F., Chaithanya, K., Koushik, M. B. V. N., Dileep, G. D., Koti, E. P., and Abdul, R. (2021). Assessment of genetic diversity of rice germplasm using microsatellite markers. The Pharma Innovation

Journal, 10(5), 1393-1397.

Tafere, C. and Irie, K. 2019. Photosynthesis Efficiency of Culm Habit Near-Isogenic Lines Rice (*Oryza sativa* L.) to Different Planting Densities. Int. *J. Res. Agric. Sci.* 6:219- 229.