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SEEDLING VIGOR AND GENETIC VARIABILITY FOR RICE SEED, SEEDLING EMERGENCE AND SEEDLING TRAITS

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Eleven local rice cultivars including Basmati 370 were evaluated for seedling vigor. Three groups of traits were evaluated *viz*; seed traits (seed density, seed volume, see weight, paddy length and grain length), seed emergence traits (emergence %, emergence index and emergence rate index), and seedling traits (fresh root length, dry root weight, root to shoot ratio and relative root weight). Genetic variability and heritability estimates for seed weight, emergence percentage, root length, dry root weight, seed weight and relative root weight were observed significant, respectively. Seed density, relative root weight, emergence rate index and root to shoot ratio were relatively more amenable to improvement. Relative expected genetic advance was the function of heritability and coefficient of phenotypic variability, latter being more important.

Key words: Seedling vigor, Variability, Root/shoot ratio, Rice.

Introduction

Research work on seed and seedling traits is an important aspect of a crop breeding program, since the final plant stand of a crop primarily depends upon seedling traits. Among seedling traits, emergency percentage has been extensively used as an indication for seedling vigor [1]. Seedling vigor is defined as the ability of a plant to emerge its aerial parts from the soil or water in sub-optimal environment [2]. Theoretically, seedling which emerge earlier would have the advantage over the late emerging seedlings because fast emerging seedlings will have increased photosynthetic activity and a more developed root system capable of absorbing more water and nutrient from soil [3]. These all factors will add to the vigor of seedling by enhancing its growth [4]. A combination of quick emergence and healthy plant stand in rice crop will generally enhance early maturity, yield, insect control, escape from unfavourable temperature and less competition with weeds. Seed maturity (seed density) and seed weight also determines the seedling growth rate [5]. Seed density affects germination and seedling from low density also exhibit low level of seedling vigor [6–8]. Eissa *et al.* [9] have made a comprehensive studies upon inheritance and variability of seed and seedling traits of cotton. Keeping in view the importance of seed and seedling traits, the present research was initiated to observed the genetic variability and heritability in some rice genotypes which not only be helpful to select parents with good seedling vigor but further may be used in hybridization program aiming at the development of cultivars with good seedling traits. The genetic variation in terms of percentage of total variation was used as an estimate of heritability in broad sense. We recognize that a better estimately and relative expected genetic advance should be obtained from a study of segregating material. Our estimate simply represents the magnitude of genetic variation among the genotypes studied in relation to the total variation.

Material and Methods

The experimental material comprised of eleven rice genotypes i.e. Basmati 385, 4048, 4029-2, 4029-3, Basmati 370, 6129, 35904, 33608, PK 2773-1-2-3, 4439 and Basmati 198. The experiment was conducted in polythene bags in the green house at Rice Research Institute, Kala Shah Kaku during 1992. Before planting, the traits related to seed were calculated. Seed was sown in polythene bags of 23 x 8 cm size, containing aproximately 500 g of sun-dried river sand. Thirty ml of tap water was applied to each bag before sowing. Fifteen seeds from each genotype were sown in randomized complete block design with three replications. Each bag accommodate single seed (seedling in latter stages) sown at 2 cm depth. Tap water was applied daily to provide adequate moisture to prevent wilting. The data on emergence and seedling traits were recorded 15 days after seedling. Ten randomly selected plants from each genotype in each replication were used for data recording. Traits evaluated were categorized into three groups.

Seed traits. Seed for each genotype was divided into three lots of 100 seed each (latter, referred as replications). Data were recorded for seed density (seed weight/seed volume), seed volume (c.c. methanol displaced by 100 seeds), seed weight (100 seed weight in grams), paddy length and grain length (measured by micrometer in millimeters.

Seed emergence traits. Emergence percentage (E%), emergence index (EI) as calculated by Mock and Eberhart [10] and emergence rate index (ERI=E1/E%) were obtained and grouped as seed emergence traits. For any given E% and EI, ERI estimates the total number of days it could take for 100% emergence to occur, assuming other factors are not limiting.

Seedling traits. Seedling traits included fresh root length (cm), dry root weight (mg), root/shoot ratio and relative root weight (dry root weight over root length). Seedlings were cut into root and shoot portions, oven dried separately at 70° to a constant weight to obtain dry root weight (mg) and dry shoot weight (mg). Data were analyzed for analysis of variance [11], variance parameters, heritability in broad sense [12] and expected genetic advance (EGA) at 10% selection intensity using phenotypic standard deviation [13]. EGA was then expressed as percentage of the mean or the relative expected genetic advance. Standard error for genotypic variance and that of heritability was estimated [14].

Results and Discussions

Analysis of variances depicted that all the rice genotypes used in this study differed significantly at 5% level for seed density, seed volume, fresh root length and relative root weight. Highly significant differences at 1% level exist for all other traits. However, the replication effects were significant at 1% and 5% levels for seed weight and dry root weight, respectively.

Study of genetic variability in seed related traits (Table 2) depicted that coefficient of genetic variability was highest (31.22%) for fresh root length and minimum (3.89%) for grain length. Significant genetic variability was available for seed weight, emergence percentage, fresh root length and dry root weight. Significant genetic variability for seed weight, seed volume and seed density in cotton have also been reported [9].

TABLE 1. MEAN SQUARES FROM THE ANALYSIS OF VARIANCE OF SEED, SEED EMERGENCE, AND SEEDLING TRAITS IN ELEVEN RICE GENOTYPES.

Source of		Seed traits					Emergence traits*			Seedling traits			
variation	d.f	SD	SV	SW	PL	GL	E%	EI	ERI	FRL	DRWT	R/S	RRWT
Replications	2	$0.0848^{n.s}$	$0.23965^{n.s}$	0.13114^{**}	$0.00292^{n.s}$	$0.00481^{n.s}$	$21.212^{n.s}$	$1.368^{n.s}$	$3.105^{n.s-04}$	$1.39^{n.s-05}$	6.932^{*-06}	$0.011^{n.s}$	$4.52^{n.s-3}$
Genotypes	10	0.1693^{*}	0.29602^{*}	0.11393^{**}	0.69920^{**}	0.25340^{**}	133.333^{**}	2.412^{**}	6.262^{**-04}	7.195^{*-05}	8.340^{**-06}	0.059^{**}	8.03^{*-3}
Error	20	0.0584	0.12004	0.00419	0.03859	0.01374	27.879	0.628	1.281^{-04}	2.404^{-05}	1.711^{-06}	0.009	3.38^{-3}
Total (N-1)	32												

$^{n.s, *, **}$ non-significant, significant and highly significant at 0.05 and 0.01 probability levels reectively. *SD=Seed density, SV=Seed volume, SW=Seed weight, PL=Paddy length, GL=grain length, E%=Emergence percentage, EI=Emergence index, ERI=Emergence rate index, FRI=Fresh root length, DRWT=Dry root weight, R/S=Dry root/shoot ratio and RRWT=Relative root weight.

TABLE 2. VARIOUS PARAMETERS MEASURING VARIABILITY AND RELATIVE EXPECTED GENETIC ADVANCE FOR SEED, SEED EMERGENCE AND SEEDLING TRAITS IN RICE.

Traits	Means	GCV%	PCV%	V_G	V_P	V_G/V_P	REGA (%)
SEED TRAITS							
Seed density (gm/cm^3)	1.175	16.37	20.14	0.037	0.056	0.661	23.3
Seed volume (cm^3)	1.921	12.64	16.38	0.059	0.099	0.596	17.1
Seed weight (gm)	2.18	8.82	8.94	0.037^{*}	0.038	0.974^{+}	15.23
Paddy length (mm)	9.78	4.80	4.94	0.220	0.233	0.944	8.15
Grain length (mm)	7.262	3.89	3.99	0.080	0.084	0.952	6.64
SEED EMERGENCE TRAITS							
Emergence percentage	86.67	6.84	7.69	35.15^{**}	44.44	0.791^{+}	10.65
Emergence index	5.67	13.60	15.81	0.59	0.80	0.734	20.26
Emergence rate index	0.067	19.23	21.56	0.0002	2.1^{-04}	0.952	35.82
SEEDLING TRAITS							
Fresh root length (cm)	12.80	31.22	38.26	1.596^{*-05}	2.398^{-05}	0.666	0.045
Dry root weight (mm)	9.10	16.34	18.32	2.209^{**-06}	2.78^{-06}	0.795	0.025
R/S ratio	0.51	25.32	27.51	0.017	0.02	0.850	41.18
Relative root weight	0.28	14.06	18.49	1.55^{-3}	2.68^{-3}	0.578^{+}	18.57

Where, GCV%=Genetic coefficient of variability, PCV%=Phenotypic coefficient of variability; V_G=Genotypic variance, V_P=Phenotypic variance; REGA=Relative expected genetic advance. V_G and V_G/V_P were considered significant as their absolute value exceeded twice its standard error (±).

The estimates of broad sense heritability was also significant for seed weight, emergence percentage and relative root weight and ranged from 57.8 to 97.4% for relative root weight and seed weight respectively. High phenotypic variability along with high estimates of heritability resulted in high relative expected genetic advance for these traits (Table 2). Relative expected genetic advance was maximum (41.18%) for dry root/dry shoot ratio and minimum (0.025%) for dry root weight. Therefore, highest genetic gain is expeted for root/shoot ratio. The results further connotes that posibility of improving seed traits was high through intensive selection. Eissa *et al.* [9] have argued that these seed traits being influenced by additive, dominance and additive x additive genetic effects, delay upto F3 generation would allow genetic recombinations to occur to facilitate selection. It is also obvious from the results that the scope of improvement for root/shoot ratio, relative root weight, emergence rate index and seed density was relatively high. It is tempting that on the basis of genetic studies parents can be identified for further utilizaion in breeding program like drought tolerance and weed comptitive ability for which root/shoot ratio and relative root weight are important characteristics.

To elucidate further the importance of seed, seed emergence and seedling traits, it is necessary to study association of these traits with one another and with other agronomic traits.

References

1. I. K. Allen and E. D. Donnelly, Crop Sci. **5**, 167 (1965).
2. W. Heydecker, Proc. Inter. Seed Test Assoc., **25**, 489 (1960).
3. W. Heydecker, 1972. *Seed Viaility.* E. H. Roberts (ed). (Syracuse Univ. Press, New York), pp.209-252.
4. T. M. Ching, S. Hedth, M. C. Boulger and W. E. Kronstad, Crop Sci., **17**, 312 (1977).
5. D. R. Krieg and J. D. Carroll, Agron., J. **67**, 343 (1978).
6. D. Furguson and J. H. Turner, Crop Sci., **11**, 713 (1971).
7. R. D. Krieg and S. N. Bartee. Agron. J. **67**, 343 (1975).
8. G. R. Tupper, L. E. Clark and O. R. Kunze, Proc. Assoc. Off. Seed Anal., **60**, 138 (1970).
9. A. M. Eissa, J. N. Jenkins and C. E. Vaughan. Crop Sci., 23 (6), 1107 (1983).
10. J. J. Mock and S. A. Eberhart, Crop Sci. **12**, 466 (1972).
11. R. G. D. Steel and J. H. Torrie, *Principles and Procedures of Statistics with Special Reference to Biological Sciences* (McGraw Hill Inc. New York, 1980).
12. G. W. Burton and E. H. Devane, Agron. J., **45**, 478 (1953).
13. D. S. Falconer, *Introduction to Quantitative Genetics* (Ronald Press Inc., New York, 1983).
14. J. E. Lothrop, R. P. Atkins and O. S. Smith, Crop. Sci., **25,** 235 (1985).