The Pharma Innovation Journal 2021; SP-10(11): 466-475

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(11): 466-475

www.thepharmajournal.com
Received: 18-09-2021
Accepted: 19-10-2021

Tiwari S
Department of Plant Breeding and Genetics, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Koutu GK
Department of Plant Breeding and Genetics, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Parte D
Department of Plant Breeding and Genetics, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Katkani D
Department of Plant Breeding and Genetics, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Corresponding Author
Tiwari S
Department of Plant Breeding and Genetics, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Agro morphological characterization of restorer lines of rice as per dus guidelines

Tiwari S, Koutu GK, Parte D and Katkani D

Abstract
The agro-morphological characterization was done among ninety genotypes of restorer line of rice for 15 quantative traits under Rice improvement Project, seed breeding farm, department of Pant Breeding and genetics, JNKVV, Jablapur, M.P. The random plants were selected for characterization and the phenotypic assessment revealed polymorphism in almost all phenological, yield and quality attributing traits. While commonness were found in traits via., long leaf length, medium leaf width, medium (91-110days) days to 50% flowering, thick (>0.55) stem, few (<11) panicle number, medium (120-140 days) time of maturity, medium (21-25 g) weight of 1000 fully developed grain and fully restore spikelet fertility percentage. The evaluation extracted elite morphological markers in genotype SUGANDHA -3 for grain quality; CNAP 318 and JR-1001 for phenological traits and PRR 78 for yield attributing traits via, lodging resistance, semi-dwarfness and high 1000 grain weight. The wide variation depict that the hybridization could obtain transgressive segregates, while superior restorer could help in gaining high yielding hybrids with full exploitation of heterotic potential.

Keywords: Agro-morphological Characterization, Hybridization, Transgressive segregates, Polymorphism, Yield attributing traits, Grain quality, Phenological traits

Introduction
Rice is the major food crop for Asiatic population and contribute maximum share in the dietary requirements of human being. Globally, paddy rank second most significant crop in term of production and consumption after wheat, while nationally India stand first in area and second in production after china. The one quarter of India population depend on rice for their daily livelihood requirement. It is important part of more than three billion people's diet around the world (Shrivastava *et al*., 2014) [19]. From plates of field labour to upper high class Indian cuisine, bowl of rice is the core preference. Also, the growth of paddy under diverse agro-climatic conditions spread its cultivation in every corner of world. Rice is undoubtedly the most important cereal of the world providing 21% of global human per capita energy and 15% of per capita protein (Maclean *et al*., 2002) [8]. The continuous increase in population density from that time enhances the need to stretch the arc of rice production within the given area (Tiwari S.*et al*., 2021) [22]. And all this made paddy a crucial crop to be focused, thus since era long researchers had discovered many high yielding varieties, which even eradicated the food hunger and famines, specifically after Green revolution. Due to more hidden potential and wider acceptance among farmers, this crop now also draws an attention of researchers towards it.

Characterization is the base stone for advance researches. Agro-morphological traits, both qualitative and quantitative have been commonly and traditionally used to estimate relationships between genotypes (Goodman, 1972) [5]. The crop on basis of observation at every stage helps to discriminate unique genetic resource, which could be further validating through molecular markers. This initial phenotypic assessment reduce cost of highly expensive marker technology through selection of only required genotypes instead of taking the whole slot of germplasms. Hence, evaluation through convention method is of prime importance before opting for supplementary method of biotechnology. Here, the research conducted to morphologically analyse the quantitative data of rice restorer lines. The restorer lines of rice are those which restore the fertility of male sterile line and thus help in hybrid seed production of rice. As, these restorer are helpful in exploitation of heterotic potential of the sterile line, thus best among them is needed to be characterized for future hybridization breeding programme. Hybrids cater to fulfil need of developing high yielding rice varieties for varied climatic condition and restorer would contribute in such task by maintaining the fertility in

hybrids (Tiwari *et al* 2019) [21]. Although, the quantative traits are continuously variable and highly influence by environment but keen evaluation with replications made further task of molecular characterization easier. Being signatory to the General Agreement on Trade and Tariffs (GAAT), Government of India has enacted its Sui generis system, Protection of Plant Varieties and Farmers' Right Act (PPV&FRA), 2001 for providing protection to plant varieties based on Distinctiveness, Uniformity and Stability. Almost in all major crop species, morphological and physiological descriptors are available to establish the uniqueness of a variety (Moukoumbi *et al*., 2011) [10]

Material method

Experimental Site

The experiment was performed under Rice Improvement Project, Department of Genetics and Plant Breeding, College of Agriculture, J.N.K.V.V., Jabalpur (M.P.) during the Kharif season 2018. The experimental area occupied was quite uniform in respect of topography and fertility.

Experimental material

The experimental material consist of ninety Rice Fertility Restorer lines, selected for the purpose of hybrid seed production by JNKVV, Jabalpur and obtained from Rice Improvement Project, JNKVV, Jabalpur. These lines were planted in Randomized Complete Block Design with three replications. The description of these lines is given in table 01.

Table 1: Details of Restorer lines used in the study programme

1	Mahamaya	46	RP 5911-52-13-3-2-2-1
2	R 548	47	CR 2829-PLN-32
3	R 650	48	CANP 318
4	R 704	49	ANP 526
5	ABHYA	50	ANP 553
6	R 321	51	NPT 32
7	R 294	52	JR 1302
8	R 712	53	IR 838614-673-13
9	R 710	54	JR 1322
10	R 304	55	NPT 89* IR64
11	JR 503	56	NPT 89*IR36
12	SUGHANDA 3	57	NPT 14-12
13	NPT 10	58	NPT 40-018* PUSA BASMATI
14	NPT 13-01	59	JR 81
15	NPT 15	60	NPT 3803
16	NPT 29	61	NPT 3804
17	NPT 35-01	62	NPT-3805
18	NPT 37	63	NPT-3806
19	NPT 65	64	NPT-3810
20	NPT 70	65	NPT 3817
21	NPT (S) 8-1	66	NPT 3820
22	SPS 71 * NPT 80	67	NPT-3821
23	NP 72	68	JR-1001
24	NP 1024	69	JR-1008
25	NP 8421	70	JR-1014
26	PSP 456	71	JR-1018
27	NPT 31	72	JR-1019
28	LAXMI 144	73	JR-1021
29	IR 09 N 261	74	JR-1023-1
30	IR 79854-38-2-4	75	JR-1054-4
31	IR 79854-48-2-1	76	JR-1062-1
32	AD 02207	77	JR-1064-1
33	JR-1004	78	JR-1101-6
34	JR-1009	79	JR-1124-4
35	JR-1103	80	PS 2
36	JR-1103-1	81	CBSN 168
37	JR-1204	82	RT CNP 28
38	JR-1301	83	PRR 801
39	JR-1306	84	PRR 805
40	JR-1309	85	PRR 828
41	JR-1312	86	PRR 831
42	JR-1327	87	PRR 78
43	JR-1326	88	RPHR 1005
44	JR-4319-1	89	RPHR 619
45	JR-4322-2	90	RPHR 2

Experimental methods

Experiment conducted over 90 Fertility Restorer lines which were sown in Randomized Complete Block Design with three replications. In experimental site, rice seedlings are transplanted in twenty one days with four rows of each genotype, spacing 15cm between plant to plant, while 20cm

between row to row, keeping single seedling per hill. Gap filling was done within a week in order to maintain uniform plant population. Fertilizer dose of 100 kg N, 60 kg P_2O_5, and 40 kg K_2O was applied. Entire dose of P_2O_5 and K_2O along with half dose of N was applied as basal dose at the time of final field preparation, remaining amount of nitrogen was splited in two equal splits and were applied at the time of active growth and grain filling stages. The standard agronomic practices were adopted for normal crop growth.

Observations recorded

Agro-morphological characterization of germplasm variety is fundamental in order to provide information for plant breeding programs (Lin, 1991) [7]. On basis of Government of India enacted legislation on the "Protection of Plant Varieties and Farmers Act" (PPV&FRA) in 2001 for providing protection to plant varieties based on distinctiveness, uniformity, and stability (DUS) test apart from novelty (Patra, 2000) [15], observations were recorded by comparing with the photographs published in guidelines (Shobha *et al*. 2003) [17]. The 15 quantative traits taken under consideration for characterization viz., Flag leaf length, Flag leaf width, Days to 50% flowering, Stem Thickness, Stem length, Panicle length of main axis, Panicle number, Time of maturity, Weight of 1000 fully developed grain, Grain Length, Grain width, Decorticated grain length, Decorticated grain width, Length/breath ratio, and Spikelet fertility percentage

Result and discussion

Genetic diversity assessment is essential in plant breeding as it helps in identifying a particular plant variety and maintaining the gene pool. In the current investigation agro-morphological characterization of 90 restorer lines of rice among 15 quantative traits had shown sufficient amount of polymorphism as displayed in table 02 & 03. The propinquity in agro-morphological diversion was also observed by Kujur et. al 2019 [9] for traits time of heading, stem length, panicle length; Suman Rawte *et al*., 2018 [20] for traits stem length, thickness, panicle length, panicle number/plant, leaf length, leaf width, time of heading, time of maturity, thousand grain weight, grain length, grain width; Bose and Pradhan (2005) [4] for days to 50% flowering.

Among the 15 quantative traits, the commonness in all ninety genotypes were reported by traits viz, Long leaf length, Medium leaf width, Medium (91-110days) days to 50% flowering, Thick (>0.55) Stem Thickness, Few (<11) panicle number, Medium (120-140 days) time of maturity, Medium (21-25 g) weight of 1000 fully developed grain and Fully restore spikelet fertility percentage. The finding correlates with Sridhar *et al*. 2016 for fifteen quantitative characters.

As, reduction in plant height may improve their resistance to lodging and reduce substantial yield losses associated with this trait (Abbasi FM *et al*., 1995) [1]. The success of the "green revolution" is directly related to the intensive use of the semi-dwarf varieties (Hirano H *et al*., 1992) [6]. The semi dwarf plant type has been extensively utilized in the improvement of rice (*O. sativa L*.) cultivars throughout the world (Chakravorty A. *et al*., 2013). Therefore, genotypes NPT 31, RPHR 1005, JR-1001, JR 1322, JR-1019, PRR 78, CBSN 168, NPT-3810, JR-1103-1 and JR-1326 depicted dwarfness along with lodging resistance expected to consider as high yielders.

Grain size and shape are among the first criteria of rice quality that breeders consider in developing new varieties for releasing for commercial production (Adair CR *et al*., 1973) [2]. The genotype SUGANDHA -3 exhibited superiority in traits high length/breath ration, high decorticated grain length, extra-long grain length and thinnest stem (below 0.4cm), made it a unique accession. In respect to 1000 grain weight, the maximum value was found in genotypes R 710, R 704, JR-1004, NPT 3820, PRR 78, JR 1302, JR-1054-4 and MAHAMAYA.

NPT (S) 8-1 was fully restorer with >75 spikelet fertility percentage along with longest flag leaf length (>45cm). Days to fifty percent flowering (DFF) also known as heading date, a crucial trait for adaptation to different cultivation areas and cropping seasons is defined as when 50% of the plants in a single line completely exerted at least one panicle Pachauri, V., (2013) [14]. DFF of the phenotypes characterized ranged earliest (<100 days) in genotypes IR 79854-38-2-4, R 712, IR 79854-48-2-1 and JR-1001 were found to be very early flowering crops to Late (111-130days) in genotype CANP 318 and RT CNP 28. The similar quantative screenings were done by Yawen *et al*. (2003) [23] for grain number per panicle (spikelet fertility percentage) and Nazem and Arzani (2013) [13] for days to 50% flowering.

In terms of time of maturity most of the restorers (75) were medium maturing followed by few (11) early maturing NPT 3820, JR-1019, JR-1327, IR 79854-38-2-4, SUGHANDA 3, JR-1312, ANP 553, R 712, JR-1326, while only two were very early maturing NPT-3806, JR-1001 and late maturing NP 1024, LAXMI 144, as per depicted in fig 01 and fig 02

Table 2: Depicting unique accession of restorer lines of rice

S.no.	Character	Class	Geno-types	Unique Accession
1.	Flag leaf length	Short(<30cm)	0	
		Medium (30-45cm)	29	RPHR 2 (Shortest)
		Long (>45cm)	61	NPT (S) 8-1 (Longest)
2.	Flag leaf width	Narrow (<1cm)	27	
		Medium(1-2cm)	62	
		Broad (>2cm)	1	SPS 71 * NPT 80
3.	Days to 50% flowering	Very early (<71 days)	0	
		Early (71-90 days)	4	IR 79854-38-2-4
				R 712
				IR 79854-48-2-1
				JR-1001
		Medium (91-110days)	84	
		Late (111-130days)	2	CANP 318
				RT CNP 28
		Very late (>131days)	0	
4.	Stem Thickness	Thin (<0.40)	5	AD 02207

				JR 503
				SUGHANDA 3
				CANP 318
		Medium (0.40-0.55)	16	
		Thick (>0.55)	69	
5.	Stem length	Very short (<91cm)	75	NPT 31
				RPHR 1005
				JR-1001
				JR 1322
				JR-1019
				PRR 78
				CBSN 168
				NPT-3810
				JR-1103-1
				JR-1326
				(Dwarf)
		Short (91-110cm)	11	
		Medium (110-130cm)	3	
		Long (131-150cm)	1	CANP 318
		Very long (>150cm)	0	
6.	Panicle length of main axis	Very short (<16cm)	0	
		Short (16-20cm)	1	PRR 831
		Medium (21-25cm)	59	
		Long (26-30cm)	29	
		Very long (>30cm)	1	JR-1009
7.	Panicle number	Few (<11)	85	
		Medium (11-20)	5	JR-1018
				ANP 526
				ANP 553
				JR-1103-1
				JR-1062-1
		Many (>20)	0	
8.	Time of maturity	Very early (<100 days)	2	NPT-3806, JR-1001
		Early (101-120 days)	11	NPT 3820
				JR-1019
				JR-1327
				IR 79854-38-2-4
				SUGHANDA 3
				JR-1312
				ANP 553
				R 712
				JR-1326
		Medium (120-140 days)	75	
		Late (142-160 days)	2	NP 1024, LAXMI 144
		Vary late (>160 days)	0	
9.	Weight of 1000 fully developed grain	Very low (<15 g)	9	
		Low (15-20 g)	18	
		Medium (21-25 g)	31	
		High (26-30 g)	24	
		Very high (>30 g)	8	R 710
				R 704
				JR-1004
				NPT 3820
				PRR 78
				JR 1302
				JR-1054-4
				MAHAMAYA
10.	Grain Length	Very short (<6.0mm)	1	PS 2
		Short (6.1-8.5 mm)	45	
		Medium (8.6-10.5mm)	41	
		Long (10.5-12.5mm)	3	ANP 553
				IR 09 N 261
				SUGHANDA 3
		very long (>12.5mm)	0	
11.	Grain width	Very narrow (<2.0mm)	4	AD 02207
				JR-1306
				NPT 40-018 PUSA BASMATI
				CBSN 168

		Narrow (2.1-2.5mm)	43	
		Medium (2.6-3.0 mm)	33	
		Broad (3.1-3.5mm)	8	
		Very broad (>3.5mm)	2	RPHR 619
				JR-1014
12.	Decorticated grain length	Short (<6.0mm)	17	AD 02207 (Shortest)
		Medium (6.0-6.61mm)	24	
		Long (6.61-7.5 mm)	35	
		Extra long (>7.5mm)	14	SUGHANDA 3
				IR 09 N 261 (Longest)
13.	Decorticated grain width	Narrow (<2mm)	39	LAXMI 144
		Medium (2-2.5mm)	46	
		Broad (>2.5mm)	5	JR-1062-1
				PS 2
				JR-1301
				R 710
				NPT 10
14.	Length/breath ratio	Low (<2.5)	7	NPT 10 (Lowest)
		Medium (2.5-3.0mm)	33	
		High (>3.0mm)	50	SUGHANDA 3 (Highest)
15.	Spikelet fertility percentage	Fully maintainer (0)	0	
		Partial maintainer (0.10-50)	0	
		Partial restorer (50.10-75)	23	
		Fully restorer (>75)	67	NPT-3806
				NPT-3821
				NP 72
				PRR 801
				NPT 3820
				(IR 838614-673-13)
				MAHAMAYA
				RPHR 619
				R 548
				JR-1004
				JR-1327
				JR 81
				PRR 828
				CANP 318
				(CR 2829-PLN-32)
				JR-1103
				JR-1124-4
				NPT (S) 8-1
				JR-1064-1
				NPT 29

Table 3: Mean performance of quantative traits of ninety restorer lines

	DFF	DTM	FLL	FLW	ST	SL	PH	Pa/PL	PL	SF%	THSWT.	GL	GW	DGL	DGW	L/B
1	93.00	124.00	40.00	1.07	6.28	83.34	106.34	7.22	23.00	93.40	31.23	8.13	3.00	6.80	2.20	3.10
2	93.00	122.00	47.67	0.93	5.67	76.28	100.44	7.78	24.17	92.42	26.47	8.40	3.00	6.50	2.50	2.60
3	101.00	131.00	44.33	1.20	7.00	73.00	99.55	7.89	26.56	81.20	24.30	8.72	2.60	6.00	2.00	3.00
4	95.00	125.33	47.33	1.23	6.89	91.06	114.94	7.89	23.89	88.49	33.23	8.70	3.20	6.03	2.50	2.42
5	95.00	125.00	45.00	0.97	5.56	71.06	92.72	8.78	21.67	72.89	28.80	9.10	2.80	5.50	2.00	2.75
6	97.00	127.00	47.67	1.10	6.89	67.11	93.00	10.78	25.89	62.10	21.50	9.00	2.50	6.27	2.03	3.12
7	101.00	132.00	50.67	1.20	6.78	71.67	97.05	8.00	25.39	81.63	15.33	8.90	2.83	6.80	2.03	3.36
8	87.00	117.00	59.00	1.17	5.72	85.28	107.50	8.22	22.22	78.58	22.20	7.50	3.00	6.93	2.50	2.77
9	92.00	122.00	44.10	1.50	7.11	78.00	101.22	7.89	23.22	60.93	37.57	9.40	3.30	7.00	2.90	2.41
10	100.00	129.00	48.00	1.23	5.34	71.11	97.67	8.89	26.55	89.43	25.43	8.30	3.10	6.70	2.30	2.92
11	102.00	126.67	55.00	0.70	3.56	88.17	113.50	8.22	25.33	87.40	23.33	7.80	2.80	6.00	2.00	3.00
12	94.00	115.00	45.83	1.30	3.44	76.00	101.34	7.78	25.33	86.50	20.53	11.10	2.47	9.00	1.80	5.01
13	96.00	129.67	59.30	1.67	9.61	75.39	98.39	5.22	23.00	76.41	26.30	8.00	3.00	6.47	3.00	2.16
14	98.00	130.00	55.90	1.30	4.72	81.00	105.11	4.00	24.11	74.05	26.37	7.80	3.03	6.33	2.30	2.76
15	102.00	130.00	50.73	1.33	7.83	82.66	103.67	6.00	21.00	78.05	23.33	8.50	3.03	6.80	2.20	3.09
16	95.67	125.00	48.17	1.60	6.67	77.89	101.55	5.22	23.67	90.16	29.47	8.00	3.00	6.00	2.20	2.73
17	96.00	127.00	60.47	1.40	8.00	121.55	145.33	4.89	23.78	85.59	23.27	7.00	3.00	6.00	2.50	2.40
18	94.00	135.00	35.93	0.90	5.94	74.11	98.89	3.78	24.78	72.10	25.43	8.00	2.80	5.47	2.43	2.26
19	92.00	137.00	44.80	1.27	8.78	73.78	98.56	5.33	24.78	89.81	28.17	8.20	2.90	6.00	2.20	2.73
20	98.00	134.33	52.10	1.47	9.00	74.55	98.00	5.44	23.44	87.31	27.50	8.50	2.70	6.00	2.30	2.61
21	99.00	127.00	71.00	1.63	7.45	114.66	141.11	4.67	26.45	90.51	24.33	9.00	3.00	8.00	2.20	3.64

22	96.00	135.00	67.87	2.03	8.67	98.78	125.66	6.22	26.89	85.94	13.37	9.40	2.47	6.50	2.20	2.96
23	93.00	126.00	50.77	1.10	6.78	78.00	99.22	9.89	21.22	95.45	14.17	7.00	2.27	6.50	1.80	3.62
24	104.00	141.00	48.40	1.13	7.44	76.22	99.00	8.00	22.78	71.75	17.73	8.00	2.47	6.30	1.80	3.51
25	91.00	135.00	48.90	1.33	5.94	80.22	104.89	8.44	24.67	78.73	18.33	8.10	3.07	6.00	2.00	3.01
26	91.00	132.67	50.60	1.10	6.67	75.89	99.78	8.00	23.89	71.38	16.43	8.03	3.07	6.30	1.90	3.32
27	94.00	140.00	39.47	0.93	5.45	60.56	83.78	8.78	23.22	71.00	16.00	8.70	2.63	7.00	1.80	3.90
28	106.00	141.00	45.90	1.07	6.56	78.44	102.44	8.56	24.00	76.80	15.57	8.50	2.23	5.50	1.70	3.24
29	97.00	139.00	47.30	1.00	6.33	74.00	101.11	9.34	27.11	71.66	24.33	11.43	2.40	9.00	1.90	4.75
30	86.00	114.33	39.40	0.87	7.00	77.22	101.83	9.78	24.61	85.21	19.97	10.33	2.50	7.50	1.93	3.90
31	88.00	125.00	50.67	1.23	4.89	71.11	95.89	9.34	24.78	77.24	26.30	8.47	3.00	7.03	1.93	3.67
32	99.00	133.00	48.00	1.20	3.78	69.11	93.89	10.67	24.78	82.78	13.57	6.80	2.00	5.00	1.70	2.95
33	98.00	126.00	43.33	0.93	5.45	69.11	91.78	7.56	22.67	92.32	32.37	9.70	2.47	7.00	2.20	3.19
34	96.00	139.00	48.67	1.00	4.00	78.33	109.67	10.45	31.33	88.28	25.43	10.20	2.40	7.70	1.90	4.06
35	98.00	125.00	48.27	1.37	8.33	80.33	107.11	8.78	26.78	90.61	24.13	8.00	2.47	6.50	2.20	2.96
36	96.00	125.67	45.33	1.27	7.89	61.11	89.33	11.67	28.22	74.27	26.43	9.00	2.60	7.20	2.40	3.00
37	92.00	122.00	46.33	1.40	8.44	82.89	109.67	9.33	26.78	88.25	26.20	8.70	2.60	6.70	2.40	2.79
38	96.00	138.00	43.33	1.37	7.89	77.22	100.56	8.33	23.33	74.06	17.37	7.70	2.30	6.20	2.80	2.22
39	97.00	125.00	55.00	1.03	4.22	79.89	106.66	9.11	26.78	86.28	18.10	7.80	2.00	6.20	1.90	3.27
40	93.00	125.33	45.93	1.50	7.00	92.33	117.78	10.00	25.44	87.84	28.10	9.97	2.53	6.50	2.20	2.96
41	95.00	115.00	48.67	1.23	6.55	66.56	91.56	10.11	25.00	67.30	24.83	8.90	2.40	6.90	2.30	3.00
42	92.00	113.00	45.67	1.43	4.22	95.00	118.00	7.00	23.00	92.28	24.33	8.10	3.00	6.80	2.40	2.84
43	93.00	117.00	45.33	1.23	7.67	61.11	84.67	7.78	23.55	58.30	26.43	8.40	3.00	7.30	2.00	3.66
44	100.00	120.00	46.67	1.10	7.00	83.45	108.33	7.56	24.89	81.90	18.80	7.60	2.60	5.70	2.00	2.86
45	102.00	138.00	47.33	1.03	5.45	103.00	125.56	7.33	22.56	57.51	13.83	7.40	2.70	5.60	2.50	2.24
46	98.00	140.00	54.33	1.13	7.33	94.44	123.44	8.44	29.00	87.48	6.50	8.60	2.30	6.40	2.20	2.91
47	99.00	126.00	60.20	1.13	5.67	92.67	118.45	10.67	25.78	90.66	22.33	8.30	2.40	6.00	2.00	3.00
48	112.00	126.00	65.33	1.00	2.78	135.00	163.22	8.56	28.22	90.72	17.40	8.30	2.33	7.20	1.97	3.67
49	102.00	128.00	54.83	1.13	4.45	103.67	126.89	12.78	23.22	78.93	26.20	8.80	2.53	6.50	2.50	2.60
50	103.00	115.00	49.00	1.27	4.56	87.78	110.89	11.89	23.11	82.30	28.50	11.50	2.70	8.50	1.80	4.74
51	91.00	132.33	43.33	1.03	5.45	89.67	113.33	5.78	23.67	79.63	17.53	8.50	2.40	6.60	2.00	3.30
52	103.00	125.00	52.80	0.90	5.67	103.00	129.89	10.22	26.89	81.47	31.60	9.40	2.80	6.73	2.20	3.06
53	92.00	127.00	45.90	1.03	6.22	96.89	123.22	9.45	26.34	94.23	25.43	10.00	2.50	7.30	2.10	3.48
54	92.00	129.00	48.73	1.13	5.22	65.11	88.56	6.11	23.45	71.49	21.33	8.80	2.47	7.00	2.00	3.50
55	94.00	126.00	61.20	1.37	7.44	99.33	125.33	5.56	26.00	72.17	23.47	7.67	2.43	6.80	2.00	3.43
56	98.00	129.00	63.53	1.37	6.78	119.78	144.56	5.56	24.78	61.84	22.13	8.30	2.40	7.40	2.00	3.72
57	104.00	127.00	53.30	1.37	5.78	78.44	102.44	5.56	24.00	84.42	24.70	9.00	2.50	7.00	2.00	3.51
58	102.00	125.00	50.43	1.13	6.45	77.55	106.00	6.56	28.44	89.06	25.40	8.20	2.00	7.80	2.00	3.90
59	92.00	123.00	34.07	0.87	5.67	66.89	93.55	8.11	26.67	92.09	28.33	9.80	2.40	7.50	2.20	3.41
60	104.00	125.00	58.80	1.37	7.22	82.67	109.33	9.00	26.67	56.76	18.53	7.60	2.50	6.20	2.30	2.70
61	92.00	125.00	40.53	1.13	9.11	84.89	108.33	7.78	23.45	84.72	22.63	8.13	2.50	7.00	1.90	3.69
62	93.00	122.00	51.33	1.40	7.56	75.33	104.33	8.44	29.00	83.36	23.63	9.07	2.50	6.80	2.20	3.10
63	98.00	105.00	48.33	1.03	8.11	68.66	93.78	10.22	25.11	97.69	22.60	10.00	2.20	8.20	1.90	4.32
64	93.00	127.00	58.70	1.03	8.33	62.55	84.33	7.56	21.78	59.56	9.30	7.40	2.50	5.50	2.00	2.75
65	98.00	126.67	52.20	1.23	8.67	90.33	117.45	6.89	27.11	88.99	22.57	7.20	2.89	6.20	2.20	2.82
66	91.00	110.33	49.17	0.87	8.33	74.45	98.33	9.45	23.89	94.74	32.33	10.30	2.40	7.60	2.50	3.04
67	100.00	127.00	45.70	1.13	9.44	68.33	94.89	10.56	26.56	96.47	27.47	8.33	3.00	6.20	2.30	2.70
68	90.00	103.00	43.90	0.97	5.11	65.11	89.78	9.56	24.67	80.30	16.37	8.00	2.20	5.70	2.20	2.60
69	94.00	126.00	46.23	1.13	8.33	74.22	101.78	9.89	27.55	86.32	26.13	9.30	2.70	7.20	2.00	3.61
70	99.00	125.00	56.93	0.90	8.00	75.94	106.61	10.00	30.66	76.78	24.27	9.40	3.60	7.20	2.20	3.27
71	99.00	126.00	42.53	0.93	8.22	77.78	103.33	13.89	25.56	83.53	18.30	7.30	2.30	6.20	2.10	2.95
72	94.00	110.33	52.40	1.03	7.78	64.89	88.78	10.89	23.89	54.52	23.30	9.03	2.30	7.00	2.40	2.92
73	96.00	127.00	40.87	1.10	7.78	79.67	104.56	9.44	24.89	88.30	25.40	9.40	2.40	7.00	2.00	3.51
74	102.00	125.00	40.40	1.07	6.67	70.22	98.78	9.55	28.55	85.37	27.47	10.00	3.20	7.30	2.40	3.05
75	94.00	128.00	50.07	1.30	7.44	69.44	96.11	9.33	26.67	89.81	31.50	9.60	2.97	8.00	2.40	3.34
76	95.00	123.00	55.73	0.97	8.55	68.44	97.22	11.11	28.78	84.75	29.27	9.40	2.87	8.00	2.60	3.08
77	99.00	125.00	38.63	1.07	5.33	78.44	99.56	10.89	21.11	90.43	18.00	8.20	2.70	6.07	2.20	2.76
78	94.00	126.00	46.57	1.13	4.89	68.11	93.00	9.11	24.89	88.08	30.50	8.60	2.77	6.30	2.30	2.74
79	97.00	129.00	44.83	1.10	8.00	66.11	92.78	7.56	26.67	90.60	30.53	10.30	2.30	7.10	1.90	3.74
80	94.00	121.00	50.57	1.20	6.33	79.34	106.67	10.00	27.33	81.47	30.43	4.23	2.30	8.70	2.70	3.22
81	102.67	127.00	36.10	0.93	7.22	64.33	89.56	7.78	25.22	81.49	9.50	8.00	2.00	6.40	2.00	3.21
82	112.67	128.00	35.60	0.83	7.22	66.00	89.00	10.00	23.00	63.04	5.47	9.00	2.80	6.70	2.00	3.36
83	105.67	125.00	39.13	1.00	8.67	71.22	97.56	6.44	26.33	95.33	27.63	9.50	2.70	6.50	2.40	2.71
84	99.00	125.33	39.27	1.00	8.67	74.45	98.67	5.34	24.22	84.13	28.37	8.60	2.50	7.60	2.40	3.17
85	102.00	126.00	37.83	1.00	8.89	66.67	90.44	4.67	23.78	90.73	25.40	8.93	2.40	6.77	2.20	3.08
86	99.00	127.00	33.70	0.70	8.45	72.22	93.11	5.89	20.89	72.23	23.30	10.30	2.20	8.00	2.00	4.01
87	98.00	129.00	34.27	0.70	6.00	64.45	91.11	7.33	26.67	87.34	31.63	8.47	2.20	8.00	1.97	4.07
88	98.00	135.00	41.23	0.77	6.33	57.67	79.89	9.22	22.22	57.42	13.50	7.40	2.40	5.70	1.93	2.96
89	98.00	131.00	43.57	0.77	6.44	73.78	98.44	9.67	24.67	92.46	20.33	7.60	5.50	6.80	2.20	3.10

90	95.00	133.00	31.00	0.63	6.89	76.78	104.00	8.78	27.22	77.42	24.50	9.00	2.40	7.50	2.00	3.75

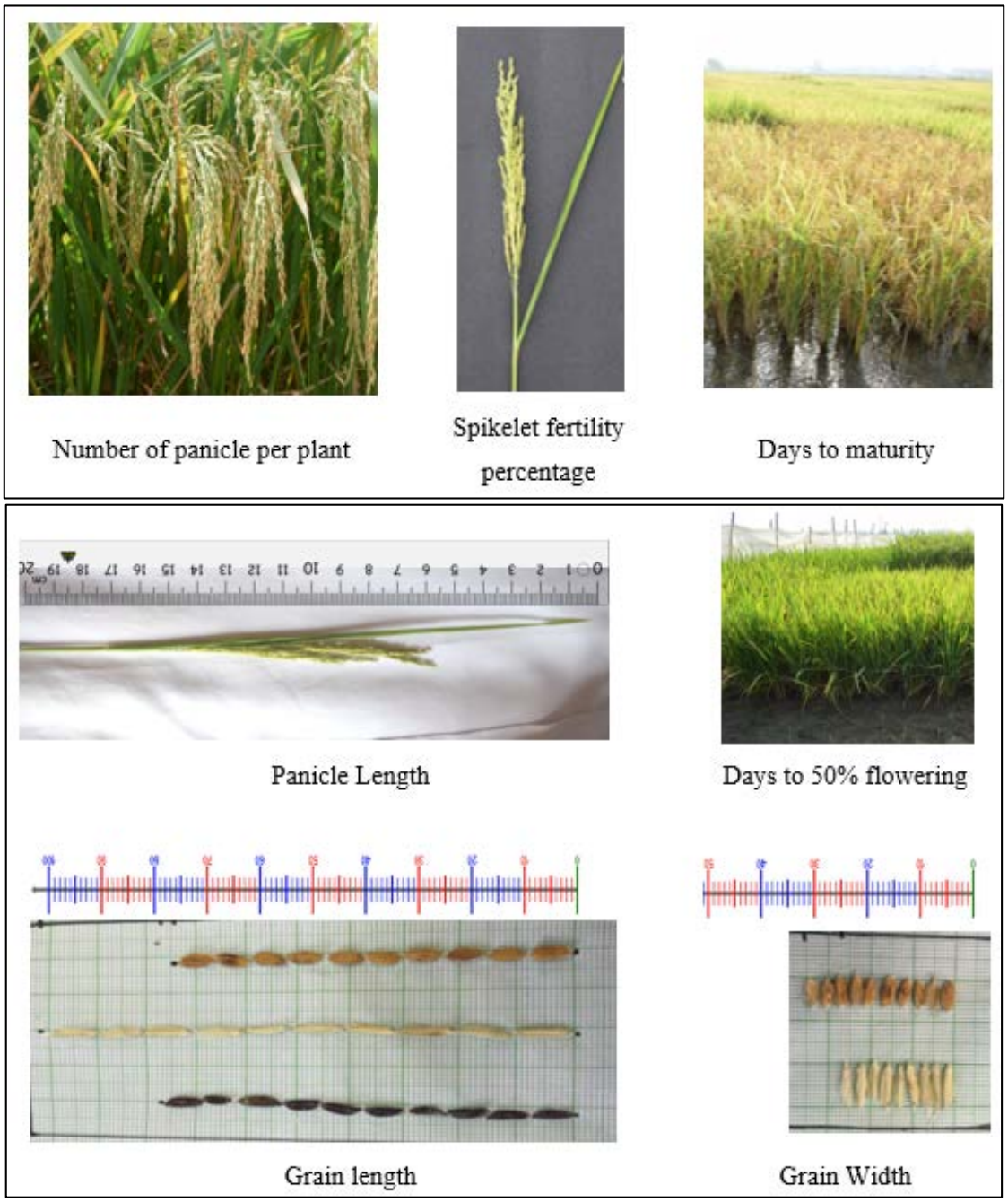
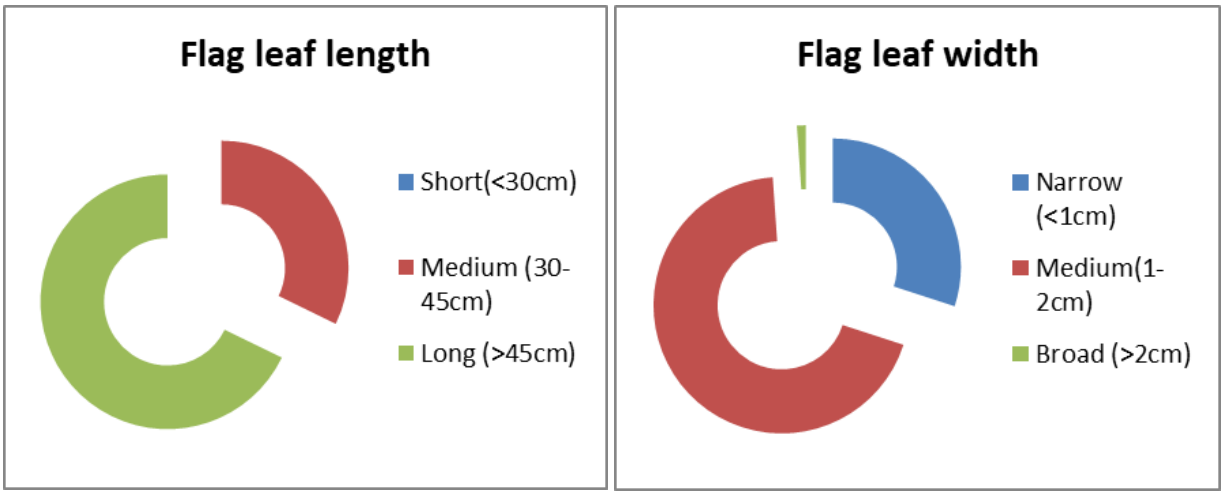
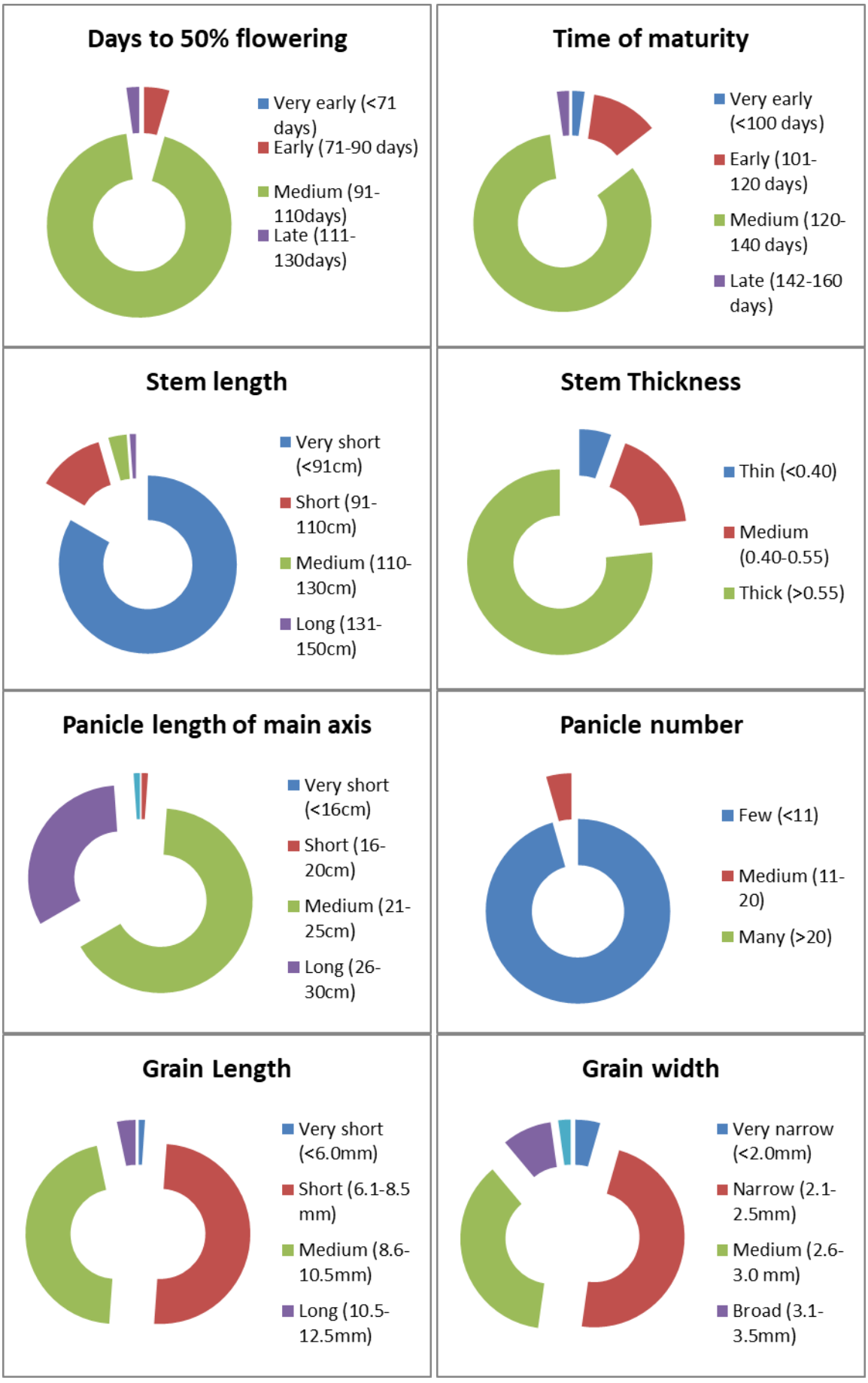


Fig 1: Depicting agro-morphic characterization of varied quantative traits




Days to 50% flowering
Very early (<71 days)
Early (71-90 days)
Medium (91-110days)
Late (111-130days)
Time of maturity
Very early (<100 days)
Early (101-120 days)
Medium (120-140 days)
Late (142-160 days)
Stem length
Very short (<91cm)
Short (91-110cm)
Medium (110-130cm)
Long (131-150cm)
Stem Thickness
Thin (<0.40)
Medium (0.40-0.55)
Thick (>0.55)
Panicle length of main axis
Very short (<16cm)
Short (16-20cm)
Medium (21-25cm)
Long (26-30cm)
Panicle number
Few (<11)
Medium (11-20)
Many (>20)
Grain Length
Very short (<6.0mm)
Short (6.1-8.5 mm)
Medium (8.6-10.5mm)
Long (10.5-12.5mm)
Grain width
Very narrow (<2.0mm)
Narrow (2.1-2.5mm)
Medium (2.6-3.0 mm)
Broad (3.1-3.5mm)

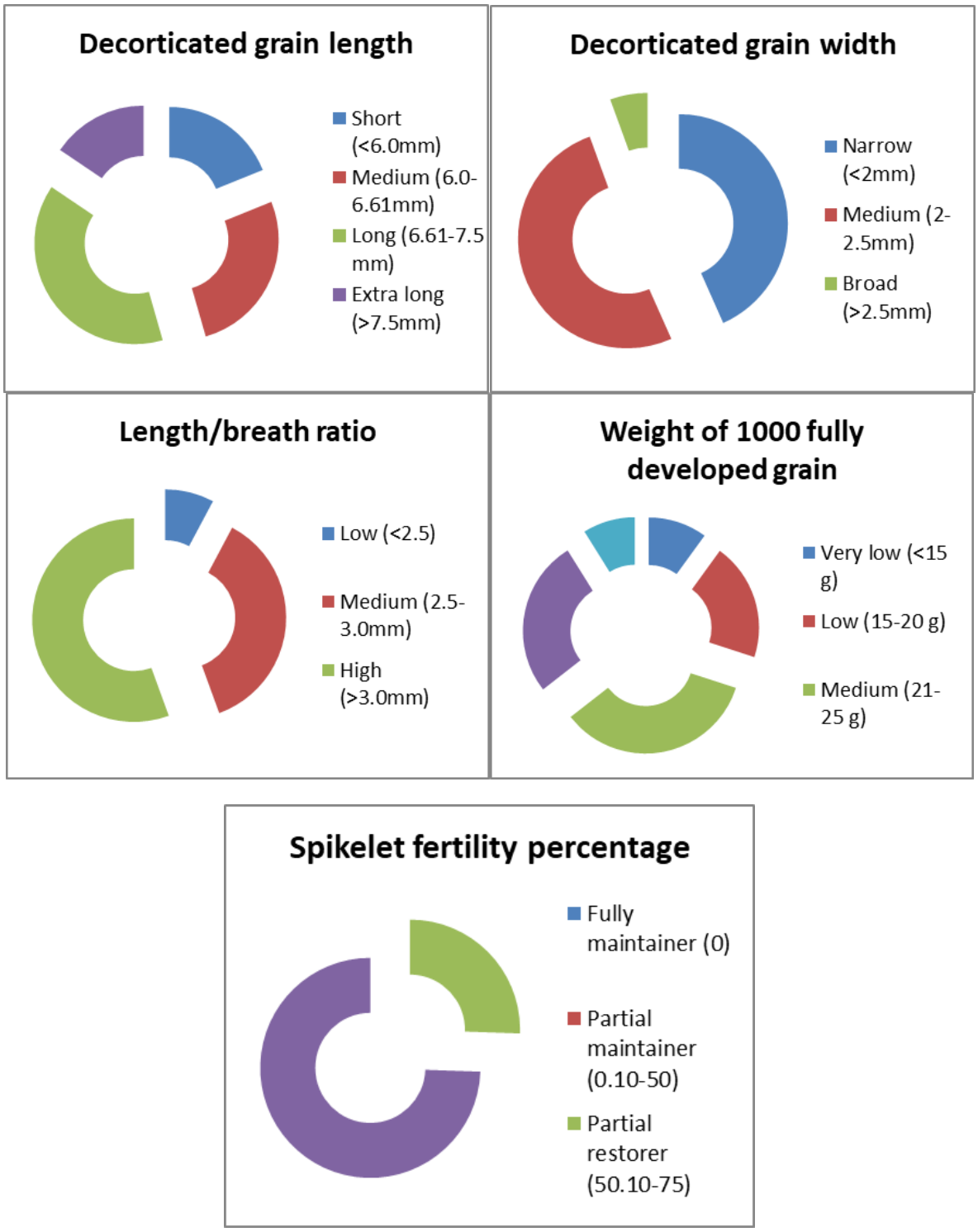


Fig 2: Frequency distribution of morphological traits showing variability

Conclusion

Assessment of genetic diversity becomes important in establishing relationships among different cultivars. Thus, among all the early flowering genotypes JR-1001 depicted short stature and early maturity also. This concluded that these restorers could be used to develop early maturing hybrids which could prevent plant from biotic and abiotic stress escaping, along with this the dwarf trait reveal its lodging resistance and high yielding property. The late flowering genotypes could be recommended for offseason and time when favourable environment delayed. CNAP 318 with late flowering, thick stem, long stature and high restoration capacity could help in extracting transgressive segregates.

SUGANDHA -3 was screen out as an elite genotype with excellent grain quality traits such as high length/breath ration, high decorticated grain length, extra-long grain length; superior phonological trait thinnest stem (below 0.4cm) and early maturity. Therefore, its utilization in hybrid formation could help in rice grain quality improvement. Morphological markers are very important and all breeders are continuously looking for these markers that will enable them to identify specific parental material for specific traits. Hence, this study would form a base for further molecular characterization.

References

1. Abbasi FM, Sagar MA, Akram M, Ashraf M. Agronomic and quality traits of some eliterice genotypes. Pakistan J. Sci. Indust. Res 1995;38:348-50.

2. Adair CR *et al*. Rice breeding and testing methods in the United States.IN: Rice in theUnited States varieties and production. U.S. Dept. Agric. HandBook-289(revised) 1973, 22-25
3. Ashim Chakravorty L, Ghosh PD, Sahu PK. Multivariate analysis of phenotypic diversity of landraces of rice (oryza sativa L) of West Bengal. American Journal of Experimental Agriculture 2013;3(1):110-123
4. Bose LK, Pradhan SK. Genetic divergence in deep water rice genotypes. Journal of Control, European Agriculture 2005;6(4):635-640.
5. Goodman MM. Distance analysis in biology. Syst Zool 1972;21:174-186
6. Hirano H, Nakamura A, Kikuchi F, Komatsu S.Protein encoded by genes linked withsemidwerfing gene in Rice.Japan Agri. Res. Quart 1992;25:223-9.
7. Lin MS. Genetic base of japonica rice varieties released in Taiwan. Euphytica 1991;56:43-46
8. Maclean JL, Dawe DC, Hardy B, Hettel GP. (ed.) Rice Almanac, Los Baños (Philippines): International Rice Research Institute, Bouaké (Côte d'Ivoire): West Africa Rice Development Association, Cali (Colombia): International Center for Tropical Agriculture, Rome (Italy): Food and Agriculture Organization 2002.
9. Monica Jyoti Kujur GK, Koutu RS, Rama Krishnan, Singh SK. Phenotypic Diversity Of Farmers' Variety Of Rice (Oryza Sativa L.) In Madhya Pradesh. Bull. Env. Pharmacol. Life Sci 2019;8:19-22
10. Moukoumbi YD, Sie M, Vodouhe R, Ndri B, Toulou B, Ogunbayo SA, Ahanchede A. Assessing phenotypic diversity of interspecific rice varieties using agro-morphological characterization. J Plant Breed Crop Sci. 2011;3(5):74-86.
11. Nascimento WFD, Silva EFD, Veasey EA. Agro-morphological characterization of upland rice accessions. Scientia Agricola 2011;68(6):652-660.
12. Nascimento, Wellington Ferreira do, Edson Ferreira da Silva, and Elizabeth Ann Veasey. "Agro-morphological characterization of upland rice accessions." Scientia Agricola 2011;68(6):652-660.
13. Nazem V, Arzani A. Evaluation of morphological trait diversity in synthetic hexaploid wheat. Journal of Applied Environmental and Biological Sciences 2013;3:20-28
14. Pachauri V, Taneja N, Vikram P, Singh NK, Singh S. Molecular and morphological characterization of Indian farmers rice varieties (Oryza sativa L.). Australian Journal of Crop Science 2013;7(7):923.
15. Patra BC. Collection and characterization of rice genetic resources from Keonjhar district of Orissa. Oryza. 2000;34:324-326.
16. Semwal DP, Pandey A, Bhandari DC, Dhariwal OP, Sharma K. Variability study in seed morphology and uses of indigenous rice landraces ('Oryza sativa'L.) collected from West Bengal, India. Australian journal of crop science 2014;8(3):460-467.
17. Shobha RN, Shobha Rao LV, Viraktamath BC, Mishra B. National guidelines for the conduct of tests for distinctiveness, uniformity and stability. Directorate of Rice Research 2003, 6-13.
18. Sridhar TC, Dushyantha BM, Kumar BR, Nishanth GK. Morphological Characterization of Traditional Rice (Oryza sativaL.) Genotypes of Southern Transitional Zone, Karnataka, According to DUS Test Guidelines. Research Journal of Agricultural Sciences 2016;7(2):317-323.
19. Srivastava N, Pathak SK, Gampala S, Singh VJ, Suresh BG, Lavanya GR. Evaluation of exotic upland rice germplasm for grain yield and its component characters in rainfed ecosystem (Oryza sativa L). Int. J. Food Agri. and Vet. Sci. 2014;4(2):102-109.
20. Suman Rawte, Ritu R Saxena. Morphological Characterization of Selected Rice (Oryza sativa L.) from Core Germplasm Group of Chhattisgarh Using DUS Descriptors. Int. J. Curr. Microbiol. App. Sci. 2018;7(10):350-357. doi: https://doi.org/10.20546/ijcmas.2018.710.037
21. Tiwari S, Koutu GK, Singh Y. Genetic evaluation of rice restorer lines through variability, heritability and genetic advance analysis International Journal of Chemical Studies 2019;7(6):1934-1937
22. Tiwari S, Koutu GK, Pathak N. Diversity Analysis of Grain Attributes in Restorer Lines of Rice (Oryzae sativa). Biological Forum – An International Journal 2021;13(2):386-392.
23. Yawen Z, Shiquani S, Zichao L, Zhongyi Y, Xiangkun W, Hongliang Z *et al*. Ecogeographic and genetic diversity based on morphological characters of indigenous rice (Oryza sativa L.) in Yunnan, China. Genetic Resources and Crop Evolution 2003;50:567-577.