Seedling Vigor in Pearl Millet. I. Role of Seed Size

R.K. Maiti, P.S. Raju**, F.R. Bidinger***

ABSTRACT

A study of the role of seed size on seedling vigor in several pearl millet genotypes indicates that there were significant variations in seed size and other seedling traits such as seedling weight at emergence, seed weight mobilized, efficiency of mobilization of seed reserve, and seedling and seedling dry weight at seven and 15 days. Highly significant correlations were found among these parameters. Therefore, the effects of seed size on seedling vigor in pearl millet seem to be significant.

COMPENDIO

Un estudio sobre el papel desempeñado por el tamaño de la semilla sobre el vigor de la plántula en mijo perla, indicó que existe variación significativa en el tamaño de la semilla y otros parámetros de la plántula tales como: el peso de la plántula y emergencia, movilización del peso de la semilla, la eficiencia de la movilización del peso de la semilla y peso seco de la plántula de siete a 15 días. Se encontraron correlaciones altamente significativas entre estos parámetros. Por lo tanto, el efecto del tamaño de la semilla sobre el vigor de la plántula en mijo perla puede ser un factor significativo.

INTRODUCTION

The establishment of a satisfactory plant stand is a major problem in the production of pearl millet (2). One reason is the small seed size of this crop in comparison to that of seeds of other major food crops of the semi-arid zones of north-west India and the Sahelian zone of Africa where pearl millet is the staple crop. Therefore the role of seed size in seedling emergence and seedling vigor in pearl millet needs to be assessed. Seedling size and growth rate have been reported to be related to seed size in a number of grasses (5, 11, 13, 14, 15) and cereals (3, 4, 7, 8, 9, 10), including pearl millet (12). The reason appears, logically enough, to be due to the greater quantity of endosperm material available to support growth during the heterotrophic and transitional (to autotrophic) growth periods (1), although some reports associate a greater biochemical potential for growth seed size (8). Individual seed size weight varies considerably within cultivated pearl millet, from as little as 4 mg per seed to more than 12 mg. This is therefore a very obvious source of variation in seedling size among individual cultivars, as well as a potential characteristic for exploitation (14).

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* Profesor in Botany, Division de Post-Grado, Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León, Ciudad Universitaria, Apartado Postal 2790, Monterrey, N.L., México.

** International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru P O, Andhra Pradesh 502324, India

MATERIALS AND METHODS

In order to evaluate the role of seed size in determining seedling size in pearl millet, a set of 52 entries from the germplasm collection and the breeding program which represented a wide range of seed size, was assembled (Table 1). The range in terms of weight of 25 seeds, is equal to a range of 4.0-11.6 mg/seed. These were sown in single-row plots in the field in two replications, and in Petri dishes lined with moistened filter paper in two replications in the laboratory in 1976; taking 30 seeds of genotype in each replication. At emergence, and at seven and 15 days after emergence 25 seelings were carefully dug out of the field plots, washed free of soil and the plumule and radicle were separated from the remains of the seed. Both parts were dried for 48 hours at 80°C and dry weights determined. The efficiency of utilization of seed reserves of produce new growth was calculated for the sample taken at emergence by dividing the dry weight of new growth (radicle, plumule) by original seed dry weight, less the dry weight of the remaining seed parts. The dry weight of the original seed was estimated from duplicate 25 seed samples from the original seed lot.

RESULTS AND DISCUSSIONS

There were large and significant differences among the lines for all of the parameters measured in the field trial (Table 1) There was a two-fold range in seedling size at the time of emergence, which increased to a five and then ten-fold range at seven and 15 days after emergence, respectively. Between one half and three fourths of the total variance for

seedling dry weight was due to genetic, as opposed to environmental effects under the conditions of the experiment. There was also a large variation in the case of both the absolute amount of seed weight lost in emergence and in the ratio of seedling weight at emergence to seed weight lost, which is a crude measure of the efficiency of mobilization of seed reserves into new growth (Table 1) In fact the range in the latter was surprisingly wide, and neither extreme value would have been predicted.

Simple linear correlations were computed between seed size and the various measurement of seedling growth, and among those measurements themselves (Table 2). Seed weight was significantly correlated to seedling weight at all three times of measurement (Fig. 1, Table 2). The strength of the correlation declined somewhat with time, however, and the percentage of the total variation in seedling size explained by seed size was not large, ranging from 32% at emergence to 17% at 15 days (Table 2).

Table 1. Summary and analyses of seed and seedling data. (Seed size comparison 1976.)

Variable	Mean	Range	S.E.	F ratio for genotype
Seed wt (g/25 seeds)	0 18	0 10–0.29	0.005	166 **
Seedling wt. at emergence (g/25 seedlings)	0 06	0 04–0 09	0 011	2.04**
Seed wt mobilized (g/25 seeds)	0 12	0.05–0.27	0.014	12 5 **
Efficiency of mobilization of seed wt.	0.56	0.27–0 92	0.132	2 11**
Seedling wt at 7 days (g/25 seedlings)	0 84	0 33–1.62	0.256	2 22**
Seedling wt at 15 days (g/25 seedlings)	11 0	2 4–24 0	3.06	3 17**

** $P < 0.01$; $n = 52$

Seed weight lost (or mobilized) in germination and emergence was highly correlated to seed size ($r = 0.93$). The efficiency of utilization of that seed weight to produce new growth was, however, significantly negatively correlated to both the amount of seed weight lost and thus to seed size (Table 2). These correlations confirm that larger seeds do mobilize more reserves for growth but that the utilization of these reserves is less efficient than in the case of small seeds. Similar results were reported by Whalley, McKell and Green (15) in range grasses. The amount of seed weight lost or mobilized at emergence, however, was significantly correlated to seedling weight at all three times of measurement (Table 2), confirming the role of seed reserves in seedling size. The efficiency of mobilization of seed reserves on the other hand, although widely different among the varieties tested, was not related to seedling size at any of three times of measurement (Table 2).

The seedling dry weight measured in Petri dishes at five days after "sowing" was significantly correlat-

Table 2. Correlations among seed and seedling variables. (Seed size comparison 1976.)

Seed wt	1				
Seed wt. mobilised	0.93**	1			
Seedling wt. at emergence	0.57**	0.49**	1		
Efficiency of mobilization of seed wt.	–0.68**	–0.74**	0.08	1	
Seedling wt at 7 days	0.45**	0.41**	0.60**	–0.16	1
Seedling wt. at 15 days	0 41**	0.36**	0 45*	–0.19	0.74**

** $P < 0.01$, $n = 53$

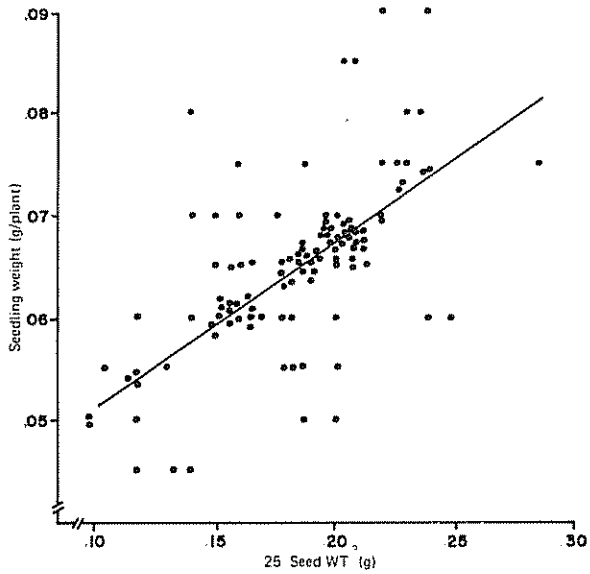

Fig 1. Relationship of 25 seed weight and seedling dry weight at emergence (Seed size comparison 1976)

ed to seedling dry weight in the field at all three times of field measurement (Table 3), but the portion of the variation in seedling size in field explained by the Petri dish estimates was no better than that explained by seed size (16-37%) Thus both measurements of potential seedling size, seed size and seedling size under laboratory conditions were related, although not strongly, to actual seedling under field conditions.

The effects of seed size seedling vigor in pearl millet thus appear similar to those in the case of other graminaceous species studied Essentially, seed size accounts for a significant proportion of the variation in seedling size but there are other differences among individual genotypes or populations not associated with seed size (3, 5, 13). Improvement in seedling vigor should thus be possible via improvement in both seed size and in vigor directly (6, 14).

Table 3. Correlation of seedling dry weights from field and laboratory measurements. (Seed size comparison 1976.)

Laboratory	Field	Correlation coeff.
Seedling wt. at 5 days	Seedling wt. at emergence	0.56**
Seedling wt. at 5 days	Seedling wt. at 7 days	0.61**
Seedling wt. at 5 days	Seedling wt. at 15 days	0.40**

** $P < 0.01$, $n = 52$

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