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Assessment of genetic variability for early seedling vigour, yield and its contributing traits in early duration genotypes of rice under direct seeded condition

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Abstract
Eighty rice genotypes were assessed for different 26 early seedling vigour traits, yield and its component traits under direct seeded condition. The entire 26 early seedling vigour, yield and its component traits showed significant variation. Highest values of PCV coupled with GCV was recorded for number of unfilled spikelet, vigour index II, seedling dry weight on 30 DAS, seedling dry weight on 20 DAS, number of filled spikelet, grain yield per meter square. Based on grain yield, genotypes namely, R1004-2552-1-1 recorded high grain yield followed by Indira aerobic-1, Asam chudi, Surekha, IR 08 L 152, Pokali and Aditya.

Keywords: Early seedling vigour, rice, upland

Introduction
Rice is the most important cereal of the world providing 21% of global human per capita energy and 15% of per capita protein. Rice (genus *Oryza*) has only two domesticated species *Oryza sativa* and *Oryza glaberrima*, out of its twenty two species. *Oryza sativa* is known as Asian rice and *Oryza glaberrima* is the African rice. Hence, *Oryza sativa* is the major food crop for people in Asia and nearly 90% of the world's rice is produced and consumed in this region. Furthermore, rice is the staple food for nearly 2.4 billion people in Asia including China, Japan, some parts of India, Thailand, Sri Lanka, Bangladesh and many more (Warusawithana, 2017) [9].

Rice is widely cultivated under irrigated and rainfed conditions, with improved varieties and landraces that specifically adapt to these situations. In India, more than 50% of rice areas under rainfed conditions are cultivated as direct seeded rice (DSR). Due to unpredictable rainfall patterns, direct seeded rice has become regular practice under rainfed situation. Conversely, due to labour scarcity and unavailability of timely irrigation water, the farmers in the irrigated ecosystems are also adapting to dry direct seeding techniques. However, DSR has major drawbacks such as the non-uniform emergence and uneven population of seedlings in the field as well as high weed growth (Chauhan and Abugho, 2013) [3]. In such situation, Early Seedling Vigour (ESV) comes in rescue. Early seedling vigour (ESV) determines rapid, uniform emergence and the development of seedlings under a wide range of field conditions and it has been considered as one of the important characteristics that determines successful crop establishment (Zhang *et al.*, 2005) [10] under DSR. Strong seedling vigour is desirable trait in dry direct-seeded rice (DSR) for enhancing crop establishment and the ability to compete against weeds. However, currently available modern irrigated rice varietal architecture with semi-dwarf stature and reduced seedling vigour is not amenable to dry direct seeded conditions. Irrigated rice varieties are high yielding but relatively poorer in early seedling vigour as compared to rainfed varieties. Genes promoting vigourous growth in young rice seedlings need to be identified and transferred into high-yielding cultivars. This will depend upon the identification of superior donors for early seedling vigour and of traits that best predict field performance (Redona and Mackill, 1996) [5].

Materials and Methods
The present research work was regulate at Research cum Instructional farm Department of Genetics and Plant Breeding, College of agriculture, Indira Gandhi Agricultural University, Raipur, Chhattisgarh, during the *Kharif* season of 2019.

Chhattisgarh is situated between 17°14'N and 24°45'N latitudes and 79°16' E and 84°15' E longitudes. Raipur (C.G.) is lies at 21°16' N latitude and 81°36' E longitude with an altitude of (289.60 m). Overhead mean sea level. The maximum mean temperature was 32.30°C and minimum mean temperature was 23.99°C during the crop development time. The overall total rainfall during crop growing period was (1199.2 mm). The highest rainfall received during August month was (316.4 mm). Eighty genotypes of rice were taken for this research (Table 1). The material was grown under direct seeded condition in the wet season of 2019. The experimental design is Randomized Compete Block Design (RCBD). The experimental material was planted is two replication and each replication comprised of 80 genotypes. Each entry was sowing in a plot of 1.20 meter length and 1 meter width as spacing of 20 cm between rows, the distance between plots was 50 cm. The checks varieties were randomized within replication. The standard agronomic practices were adopted for normal crop growth. Random five plant are selected from each of the plot were taken for collecting data on yield and yield attributing traits.

The observation was recorded on Germination per cent, Seedling length (cm) (10, 20 and 30 DAS), Number of leaves per plant (10, 20 and 30 DAS), Seedling dry weight (g) (10, 20, and 30 DAS), Vigour index I and II, Days to 50% flowering, flag leaf length (cm), flag leaf width (mm), panicles per square meter, plant height (cm), panicle length (cm), number of filled spikelet per panicle, number of unfilled spikelet per panicle, spikelet fertility percentage (%), 1000 grain weight (g), grain yield per meter square (g), paddy length (mm), paddy breadth (mm), paddy L/B ratio. The data was notable in favour to early seedling vigour, yield and their related character of rice accessions were subjected to the statistical analysis. In this calculation mean values were succeed for all character for everyone genotype. These mean data are used to estimate the variability parameters. ANOVA is deliberated by using O.P.STAT software.

Table 1: List of germplasm accessions used in the study

S. No.	Accessions	S. No	Accessions
1	Aditya	41	R971-25-2-1
2	Kalinga-3	42	R1152-2-64-1
3	Bala	43	R1004-2552-1-1
4	Poorva	44	CR-306-37-13
5	Lallu-14	45	CR-314-5-10
6	MR 1523	46	Asam chidi
7	IR-38	47	R1723-1411-1-3551
8	Surekha	48	ARC-15831
9	Tripti	49	Danteshwari
10	T-10	50	Poornima
11	Aganni	51	Salim paket
12	Jhitpiti	52	R1238-19361
13	R1558-2423-1-1445-1	53	R1182-31-2-151
14	Kaweri	54	R1122-167-2-1571
15	Shwnong-89366	55	Vandana
16	Chom phool	56	R1546-1382-1-40-1
17	Asha	57	MTU-15
18	Bangoli-3	58	Mamhar
19	Nipon bare	59	C101 LAC
20	Lal mati	60	Shyamla
21	Usai buta-2408	61	IR-64
22	Banisar No-31	62	Pokali
23	Karhani-No-9	63	Krishna hansa
24	Balsi ralu kanb-694	64	IR 08 L 152
25	Banso bnisa B-1021	65	RP-5125-2-4
26	DU-95-0-137-1	66	CR-Dhan-40
27	Sawas-D-137-1	67	R1882-306-4-243-1
28	Brown gova	68	R1986-296-2-867
29	Danwas 2511	69	R1973-206-2-86-1
30	Duma-bada-25-55	70	CG zinc rice-1
31	Fent 2679	71	CG zinc rice-2
32	Gutla 2614	72	R1779-321-1-112-1
33	Gurmetta 2697	73	R1882-301-1-234-1
34	Danwar 2129	74	R2221-391-1-248-1
35	R1558-1419-2-1442-1	75	R1882-310-4-257-1
36	R1519-769-2-1442-1	76	IR-36
37	R1551-2169-1	77	IR-64 (DRT)
38	R1448-578-2	78	Indira aerobic-1
39	R1013-2307-1-4	79	Shamleshwari (Check)
40	IR-7866-BIO-BBB-SBI	80	MTU-1010 (Check)

Range was expressed as minimum and maximum value of a trait. The mean was estimated as sum of number of observation by total number of observation. The coefficient of variation for different traits was calculated by formula which is given by Burton and De Vane (1953) [1]. The category of magnitude of coefficient of variation was given as higher (greater than 20%), moderate (between 20% - 10%) and low (lower than 10%).

Result and Discussion

The analysis of variance of 26 early seedling vigour, yield and yield attributing traits of rice germplasm accessions are presented in Table 2. The mean sum of squares due to genotype/treatments were found to be highly significant for all the traits except number of leaves on 10 DAS and the Number of leaves on 20 DAS. This clearly indicates that variability exist in all the genotypes for all the traits. Sravan *et al*. 2012 [7] reported significant variability among all the genotypes for all the characters. Our results confirm to the results of the above researchers indicating the presence of a considerable amount of variability among the genotypes.

Table 2: Analysis of variance for early seedling vigour, yield and its components during 2019 at IGKV Raipur (C.G.)

S. No.	Characters	Source of variation with degree of freedom		
		Replication (1)	Genotype (79)	Error (79)
1	Number of leaves in 10 days	0.32*	0.07	0.05
2	Seedling length in 10 days (cm)	6.68*	3.11**	1.36
3	Seedling dry weight in 10 days (g)	0	0**	0
4	Number of leaf in 20 days	0.21	0.19	0.19
5	Seedling length in 20 days (cm)	16.77	22.713**	4.45
6	Seedling dry weight in 20 days (g)	0	0.001**	0
7	Number of leaves in 30 days	0.012	0.18**	0.05
8	Seedling length in 30 days (cm)	53.24	123.52**	15.39
9	Seedling dry weight in 30 days (g)	0.001	0.01**	0.001
10	Germination percent	49.5	137.63**	13.81
11	Vigour index 1	7,72,520.33*	9,50,228.50**	1,35,137.13
12	Vigour index 2	0.003	66.74**	8.95
13	Days to 50% Flowering (days)	6	103.16**	2.56
14	Panicle length (cm)	1.13	9.864**	0.89
15	Plant height (cm)	768.73**	480.119**	71.69
16	Flag leaf length (cm)	121.13*	78.524**	22.17
17	Flag leaf width (mm)	12.26*	6.071**	2.46
18	Panicle per meter square	709.8	2,733.16**	499.97
19	1000 grain weight (g)	0.19	22.552**	0.76
20	Filled spikelet	18.22	1,654.75**	31.89
21	Unfilled spikelet	0.02	226.66**	3.22
22	Spikelet fertility percent (%)	0.003	88.74**	1.21
23	Paddy length (mm)	0.009	1.324**	0.014
24	Paddy Breadth (mm)	0.001	0.155**	0.004
25	Paddy L/B ratio	0	0.664**	0.01
26	Grain yield per meter square (g)	970.22	7,612.22**	518.02

** significant at 1% level, * significant at 5% level.

The mean and genetic variability parameters for 26 ESV and yield traits of rice germplasm accessions are presented in Table 3. The range for number of leaves on 10 days varied from 2.0 (Bala, Lallu-14, Sawas-D-137-1, Danteshwari, Shamleshwari and MTU-1010) to 2.8 (Gutla 2614) with the overall mean of 2.30 with the CV was 8.15%. The range for seedling length on 10 days varied from 9.62 cm (CR-Dhan-40) to 15.45 (Gutla 2614) with the overall mean of 11.81 days, CV was 10.55%. The range for seedling dry on 10 days weight varied from 0.01 (R1448-578-2, Poornima, Salim paket, Krishma hansa, IR 08 L 152 and R2221-391-1-248-1) to 0.02 g (Gutla 2614) with the overall mean of 0.01 (gm). The coefficient of variation of seedling dry weight on 10 days was 19.72%.

The range for number of leaves on 20 days varied from 3.6 (CR-306-37-13, CR-314-5-10, R1723-1411-1-3551, ARC-15831 and MTU-15) to 4.8 (Balsi balu kanb-694) with the overall mean of 4.15 days with the CV was 7.49%. The range of seedling length on 20 days varied from 14.96 (CR-306-37-13) to 29.79 cm (Gurmetta 2697) with the overall mean of 20.43 (cm) with CV the was 16.49%.The range for seedling dry weight on 20 days varied from 0.04 (Chom phool) to 0.12 (g) (Pokali) with the overall mean is 0.07 (g). The coefficient of variation was 27.48%.

The range for number of leaves on 30 days varied from 4.0 (Asam chidi) to 5.7 (Aganni) with the overall mean of 4.64 days with the CV was 6.49%. The range for seedling length on 30 days varied from 28.4 (Aditya) to 67.62 cm (Pokali) with the overall mean of 41.18 cm and CV was 19.05%. The range for seedling dry weight on 30 days varied from 0.098 (IR-64) to 0.42 gm (Pokali) with the overall mean is 0.22 (gm). The coefficient of variation was 30.68%.

The range for germination % varied from 69 (Lallu-14) to 98.5 (MTU-1010) with the overall mean of 81.71. The coefficient of variation was 10.37%. The range for vigour index I varied from 2101.38 (Bala) to 6322.47 (Pokali) with the overall mean of 3359.96. The coefficient of variation was 20.43%. The range for vigour indexII varied from 6.94 (IR-64) to 38.91 (Pokali) with the overall mean of 18.59. The coefficient of variation was 30.96%.

The range for days to 50% flowering varied from 60.5 days (Kalinga-3) to 90.00 days (Danteshwari and Pokali) with the overall mean of 79.83 days with the CV was 8.99%. Highest panicle length was found 17.84 cm in (R1152-2-64-1) to 27.85 cm in Bongali-3 with a mean of 23.12 cm. The coefficient of variation was 9.60%. The range for plant height varied from 75.58 cm (Banisar No-31) to 160.84 cm (Pokali) with an overall mean of 102.96 cm. The coefficient of variation of plant height was 15.04%. The range for flag leaf length varied from 17.11 cm (R1519-769-2-1442-1) to 50.08 cm (Gurmetta 2697) with the overall mean of 32.60 cm. The coefficient of variation was 19.21 %. The range for flag leaf width varied from 11.0 cm (Jhitpiti and R1973-206-2-86-1) to 20.3 cm (Shamleshwari) with the overall mean of 14.83 cm. The coefficient of variation was 11.74 %. 1000-grain weight ranged from 14.02g (Lal mati) to 32.23g (R1448-578-2) with

an average weight of 24.67g. The coefficient of variation was 13.6%. Spikelet fertility % ranged from 60.77 (Asha) to 92.2 (R1551-2169-1) with an average of 83.37. The coefficient of variation was 7.98%.

The range for paddy L/B ratio varied from 2.35 mm (R2221-391-1-248-1) to 5.49 (R1519-769-2-1442-1) with the overall mean of 3.50 mm. The coefficient of variation was 16.52%. The range for grain yield/m2 (g) varied from 76.5 g (Banisar No-31 and Birsa gova) to 409 g (R1004-2552-1-1) with a mean value of 235.82 g. The coefficient of variation was 26.16%.

Table 3: Mean and genetic variability parameters for 26 early seedling vigour, yield and it's attributing traits during wet season *Kharif* 2019.

S. No.	Characters	Mean	Range	SD	GCV	PCV	CV%
1	Number of leaves in 10 days	2.305	2.80 – 2.00	0.188	10.866	3.781	8.156
2	Seedling length in 10 days (cm)	11.810	15.45 - 9.62	1.247	12.663	7.917	10.558
3	Seedling dry weight in 10 days (g)	0.015	0.02-0.01	0.003	23.786	16.799	19.722
4	Number of leaf in 20 days	4.151	4.80 - 3.60	0.311	10.568	0.742	7.491
5	Seedling length in 20 days (cm)	20.431	29.79 -14.96	3.370	18.038	14.789	16.494
6	Seedling dry weight in 20 days (g)	0.069	0.12 -0.04	0.019	29.537	24.518	27.488
7	Number of leaves in 30 days	4.646	5.70 – 4.00	0.302	7.457	5.368	6.4998
8	Seedling length in 30 days (cm)	41.189	67.62 - 28.40	7.850	20.237	17.854	19.058
9	Seedling dry weight in 30 days (g)	0.228	0.42 - 0.09	0.070	32.690	28.686	30.680
10	Germination percent	81.710	98.50 – 69.00	8.468	10.644	9.624	10.379
11	Vigour index 1	3359.960	6321.81 – 2101.90	684.799	21.925	19.00	20.435
12	Vigour index 2	18.610	38.91 - 6.94	5.744	33.043	28.871	30.965
13	Days to 50% Flowering (days)	79.831	90.00 - 60.50	7.182	9.108	8.884	8.9964
14	Panicle length (cm)	23.128	27.85 -17.84	2.221	10.026	9.159	9.603
15	Plant height (cm)	102.961	160.84 -75.58	15.494	16.133	13.879	15.048
16	Flag leaf length (cm)	32.602	50.08 - 17.11	6.266	21.765	16.28	19.219
17	Flag leaf width (mm)	14.834	20.30 – 11.00	1.742	13.928	9.049	11.743
18	Panicle per meter square	209.981	29.10 - 125.50	36.967	19.148	15.914	17.604
19	1000 grain weight (g)	24.675	32.23 -14.02	3.358	13.838	13.375	13.608
20	Filled spikelet	106.550	188.50 - 47.50	28.764	27.255	26.734	26.995
21	Unfilled spikelet	20.950	69.00 -9.00	10.646	51.176	50.452	50.816
22	Spikelet fertility percent (%)	83.376	92.20 - 60.77	6.661	8.044	7.934	7.989
23	Paddy length (mm)	8.7587	11.25 - 6.65	0.822	9.334	9.233	9.384
24	Paddy Breadth (mm)	2.541	3.25 - 1.85	0.278	11.071	10.821	10.939
25	Paddy L/B ratio	3.498	5.49 - 2.35	0.578	16.577	16.335	16.520
26	Grain yield per meter square (g)	235.825	409.00 - 76.50	61.694	27.036	25.255	26.160

The genetic variability in any breeding material is a pre-requisite as it does not only provide a basis for selection but also provides some valuable information regarding the selection of diverse parents for use in the improvement program. The coefficient of variation was evolved by Karl Pearson. It is very useful for the study of variation. It indicates that when the CV% is high the sample is less consistent or more variable. Coefficient of variation truly provides a relative measure of variability among different traits. In the present investigation, a wide range of variability was observed for most of the quantitative traits. High magnitude of coefficient of variation (more than 20%) for seedling dry weight on 20 days (27.44), seedling dry weight on 30 days (30.68), vigour indexI (20.43), vigour indexII (30.96), filled spikelet (26.99) and unfilled spikelet (50.81) and grain yield per meter square (26.16).

Phenotypic and Genotypic coefficient of variation: Coefficient of variation was calculated at genotypic and phenotypic levels as analysis of variance permits estimation of phenotypic, genotypic and environmental coefficient of variation (Burton, 1952) [2]. The phenotypic coefficient of variation was higher than genotypic coefficient of variation. The PCV and GCV are classified as suggested by Siva Subramanian and Madhavamenon (1973) (low <10%; moderate 10-20% and high >20%). The estimates of phenotypic and genotypic coefficient of variation for different quantitative characters are present in Table 2.2.

The high GCV observed for seedling dry weight on 10 days (23.76), seedling dry weight on 20 days (29.53), seedling dry weight on 30 days (32.69), seedling length on 30 days (20.23), vigour index I (21.92), vigour index II (33.04), Flag leaf length (21.76), filled spikelet (27.25), unfilled spikelet (51.17) and grain yield (27.03). Likewise, PCV was obtained high in seedling dry weight on 20 days (24.51), seedling dry weight on 30 days (28.68), vigour index II (28.87), filled spikelet (26.73), unfilled spikelet (50.45) and grain yield (25.25). However, moderate values of GCV observed for number of leaves on 10 days (10.86), seedling length on 10 days (12.66), number of leaves on 20 days (10.56), seedling length on 20 days (18.03), germination% (10.64), panicle length (10.02), plant height (16.13), flag leaf width (13.92), panicle per meter square (19.14), 1000 grain weight (13.83), paddy breadth (11.07) and paddy L/B ratio (16.57). Likewise, characters for PCV was recorded for seedling dry weight on 10 days (16.79), seedling length on 20 days (14.78), seedling length for 30 days (17.85), vigour indexI (19), plant height (13.87), flag leaf length (16.28), panicle per meter square (15.91), 1000 grain weight (13.37), paddy breadth (10.82) and paddy L/B ratio (16.33). The values of PCV is higher than GCV, indicates the apparent variation is not only due to genotypes but also due to the influence of the environment. The high magnitude of genotypic coefficient of variation reveals the high genetic variability present in the material studied similar findings of high PCV coupled with GCV for traits namely, number of filled grains and thousand-grain weight was reported by Sravan *et al.*, 2012 [7] and Vanisree *et al*. 2013 [8]. Satheesh kumar and Saravanan (2012) [6] reported high estimates for these genetic parameters for all the yield traits.

This study was a first step in gaining an insight into the genetic variability, which is an important step towards an efficient exploitation of genetic resources of rice genotypes. Based on grain yield per meter square, genotypes namely, R1004-2552-1-1 (409) recorded high grain yield per meter square followed by Indira aerobic-1 (361), Asam chidi, Surekha (338), IR 08 L 152 (335), Pokali (332) and Aditya (328). These genotypes may be used in upland rice breeding programme.

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