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INFLUENCE OF SEED SIZE AND DENSITY ON GERMINATION, SEEDLING EMERGENCE, AND YIELD OF GRAIN SORGHUM[1]

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ABSTRACT

Seed size is highly influential in determining germinability and seedling vigor of grain sorghum (*Sorghum bicolor* L. Moench), but whether this factor is predominate over seed density (i.e. specific gravity) has not been established. A 2-year study was conducted to determine to what extent seed size and density influence germination and subsequent field performance. Large and small seed lots from the same genotype were compared to "more dense" and "less dense" seed lots which were separated using either urea-phosphate or sucrose solutions. The results indicated that seed lots with larger and denser seeds had a higher percent germination. The data also supported the conclusion that a higher percentage of viable seeds could be selected from seed lots with low average germinability by using specific gravity separations. However, the establishment of seedlings, final stands, and grain yields were not a function of size or density when the same number of viable seeds were planted in the field.

Additional index words: **Seed vigor, Stand establishment, *Sorghum bicolor* (L.) Moench.**

WHILE environmental factors such as moisture and temperature probably exert the greatest influence on seed germination, emergence and early seedling performance, factors such as seed size, weight, and density also have been shown to be highly important. Most research has indicated that the larger the seed, the better germination and subsequent rate of growth (2). Some studies with grain sorghum (*Sorghum bicolor* (L.) Moench) have shown that medium and large size kernels produce better germination percentages and more vigorous seedlings than small,[3] but other work has shown kernel size to have little effect on germination percentage[4] or seedling establishment (7). Grain yields appear to be unaffected by either size or related to source in some studies (1). Kernel density (ie. specific gravity) however, greatly influences the growth of many species (4, 6, 8). High density seeds of grain sorghum have a higher percent and rate of germination and, in general, produce more vigorous seedlings[4]. Research in our laboratory has confirmed the latter observation and one would suspect that this increased vigor would ultimately result in higher grain yield. No concrete evidence for this has been reported. The purpose of the present study was to determine overall field performance, including yield, of several seed lots differing in seed size and density.

MATERIALS AND METHODS

Experiments were conducted over 2 years in both laboratory and field. In 1973, two sorghum cultivars were used. 'TX 414' had 58% germination and variety '7301' had 95% germination. Each original seed lot was separated into two size classes by use of seed sieves. A portion of each was retained to serve as a control. The large fraction (25% of total) would not pass 10/64 hole size and the smaller fraction (70% of total) would pass 10/64 but was retained by 8/64 hole size. Separations into two density classes were made by floating a portion of the original seed lots on a concentrated urea-phosphate solution and then diluting with water until approximately one-half of the seeds (the "more dense") had sunk to the bottom of the container. Densities of the solutions at which this occurred were 1.228 g/ml for TX 414 and 1.267 g/ml for 7301. Each density fraction was thoroughly washed with distilled water and air dried to approximately 8% moisture. Washings with urea-phosphate followed by distilled water were given the large, small and control seed fractions, the control being a sample of the original seed lot. All fractions were retested for percent germination and calculations adjusted to permit planting two populations in the field. The exact number of viable seeds needed to produce 125,000 and 250,000 plants/ha were planted in a complete randomized design with four replications. Plots were four rows in 76 cm spacing and 4.6 m in length. Final stands and grain yields (14% moisture) were taken from an area 3 m in length of the two center rows.

In 1974, three hybrids were used. 'RS 671' and 'NC + 70 X' were obtained from commercial sources as unprocessed seed and 'Martin × SC33' experimental was increased in Puerto Rico. The latter was included in order to have a seed lot with poor germination. Density separations were made as above except a sucrose solution was used and the fractions were segregated at a density of 1.237 g/ml. Seed sizing was accomplished as in the first year. Stand counts were taken from 3 m of the middle two rows at 3-day intervals starting when seedlings began to emerge through the soil surface. Final stands and grain yields were taken from the same area.

RESULTS AND DISCUSSION

The cultivars (1973) and hybrids (1974) responded similarly within the various seed classes so the performance data for each were combined and tabulated. Percent germination was higher for the large size and more dense seed classes than for either the smaller or less dense seed classes for the two cultivars (Table 1). However, only the more dense fraction proved su-

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Table 1. Effect of seed size and density separation on the germination, kernel weight, kernel size, final field population, and grain yield of grain sorghum varieties in 1973.

Treatment	Germination	Wt./1,000 kernels	Kernels/15 cc volume	Final stand†	Grain yield†
	%	g		plants/ha × 10^3	kg/ha
Control	76 bc*	24.0 c	477 b	60.7 b	4,315 a
Size					
Larger	81 a	30.7 a	376 c	63.9 b	4,320 a
Smaller	74 c	22.9 d	498 a	58.2 b	4,345 a
Density					
More dense	80 ab	25.2 b	479 b	70.7 a	4,425 a
Less dense	52 d	18.9 e	500 a	62.7 b	4,280 a

* Means followed by the same letter within a column are not significantly different at 0.05% probability according to Duncan's Multiple Range Test.
† Field values are means of two varieties, two populations, and four replications.

Table 2. Effect of seed size and density separation on several laboratory and field measured parameters for grain sorghum hybrids in 1974.

Treatment	Germination	Wt./1,000 kernels	Kernels/15 cc volume	Emergence 1†	Emergence 2†	Emergence 3†	Final stand†	Grain yield†
	%	g		plants/ha × 10^3				kg/ha
Control	83 b*	35.0 c	--	56.5 a	69.3 a	76.3 a	64.3 a	3,830 a
Size								
Larger	83 b	38.9 a	--	46.3 b	63.1 a	70.3 a	62.4 a	3,608 a
Smaller	81 bc	30.3 e	--	50.3 ab	61.0 a	71.6 a	60.5 a	3,388 a
Density								
More dense	93 a	36.6 b	472 a	56.0 a	67.5 a	71.1 a	64.2 a	3,563 a
Less dense	80 c	33.9 d	475 a	53.0 ab	62.9 a	67.6 a	63.7 a	3,803 a

* Means followed by the same letter within a column are not significantly different at 0.05% probability according to Duncan's Multiple Range Test.
† Field values are means of three hybrids, two populations, and four replications.

perior in germinability for the hybrids (Table 2). This confirmed our original observations and also the work of Cleveland.[4] The larger seed fractions were the heaviest on a per seed (1,000 kernel weight) basis for both the cultivars and hybrids as would be expected. The less dense seed weighed less per seed for the varieties (Table 1) while the smaller size fraction weighed less in the hybrids (Table 2). The less dense seeds were significantly smaller than the more dense fraction in the cultivars, but there was no size difference between these fractions within the hybrids.

There were significant differences between populations for all the measured field parameters as would be expected. However, the population × treatment interactions were nonsignificant so the data are presented as means of populations. The first year (Table 1), the more dense seed produced significantly more plants at final harvest than any of the other fractions, but there was no difference in grain yield. The seedlings emerged more slowly from the large seed size fraction for the hybrids (Table 2), but there was no difference in later emergence values, final stand or grain yield among the size or density classes. This is in agreement with Suh et al. (5) who determined that weight per kernel had no influence on these traits. Results with soybeans also have shown that vigorous seed produced no better yields than low vigor seed once the stand was established (3).

From the results of the two experiments, it is concluded that a more dense or larger seed from a heterogeneous population will have a higher percentage germination; but this does not mean that there will be an increase in number of seedlings emerging or final grain yield if the desired number of viable seeds are planted. It was observed, however, that the more dense or larger seed fractions both produced more vigorous seedlings. When conditions of stress are imposed such as soil crusting, low soil moisture availability or poor weed control, perhaps the benefit of a more vigorous seedling would be evident in final grain yield. The data support the conclusion that the more viable seeds can be selected from seed lots with low average viability by using specific gravity separations.

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