INFLUENCE OF SEED DENSITY CLASSIFICATION ON EMERGENCE AND SEEDLING TRAITS IN RICE (Oryza sativa L.)

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ABSTRACT

This study reports on the different densities of seed and their influence on some emergence and seedling traits in a group of ten rice genotypes. The germination performance of rice seeds with four classes of seed densities was evaluated. Shoot length, fresh shoot weight, fresh root weight, and dry shoot weight appeared to be proportional to the seed densities. Emergence percentage, shoot length, fresh shoot weight, fresh root weight and dry shoot weight were maximum at seed density of class I (pure water). Root length and dry root weight were maximum at seed density of class III (20 g Na Cl / 1000 ml of water). Seedlings from seeds of density class III and IV performed best for almost all characters observed. Selection of rice seeds on basis of density classification should, therefore, be done so that the light weight but high density seed are separated from the low density seeds

Key words: Emergence Index, Oryza sativa L, Relative root weight, Seedling vigor and Seed density

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INTRODUCTION

A consistent problem in the production of rice (*Oryza sativa* L.) has been the variable performance of seeds within a given seed lot. This variation is often exhibited by the failure to establish a crop stand; and by the non uniform growth of seedlings. Wanjura *et al* (1969) demonstrated the desirability of rapid and uniform establishment of a stand of vigorously growing seedlings. They found that majority of yield was produced by those plants originating from seedlings that had emerged most quickly from the soil. Therefore, variable performance of rice seeds has stimulated considerable research to facilitate the selection of high quality seeds from a seed lot. Tupper *et al* (1970, 1971) found that seed density was directly related to the earliness of germination. Similarly, Ferguson and Turner (1971) observed that degree of fill was positively related to both emergence and seedling vigor. Krieg and Bartee (1975) evaluated the influence of seed density on various aspects of germination and emergence. Krieg and Caroll (1978) demonstrated that seed maturity (density) and seed weight determined seedling growth rate. Hussaini *et al* (1984) found that larger seed were superior to medium and small seed in germination percentage and seedling vigour. Ali *et al* (1991) observed that root / shoot ratio, relative root weight, emergence rate index and seed density of rice seed could be improved through intensive selection, as these traits showed high relative expected genetic advance and heritability. While Ali *et al* (1992) observed positive genetic correlation of seed weight with fresh shoot length, fresh root length, fresh shoot weight, fresh root weight, dry root weight. Jafri *et al* (1992) also found positive correlation between 100 seed weight and germination percentage at both genotypic and phenotypic level. This indicated that seed weight can be an effective selection criterion for the development of cultivars with better seedling traits, influencing ultimately mature plant characteristics including grain yield. Since the higher mean seed density might influence the seed lot performance, we undertook an evaluation of rice seeds produced at Kala Shah Kaku, Pakistan, to determine the effects of these higher levels of seed density on both germination and seedling growth.

MATERIALS AND METHODS

A set of ten rice genotypes viz; Bas 385, 4439, Super Basmati, 35904, 43175, 4029A, 4029B, 4048-3-3, 1053-2-4-30 and Bas.Pak were grown during May (Temperature ranging from 30° to 35° C) 2004, at Rice Research Institute, Kala Shah Kaku, Pakistan. All the evaluations were made during the first season after seed production. Seeds were separated into four density classes by brine flotation procedure described by Hess (1977), King and Lamkin (1979). Brine solutions were of four concentrations i.e., tap water (no NaCl mixed), 10 g NaCl / 1000 ml of water, 20 g NaCl / 1000 ml of water, 40 g NaCl / 1000 ml of water. Seeds were transferred from one concentration to the next higher concentration of brine solution, if they did not float in lower density solution. All seeds that floated on any brine solution were removed rinsed and dried. Upon completion of density classification, four lots of seed were produced. They were identified by density, as follows. I = Tap water, II<10 g NaCl, III<20 g NaCl, IV< 40 g NaCl / 1000 ml of water.

Weights and volumes were determined on 100 seed samples. Volumes were measured in volumetric displacement of water. Thirty seeds of each genotype were sown at a depth of 3 cm in polyethylene bags of 23 x 8 cm size, containing approximately 500 g of sun dried river sand. Then 30 ml of tap water was applied to each bag before sowing. The design used was randomized complete block design with three replications. Tap water was applied daily to provide adequate moisture to prevent wilting. Data on emergence percentage and emergence index were obtained by following formulae.

$$\text{Emergence \% age} = \frac{\text{Total No. of Seedlings emerged by (DAP)}}{\text{Total No. of seeds planted}} \times 100$$

$$\text{Emergence Index} = \frac{\text{Plants emerged in a day (DAP)}}{\text{Plants emerged by (DAP)}}$$

(DAP) = Days after planting

After fifteen days the seedlings were harvested and divided into their root and shoot portions from their first cotyledonary node. The data were collected for fresh root and shoot length (cm) , fresh root and shoot weight (mg), Later these root and shoot portions were placed into an electric oven at 75°C for three days to a constant weight to record data on dry root and shoot weight (mg), relative root weight , Dry root/shoot ratio. The data so obtained were subjected to analysis of variance technique (Steel *et al*. 1997).

RESULTS AND DISCUSSION

Analysis of variance revealed significant genetic differences at 1% level for emergence percentage, shoot length, root length, fresh shoot weight, fresh root weight and dry shoot weight among ten rice genotypes and four densities. However G x D interaction was also significant for dry root weight in addition to these above mentioned traits. Seed weight, Emergence Index, Relative root weight, and root / shoot ratio were observed to be non significant (Table 1). Shoot length, fresh shoot weight, fresh root weight, dry shoot weight and Emergence percentage appeared to be proportional to the seed densities. Dry shoot weight and dry root weight were non significant across seed densities (Table 2). High density seeds weighed more than the low density seeds. This may be due to the fact that the low density seeds are generally poorly filled than high density seeds.

Emergence percentage of ten rice genotypes at each density was examined in greenhouse. After 15 days of sowing, the differential germination by seeds of these density classes was found to be highly significant. Maximum germination took place in the seeds of density class IV, while it was minimum in class I. This may be due to that the high density seeds might have embryo fully mature and more reserve food in the seeds as compared to the low density seeds. Therefore, this difference in maturity affected the emergence accordingly. Similar results have been reported by Tupper *et al* (1970, 1971) they observed that high density seeds increases the rate of initiation of germination.

Once germination occurs and seedling emerges from the soil, a sustained vigorous growth rate becomes of primary importance. Seedlings from four density classes, harvested after 15 days of germination exhibited differential growth. The shoot length from class IV seeds and root length from class III were significantly larger than others. Bartee and Krieg (1974) found that radicle growth was positively related to initial seed density classification. Fresh shoot weight, fresh root weight, dry shoot weight and dry root weight were also significant across seed densities. Maximum fresh shoot weight, fresh root weight and dry shoot weight were produced from seedlings which were produced from the seeds of class IV, while seeds from class III gave maximum dry root weight (Table 2). Similarly Krieg and Caroll (1978) concluded that seed maturity (density) determined seedling growth rate at optimum temperature.

TABLE 1: MEAN SQUARES FROM THE ANALYSIS OF VARIANCE OF TWELVE INDICATED SEED AND SEEDLING TRAITS ACROSS FOUR SEED DENSITIES IN RICE (*Oryza sativa* L.).

		Seedling traits										
SOV	df	S.W	E%	E.I	SL	RL	FSW	FRW	DSW	DRW	RRW	R/S
Replications	2	0.077^{NS}	15.833^{**}	0.199^{NS}	3.962^{*}	1.341^{NS}	106.400^{**}	541.932^{**}	8.265^{**}	20.410^{**}	0.124^{NS}	1.359^{NS}
Genotypes	9	0.904^{NS}	161.944^{**}	0.761^{NS}	26.674^{**}	16.125^{**}	1028.267^{**}	996.008^{**}	35.557^{**}	10.437^{NS}	0.060^{NS}	0.866^{NS}
Densities	3	0.203^{NS}	503.056^{**}	0.523^{NS}	16.911^{**}	6.625^{**}	894.792^{**}	3363.063^{**}	4.521^{**}	1.860^{NS}	0.005^{NS}	0.694^{NS}
Genotypes x Densities	27	0.039^{NS}	249.352^{**}	0.269^{NS}	11.918^{*}	6.301^{**}	194.798^{**}	819.196^{**}	15.892^{*}	20.217^{**}	0.032^{NS}	0.781^{NS}
Error	78	0.016	81.645	0.245	1.097	2.596	84.497	216.273	3.329	3.951	1.008	0.707

Where

SW =100 Seed weight, E% = Emergence %age, El = Emergence index, SL = Shoot length, RL = Root Length
FSW= Fresh shoot weight, FRW= Fresh root weight, DSW= Dry shoot weight, DRW= Dry root weight,
R/S= Root to shoot ratio, and RRW= Relative root weight.
*,** = Significant at 0.05 and 0.01 Probability levels, respectively. NS = Non significant.

Table 2:Mean performance of experimental material across four classes of seed densities for some emergence and seedling traits in rice (*Oryza sativa* L.)

		Means						
S.No.	S.D.	E%	SL	RL	FSW	FRW	DSW	DRW
1.	I	86.87 B	15.07 B	14.17 B	52.00 C	24.65 C	9.88 A	5.78 A
2.	II	94.33 A	15.40 B	14.47 AB	52.85 B	25.91 C	10.07 A	5.82 A
3.	III	93.33 A	16.24 A	15.11 A	56.77 B	37.58 B	10.60 A	6.27 A
4.	IV	96.00 A	16.71 A	14.07 B	63.98 A	47.07 A	10.67 A	5.74 A

SD = Seed densities, E% = Emergence percentage, SL & RL = Shoot and root length (cm), respectively.
FSW & FRW = Fresh shoot and Fresh root weight (mg), respectively.
DSW & DRW = Dry shoot and Dry Root weight (mg), respectively.
Means sharing same letters in a column do not differ significantly at 5% probability level.

Seedlings from low density seeds not only emerge slowly but exhibit low levels of seedling vigour for plant traits like shoot length, fresh shoot weight, fresh root weight and dry shoot weight (Table 2). Ferguson and Turner (1971), Krieg and Bartee (1975) and Tupper *et al* (1970, 1971) reported similar results.

From the above mentioned results, it is anticipated that the seedlings which emerge earlier and got maximum seedling values will carry advantage over the late emerging seedling. So prior to actual sowing, if seed is separated through some brine solution we can get good germination percentage and later seedling growth and finally increased crop yield.

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