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PHENOTYPIC DIVERGENCE FOR AGRO-MORPHOLOGICAL TRAITS AMONG DWARF AND MEDIUM DURATION RICE GERMPLASM AND INTER-RELATIONSHIP BETWEEN THEIR QUANTITATIVE TRAITS

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ABSTRACT
The present studies were carried out to characterize dwarf and medium duration rice germplasm accessions on the basis of eighteen morphological and seven agronomical traits. The coefficient of variation ranges from 9.66 to 43.52% indicating that selection based on the characters showing variation more than 10% is expected to be effective. Plant height has significant correlation with panicle length (r = 0.268) and highly significant correlation with 100-seed weight (r = 0.155) indicating the importance of plant height in improving these traits in rice accessions. Based on the results of the means of the checks, IC 292977 identified superior for highest number of effective tillers per plant (15.93); IC 491282 for 100-seed weight (4.79g), whereas the accession IC132899 was found superior for grain yield per plant (24.63 g) and number of effective tillers (6.53). Likewise, IC491367 had high grain yield per plant (24.30g) with high 100-seed weight (3.51g). Similarly other accessions could be select for different agronomical characters.

INTRODUCTION

Rice is the most consumed cereal grain in the world, constituting the dietary staple food for more than half of the planet's human population. India being the second largest producer of rice still lacks behind. By the year 2025, about 785 million tonnes of paddy which is 70 per cent more than the current production will be needed to meet the growing demand. Therefore being the staple food of the population in India, improving its productivity has become a crucial importance (Subbaiah *et al.,* 2011). Rice production needs to be increased to keep pace with the growing population. A breakthrough in plant breeding was attained with the development of semi dwarf cultivars characterized by lodging resistance, nitrogen responsive and erect leaves. Dwarfism is one of the most valuable agronomic traits in crop breeding because it affects lodging resistance and grain yield (Khush 1997, 2001). The success of the "Green Revolution" is directly related to the intensive use of semi dwarf varieties (Hirano *et al.*, 1992) using rice semid-dwarf1 (*sd1*) gene. The reduction in plant height enhances lodging resistance, and improves harvest index (grain/grain plus straw) and biomass production in the semi-dwarf cultivars of rice. The semi dwarf plant type has been extensively utilized in the improvement of rice (*Oryza sativa* L.) cultivars throughout the world.

Germplasm are an important source of useful genes. The adequate characterization and evaluation is a prerequisite both for the effective management and use of plant germplasm in breeding programs. Until the collected germplasm in the gene bank is properly evaluated and its attributes are made available to the breeders, it has little practical value. Although rice germplasm characterization and identification of better genotypes has been done by several workers, variability studies of the landraces and cultivars grown by farmers is limited. Considering the wide importance of such dwarf and medium duration rice, the present study was undertaken with the objective to access the morphological diversity of rice germplasm accessions and identification of better accessions for yield and yield attributing traits.

MATERIALS AND METHODS

Plant material for the present investigations consisted of 408 rice germplasm accessions of dwarf (<110cm) and medium duration (110-130 days) group with six popular standard checks viz., Annada, IR 64, Pusa Basmati, Swarna, NDR 97 and Jaya. These accessions were received from NBPGR, New Delhi. The material was grown in Augmented Completely Randomized Block Design during Wet season, 2010 at IGKV, Raipur. The experimental field was divided into eight blocks and each block consisted of 51 accessions with six checks. Each entry was sown in a plot comprising three rows having three meter length at spacing of 20 cm between rows and 15 cm between plants. Check varieties within the blocks were randomized. The recommended agronomical practices were followed to raise good crop in the season. Observations were recorded on five randomly chosen plants of each genotype for twenty-six morphological and agronomical traits.

Estimation of Agro-morphological parameters

All the agro-morphological traits studied *viz.*, early plant vigour, coleoptile colour, basal leaf sheath colour, leaf blade colour, leaf pubescence, panicle exsertion, stigma colour, apiculus colour, panicle type, awning, seed coat colour, hull colour, threshability, flag leaf angle, ligule shape, leaf senescence, sterile lemma and auricle presence, plant height, panicle length, number of effective tillers, L/B ratio and test weight were recorded as per SES, 2002.

Data analysis and inter-relationship

Frequency distribution was computed to categorize the genotypes into different classes. Simple statistics (means, ranges, standard deviation and coefficient of variation) was calculated to have an idea of the label of genetic diversity. Statistical analysis was done according to the standard statistical procedures (Federer, 1956). Correlation coefficients between two variables were estimated by using the formula proposed by Miller *et. al* (1958).

RESULTS AND DISCUSSION

Agro-morphological characterization

Qualitative characters are important for plant description (Kurlovich, 1998) and mainly influenced by the consumers preference, socio-economic scenario and natural selection (Hien *et al,* 2007). Frequency distribution for eighteen qualitative traits is presented in Fig. 1. The variable expressions of most of the morphological characters were recorded for different accessions except coleoptile colour, ligule shape and presence of auricle. A majority of genotypes were found to possess good early plant vigour (95.83%), green basal leaf sheath colour (87.25%), green leaf blade colour (89.70%), pubescent leaf (48.03%), well panicle exsertion (57.105), white stigma colour (65.93%), straw apiculus colour (78.18%), compact panicle type (55.63%), awnless (88.48%), white seed coat (82.84%), straw hull colour (70.34%), intermediate threshability (47.30%), erect flag leaf angle (57.59%), medium leaf senescence (67.15%) and straw sterile lemma (97.05%). Similar type of work was also reported by Bisne and Sarawgi, 2008; Moukoumbi *et al.,* 2011; Chakrabarty *et al.,* 2012; Roy *et al.* 2013; Tandekar and Koshta, 2014.

Basic statistics for leaf length, leaf width, number of effective tiller per plant, plant height, panicle length, L/B ratio, 100-grain weight and grain yield per plant is presented in Table 1. The wider range was observed for the plant height (44.0-110.0 cm) followed by leaf length (24.5-68.5 cm) and grain yield per plant (0.8-40.0 g). The coefficient of variation is useful tool for obtaining comparisons of variability in different characters. A reasonable amount of genetic variation was displayed for the traits evaluated. Plant height was the only character with coefficient of variation (CV) values less than 10%. However,

Table 1: Mean $\pm$ SE, range, standard deviation and coefficient of variation of 408 accessions

Characters	Mean	Range	Standard deviation	Coefficient of variation %
Leaf length (cm)	45.7$\pm$0.43	24.5-68.5	8.65	19.05
No. of effective tillers/plant	3.9$\pm$0.07	2.0-16.0	1.46	37.86
Plant height (cm)	98.1$\pm$0.47	44.0-110.0	9.48	9.66
Panicle length (cm)	22.3$\pm$0.14	11.8-30.2	2.85	12.81
L/B ratio	3.1$\pm$0.03	1.5-5.3	0.52	17.04
100-seed weight (g)	2.4$\pm$0.02	1.05-4.74	0.48	20.72
Grain yield / plant (g)	12.7$\pm$0.27	0.8-40.0	5.52	43.52

Table 2: Correlation coefficient among seven quantitative traits of rice

Characters	Leaf length (cm)	No. of effective tillers / plant	Plant height (cm)	Panicle length (cm)	L/B ratio	100-seed weight (g)	Grain yield / plant (g)
Leaf length (cm)	1.000	0.060	0.170**	-0.101*	-0.025	-0.042	-0.017
No. of effective tillers / plant		1.000	0.104*	0.163**	0.056	0.003	0.034
Plant height (cm)			1.000	0.268**	-0.080	0.155**	0.037
Panicle length (cm)				1.000	0.212**	-0.043	-0.085
L/B ratio					1.000	-0.055	0.046
100-seed weight (g)						1.000	0.024
Grain yield/ plant (g)							1.000

Table 3: Performance of commercial varieties of rice used as check

Characters	Annada	IR 64	Pusa Basmati	Swarna	NDR 97	Jaya
Leaf length (cm)	52.68	54.66	50.14	50.96	54.03	46.31
No. of effective tillers / plant	4.63	4.18	4.08	3.83	4.38	3.88
Plant height (cm)	86.65	84.98	100.60	88.13	82.48	93.05
Panicle length (cm)	23.83	23.30	28.10	21.95	21.38	24.23
L/B ratio	2.62	4.00	4.99	3.04	3.73	3.02
100-seed weight (g)	2.36	2.46	2.01	1.92	2.18	2.56
Grain yield / plant (g)	13.55	11.73	11.60	11.75	12.15	12.20

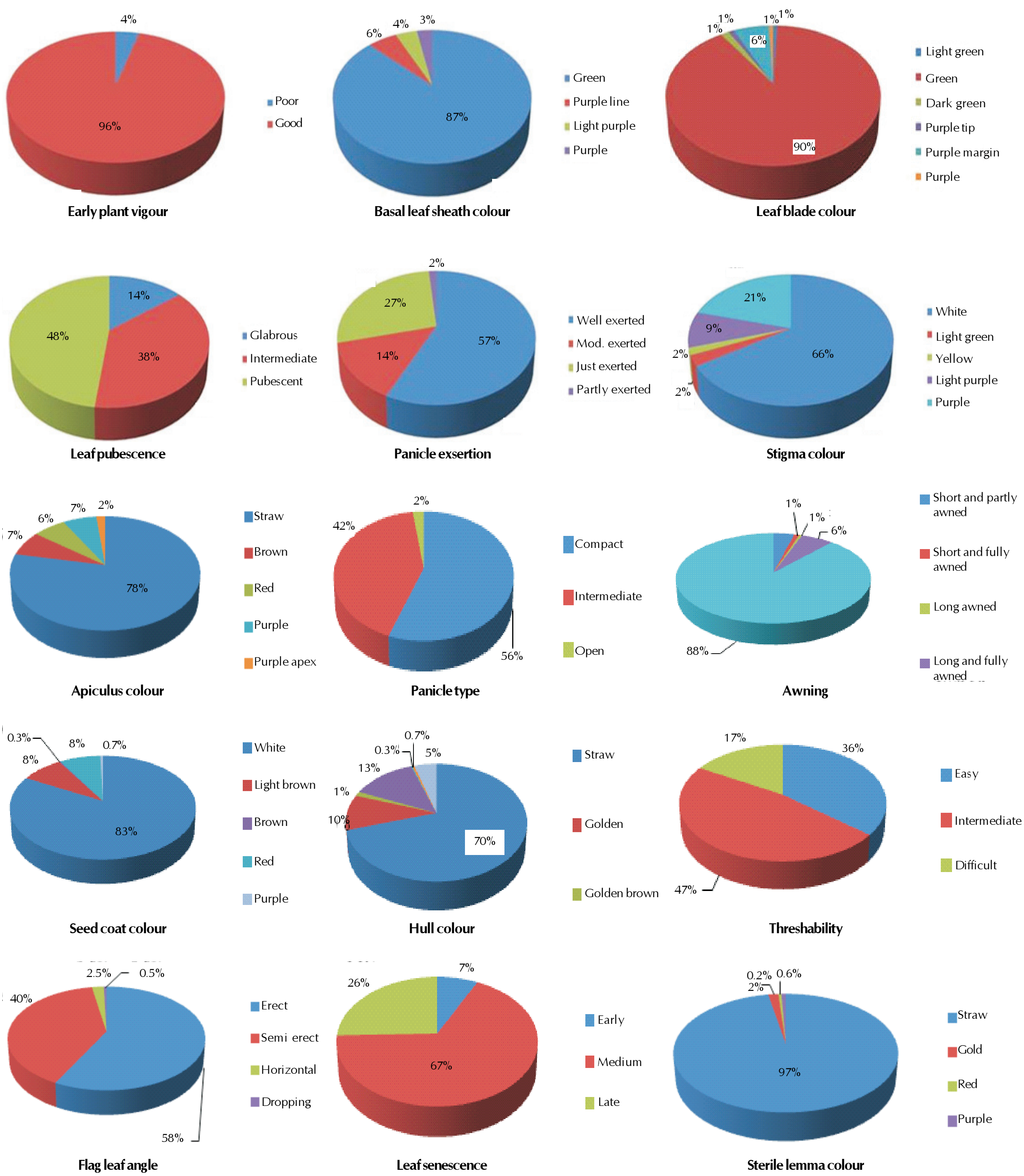

Figure 1: Frequency distribution for eighteen qualitative traits

most traits have CV values above 10 % and as high as 43.52% for the grain yield per plant indicating that selection based on these characters is expected to be effective (Zafar *et al.*, 2004;).

Correlation is a measure of the degree to which variables vary together or a measure of intensity of association. The efficiency of selection for yield mainly depends on the direction and magnitude of association between yield and its components and among themselves. In the present investigation, the correlation analysis indicated that the grain yield was positively associated with number of effective tillers per plant (r = 0.034),

Table 4: Number of accessions better than best check for different quantitative characters

Characters	Best check value	Number of accessions better than best check
Leaf length (cm)	54.7 (IR64)	62
No. of effective tillers / plant	4.63 (Annada)	83
Panicle length (cm)	28.1(Pusa Basmati)	7
L/B ratio	4.50 (Pusa Basmati)	3
100-seed weight (g)	2.56 (Jaya)	127
Grain yield / plant (g)	13.55 (Annada)	148

Table 5: Top ranking accessions selected on the basis of adjusted mean values of different characters

Rank	Leaf length (cm)	No. of effective tillers / plant	Plant height (cm)	Panicle length (cm)	L/B ratio	100-seed weight (g)	Grain yield / plant (g)
1	IC558335(68.9)	IC292977(15.93)	IC490329(41.68)	IC326491(30.23)	IC326217(5.196)	IC491282(4.792)	IC282422(40.333)
2	IC382648(65.5)	IC282980(14.53)	IC490323(55.48)	IC490337(29.23)	IC382629(5.181)	IC491377(4.002)	IC282423(34.333)
3	IC321833(64.0)	IC282981(13.33)	IC545349(56.28)	IC326487(29.03)	IC356449(5.124)	IC491476(3.872)	IC256850(28.333)
4	IC282821(64.0)	IC282471(8.46)	IC347240(65.35)	IC283245(28.43)	Pusa Basmati(4.986)	IC497091(3.705)	IC283101(26.7)
5	IC337622(63.5)	IC282437(7.66)	IC282936(68.15)	IC326465(28.43)	IC282823(4.817)	IC497168(3.565)	IC311024(26.7)
6	IC491370(62.7)	IC491204(6.99)	IC282395(72.48)	IC413573(28.40)	IC382631(4.715)	IC491367(3.512)	IC298568(25.5)
7	IC343507(62.5)	IC491264(6.59)	IC496890(73.65)	IC491471(28.20)	IC383441(4.715)	IC356429(3.477)	IC283107(25.1)
8	IC491264(62.2)	IC132899(6.53)	IC283436(74.08)	Pusa Basmati(28.1)	IC490276(4.701)	IC347240(3.477)	IC282452(24.7)
9	IC282437(62.1)	IC490335(6.53)	IC544870(75.28)	IC337627(27.60)	IC490247(4.508)	IC481181(3.470)	IC320960(24.7)
10	IC545146(61.9)	IC496861(6.39)	IC132899(75.48)	IC413610(27.60)	IC282530(4.482)	IC486887(3.412)	IC132899(24.633)
11	IC545144(61.4)	IC347240(6.13)	IC282396(75.48)	IC326479(27.43)	IC326479(4.472)	IC496914(3.405)	IC288383(24.333)
12	IC298578(61.0)	IC350130(6.13)	IC282439(76.68)	IC415441(27.40)	IC447282(4.421)	IC316060(3.397)	IC282444(24.333)
13	IC282818(60.5)	IC373167(6.13)	IC282402(77.88)	IC316060(27.20)	IC356448(4.413)	IC491182(3.360)	IC491367(24.3)
14	IC342645(60.5)	IC282438(6.06)	IC328524(77.98)	IC282823(27.03)	IC446975(4.413)	IC491183(3.360)	IC282446(24.3)
15	IC545146(60.4)	IC334190(6.06)	IC282471(78.58)	IC337615(27.03)	IC382632(4.317)	IC497172(3.345)	IC496977(23.633)

plant height (r = 0.037), L/B ratio (r = 0.046), and 100 Seed weight (r = 0.024) presented in Table 2. Similar kind of results was reported for effective tillers per plant (Seyoum *et al.* 2012, KrishnaVeni *et al.* 2013), for panicle length (KrishnaVeni et al. 2013). Number of effective tillers per plant also showed positive and significant correlation with plant height (r = 0.104) and panicle length (r = 0.163). Plant height has significant correlation with panicle length (r = 0.268, $p \leq 0.01$) indicating the importance of plant height in improving panicle length in rice. Similar results were also reported by Zafar *et al.,* 2004, Mathure *et al.,* 2011 and Aditya *et al.* 2013. Plant height was also showed the highly significant correlation with 100-seed weight (r = 0.155, $p \leq 0.01$). Panicle length showed significant correlation with L/B ratio (r = 0.212, $p \leq 0.01$). The results of this study were in agreement with Zafar *et al.* (2004). The grain yield per plant had non-significant and negative association with leaf length (r = -0.017) and panicle length (r = - 0.085), indicated less importance of these components in reflecting final yield. The result of this study was in agreement with Mustafa and Elsheikh (2007). The correlation studies finally revealed that the selection of genotypes with more number of effective tillers per plant, balancing plant height, optimum L/B ratio and higher 100 seed weight would be the best approach.

The performance of commercial varieties, used as checks for the comparison of the germplasm accessions is presented in Table 3. The number of accessions showed better performance over the mean values of checks for different quantitative traits are depicted in Table 4. Pusa basmati had the long panicle and high L/B ratio, so that only few accessions were superior to Pusa basmati for these characters. Out of these only few top ranking accessions are mentioned in Table 5, based on adjusted mean values. These can be used to identify phenotypically divergent sources for traits of interest in breeding programs. IC 292977 (15.93) had the highest number of effective tillers per plant followed by IC 282980 (14.53). Similarly, IC 491282 (4.79g) had the highest rank for 100-seed weight followed by IC491377 (4.00g). IC132899 was better for grain yield per plant (24.63 g) with good number of effective tillers (6.53) and short heighted (75.48 cm). Likewise, IC491367 had high grain yield per plant (24.30g) with high 100-seed weight (3.51g). Similarly other accessions could be select for different agronomical characters.

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