Original Research Article

Studies on Variability, Correlation and Path analysis for seedling vigour traits in rice (*Oryza sativa* L.)

Abstract

The research work was undertaken to assess seedling vigour traits and analysis of variance revealed existence of significant differences among the genotypes. Dry weight of seedling followed by seedling vigour index-II had showed high PCV and GCV. Germination (%) -first count length, length of shoot, length of root, dry weight of seedling, seedling vigour index-I, seedling vigour index-II and field emergence exhibited high heritability along with high genetic advance as per cent of mean. Length of seedling, seedling vigour index-II and germination (%) -first count exhibited the high positive direct effect on per plant grain yield. Therefore, these traits have to be given importance during selection process for identification of high vigour rice lines.

Keywords: Rice, Vigour, Variability, Correlation, Path analysis

Introduction

Rice is one of the most important food crops in the world providing staple food for nearly half of the global population. Rice crop is exposed to many unfavourable conditions like drought, salinity, extreme temperatures and many biotic stresses. To overcome all these adverse effects high quality seed has to be used. Seed vigour is an important characteristic of seed quality, reflecting potential seed germination, seedling growth, seed longevity and tolerance to adversity. Strong vigour seeds can boost seed germination, speed and uniformity,

as well as the ultimate percentage of germination, resulting in flawless field emergence, crop performance, and even high yield under various (Foolad*et al*., 2007). Cultivars with strong seed vigour are desirable for farmers to get optimum stand establishment. Keeping in view the importance of seedling vigour present study was undertaken.

Materials and methods

Present study was undertaken with 30 rice genotypes to estimate the variability, heritability and genetic advance of rice genotypes for seedling vigour traits. Seedling vigour analysis was carried out at Department of Seed Science and Technology, College of Agriculture, PJTS Agriculture University. The data was collected on characters *viz* germination (%)-first count, germination (%)-final count, length of seedling (cm), length of root (cm), length of shoot (cm), dry weight of seedling (mg), seedling vigour index-I, seedling vigour index-II, field emergence and grain yield per plant (g).

Statistical analysis

Standard procedure given by Panse and Sukhatme, 1978 was used for analysis of variance done for each character. Johnson *et al*. (1955) proposed estimation of genotypic and phenotypic correlation coefficients and the range of genetic advance as per cent of mean based on classes high (20 and above), medium (10 - 20) and low (0 - 10). GCV and PCV values were classed as high (20 and beyond), medium (10-20) and low (0-10) as given by Sivasubramanian and Menon (1973). Allard (1960) suggested that heritability in broad sense was estimated as the ratio of genotypic variance to the total variance and expressed as percent. Johnson *et al*. (1955) estimates of heritability were classified as high (61-100), moderate (30-60) and low (0-29). Falconer's formulas were used to calculate correlation coefficients at the genotypic and phenotypic levels (1964). INDOSTAT software was used to conduct all statistical analysis.

Results and discussion

Genetic parameters

Significant variation was observed among the genotypes for all the traits under study presented in Table 1. Table 2 indicates the results pertaining to genetic variability parameters *viz*., mean, genotypic coefficient of variability (GCV), phenotypic coefficient of variability (PCV), broad sense heritability (h^2) and genetic advance as per cent of mean (GAM) for seedling vigour traits. For all the traits the values of PCV were higher than the GCV values indicating that these characters may be influenced by the environment. High PCV and GCV values were observed for dry weight of seedling followed by seedling vigour index-II.Whereas moderate values were registered for length of seedling, length of shoot, length of root, seedling vigour index-I, field emergence and germination (%) first count, similar findings were given by Pavan *et al.* (2016). Low for germination (%) final count, similar results were accordance with findings of Rishabh *et al*. (2019).

High heritability coupled with high genetic advance as per cent of mean observed for germination (%) -first count, length of seedling, length of shoot, length of root, dry weight of seedling, seedling vigour index-I, seedling vigour index-II and field emergence indicated that these traits were controlled by additive type of gene action. Similar findings were given by Pavan *et al.* (2016), Nusrat *et al*. (2018) for length of shoot and Rishabh *et al*. (2019) for dry weight of seedling, Pavan *et al.* (2016) for seedling vigour index-II. For selection of traits for improving yield along with PCV and GCV values, heritability and genetic advance has to be considered to get reliable results.

The high estimates of heritability coupled with moderate genetic advance as per cent of mean were observed for germination (%)-final count.

Table 1. Analysis of variance for yield and vigour traits in rice.

Sl. No	Characters	Mean sum of squares		
		Replications (d.f. = 1)	Treatments (d.f. = 29)	Error (d.f.= 29)
1	Germination (%) -First count	1.35	275.17**	4.04
2	Germination (%) -Final count	1.35	95.57**	9.04
3	Length of seedling (cm)	1.11	31.10**	3.27
4	Length of root (cm)	0.19	9.46**	0.54
5	Length of shoot (cm)	4.04	16.46**	3.19
6	Dry weight of seedling (mg)	0.001	0.003**	0.0001
7	Seedling vigour index -I	13127.60	350230.6**	37172.46
8	Seedling vigour index-II	2.36	21.40**	0.62
9	Field emergence	240.0	484.83**	67.58
10	Grain yield per plant (g)	0.32	25.21**	0.52

** Significant at 1 level of probability

Table 2. Genetic Variability parameters for seedling vigour and yield in rice.

S. No	Characters	Mean	Range		Phenotypic Variance	Genotypic Variance	PCV (%)	GCV (%)	Heritability in broad sense (h^2) (%)	Genetic advance as percent of mean
			Min	Max						
1	**Germination (%)-First count**	93.42	32.50	99.00	139.61	43.26	12.65	12.46	97.10	25.30
2	**Germination (%)-Final count**	91.98	62.00	99.50	52.30	0.17	7.86	7.15	82.70	13.40
3	**Length of seedling (cm)**	25.78	16.25	32.40	17.19	13.91	16.08	14.47	80.90	26.81
4	**Length of shoot (cm)**	11.38	8.45	17.90	5.00	4.46	19.65	18.56	89.20	36.10
5	**Length of root (cm)**	14.40	7.15	18.95	9.83	6.64	21.77	17.89	67.50	30.27
6	**Dry weight of seedling (mg)**	0.11	0.06	0.20	0.001	0.001	34.52	32.51	88.70	63.07
7	**Seedling vigour index-I**	2376.06	1276.5	3079.6	193701.5	156529.1	18.52	16.65	80.80	30.84
8	**Seedling vigour index-II**	10.22	4.92	16.44	11.01	10.39	32.49	31.56	94.40	63.15
9	**Field emergence**	87.00	35.00	100.00	276.21	208.62	19.10	16.60	75.50	29.73
10	**Grain yield per plant (g)**	19.12	10.45	26.75	12.87	12.35	18.7	18.38	96.00	37.09

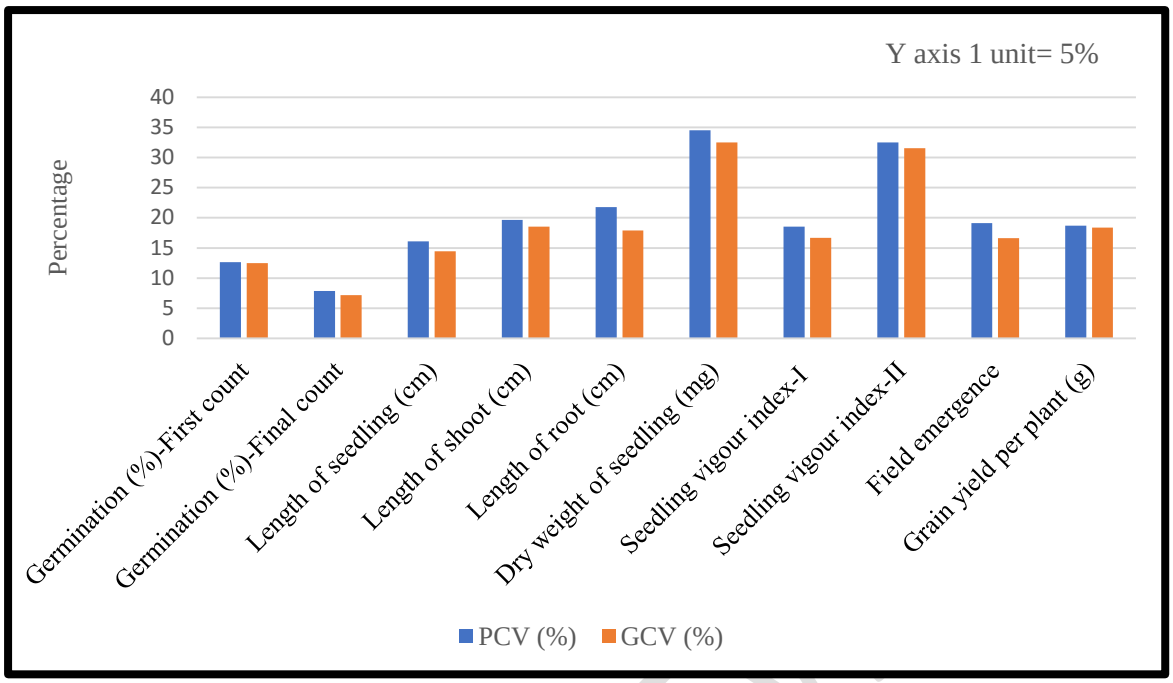

Fig. 1 Graphical representation of PCV and GCV

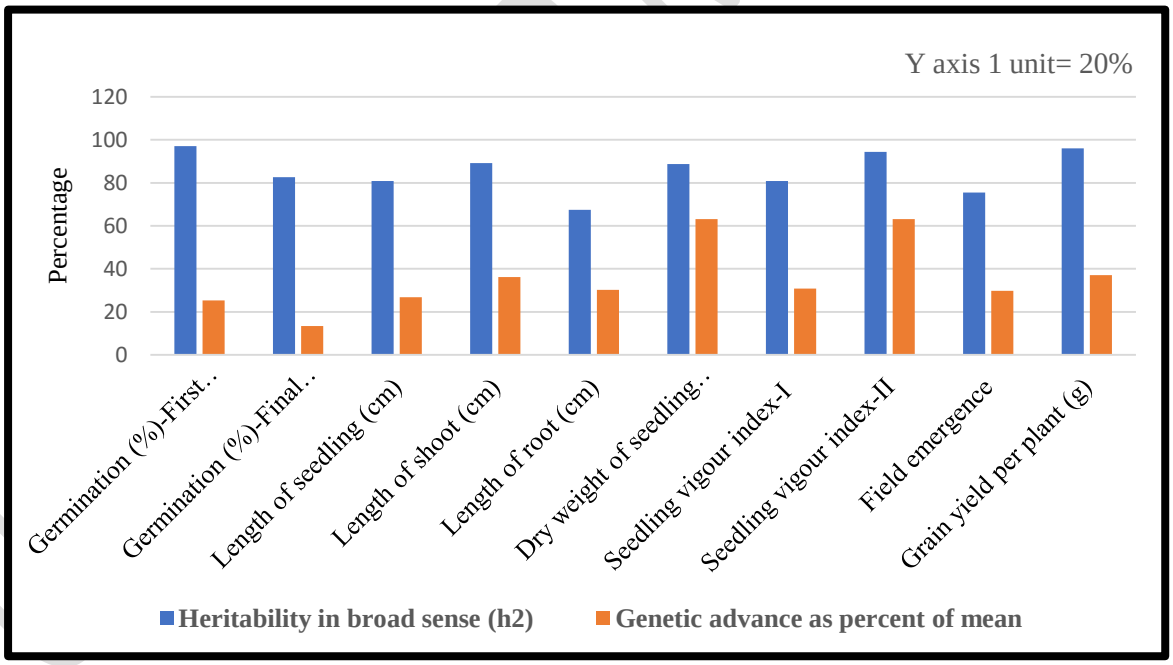

Fig. 2 Graphical representation of Heritability and Genetic advance

Character association studies revealed that grain yield per plant showed significant and positive association with seedling vigour index-II. However, it had negative and significant correlation with field emergence. Correlation analysis gives nature and degree of relationship only, path analysis can be used to study direct and indirect cause and effect relationship. Table 3. contains the data.

Table 3. Correlation analysis for seedling vigour and yield traits in rice.

Character		GER 1	GER 2	SL	SHL	RL	SDW	SV-I	SV-II	FE	GYP
GER 1	**G**	**1.00**	0.90**	0.21	0.00	0.31	-0.06	0.50**	0.21	0.15	0.08
	P	**1.00**	0.82**	0.19	0.00	0.25	-0.05	0.45**	0.21	0.11	0.08
GER 2	**G**		**1.00**	0.17	-0.02	0.27*	-0.18	0.53**	0.15	0.14	0.12
	P		**1.00**	0.15	-0.01	0.21	-0.16	0.50**	0.14	0.12	0.13
SL	**G**			**1.00**	0.75**	0.84**	0.83**	0.93**	0.86**	0.03	0.14
	P			**1.00**	0.66**	0.84**	0.69**	0.92**	0.76**	0.01	0.13
SHL	**G**				**1.00**	0.26*	0.64**	0.63**	0.65**	-0.03	0.13
	P				**1.00**	0.17	0.56**	0.57**	0.59**	0.01	0.13
RL	**G**					**1.00**	0.67**	0.82**	0.72**	0.07	0.10
	P					**1.00**	0.51**	0.81**	0.58**	0.01	0.08
SDW	**G**						**1.00**	0.65**	0.95**	0.05	0.21
	P						**1.00**	0.53**	0.93**	0.10	0.18
SV-I	**G**							**1.00**	0.80**	0.07	0.18
	P							**1.00**	0.71**	0.04	0.18
SV-II	**G**								**1.00**	0.07	0.27*
	P								**1.00**	0.09	0.25*
FE	**G**									**1.00**	-0.38**
	P									**1.00**	-0.33**

Path coefficient analysis revealed that length of seedling, seedling vigour index-II and germination (%) -first count exhibited higher positive direct effect on grain yield per plant indicating that the selection for these characters was likely to bring about an overall improvement in grain yield per plant directly. Similar findings were observed by Nusrat *et al*. (2018) for length of seedling, Rajendragouda *et al*. (2014) for seedling vigour index-II and Saxena and Suman (2017) for positive direct effect of germination (%)-first count. As a result, it is advised that these traits to be prioritized in the selection process in order to isolate better lines with higher production potential in rice. The Table 4 contains the data.

Table 4. Phenotypic (P) and Genotypic (G) path coefficients of seedling vigour and yield traits in rice.

Character		GER 1	GER 2	SL	SHL	RL	SDW	SV-I	SV-II	FE	GYP
GER 1	**G**	**-1.3341**	-1.2035	-0.2830	0.0014	-0.4110	0.0807	-0.6706	-0.2738	-0.2061	0.0851
	P	**0.1750**	0.1441	0.0329	0.0002	0.0434	-0.0079	0.0788	0.0364	0.0200	0.0845
GER 2	**G**	0.7899	**0.8756**	0.1487	-0.0209	0.2324	-0.1616	0.4614	0.1298	0.1263	0.1261
	P	-1.4095	**-1.7114**	-0.2637	0.0108	-0.3564	0.2809	-0.8706	-0.2317	-0.1986	0.1304
SL	**G**	-0.1308	-0.1047	**-0.6166**	-0.4594	-0.5162	-0.5112	-0.5704	-0.5320	-0.0189	0.1432
	P	0.8863	0.7258	**4.7109**	3.1393	3.9892	3.2514	4.3666	3.5849	0.0426	0.1376
SHL	**G**	-0.0003	-0.0063	0.1977	**0.2654**	0.0687	0.1708	0.1682	0.1728	-0.0082	0.1308
	P	-0.0065	0.0307	-3.2356	**-4.8555**	-0.8143	-2.7274	-2.7790	-2.8645	-0.0349	0.1330
RL	**G**	0.3656	0.3150	0.9935	0.3072	**1.1867**	0.7985	0.9728	0.8490	0.0827	0.1001
	P	-1.7006	-1.4289	-5.8112	-1.1509	**-6.8625**	-3.5125	-5.6086	-4.0166	-0.0469	0.0870
SDW	**G**	0.1745	0.5323	-2.3915	-1.8563	-1.9409	**-2.8848**	-1.8642	-2.7350	-0.1356	0.2107
	P	0.0075	0.0273	-0.1148	-0.0935	-0.0852	**-0.1664**	-0.0887	-0.1557	-0.0166	0.1808
SV-I	**G**	-0.8814	-0.9239	-1.6219	-1.1113	-1.4373	-1.1331	**-1.7534**	-1.4110	-0.1230	0.1896
	P	2.1697	2.4515	4.4668	2.7581	3.9384	2.5692	**4.8189**	3.4244	0.1763	0.1838
SV-II	**G**	0.9138	0.6601	3.8412	2.8988	3.1854	4.2213	3.5830	**4.4524**	0.3155	0.2762*
	P	0.0556	0.0362	0.2034	0.1577	0.1564	0.2502	0.1899	**0.2673**	0.0251	0.2520*
FE	**G**	-0.0357	-0.0334	-0.0071	0.0071	-0.0161	-0.0109	-0.0162	-0.0164	**-0.2312**	-0.3832**
	P	-0.0241	-0.0245	-0.0019	-0.0015	-0.0014	-0.0210	-0.0077	-0.0198	**-0.2110**	-0.3354**

GER 1; Germination (%) First count, **GER 2;** Germination (%) Final count, **SL;**Length of seedling (cm),**SHL;** Length of shoot (cm), **RL;** Length of root (cm), **SDW;** Dry Weight of Seedling (mg), **SV-I**; Seedling Vigour Index-I, **SV-II;** Seedling Vigour Index-II, **FE;** Field Emergence, **GYP;**Grain yield per plant (g).

Conclusion:

In conclusion, Analysis of variance revealed that all genotypes had shown the significant variation for all traits under study indicating that genotypes possessed inherent genetic differences. It was observed that seedling dry weight followed by seedling vigour index-II, had high heritability and high genetic advance as per cent of mean and indicating that inheritance was controlled by additive gene. Simple selection can be done to improve these traits. The remaining traits, seedling length, shoot length, root length, seedling vigour index-I, field emergence and germination (%) first count had low to moderate estimates of genetic advance, were largely influenced by non-additive gene effects. Analysis of correlation studies revealed that selection of plants with more seedling vigour index-II. would result in improvement of yield. Path coefficient analysis revealed that higher positive direct effect on per plant grain yield was shown by seedling vigour index-I, seedling length, seedling vigour index-II and germination (%)-first count. So these traits can be considered as critical for improving yield and vigour. Therefore, these characters should be prioritized during the selection process in order to identify better lines with more genetic potential for higher rice yield and high vigour.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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