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EFFECT OF NONGENETIC VARIATION IN SEED SIZE ON GROWTH, GRAIN YIELD AND ITS COMPONENTS IN WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

Progenies raised from bigger seeds of the same genotype were taller, had more leaves, tillers and number of spikelets, heavier seeds and higher grain yield than their small seeded counterparts. Differences between seed categories were also recorded for leaf area, their number, tillering and plant height at all the five growth stages, largest being at the initial stages of plant growth. Seed weight x variety interaction was also significant for many attributes. Implication of intragenotypic variation in seed size on ranking of varieties for grain yield and in biometrical studies are discussed.

Key words: Seed size, nongenetic variation, growth, wheat.

Seeds formed on late tillers, top/bottom spikelets as well as central florets of wheat are usually smaller than those on the main shoot, central spikelets and lateral florets, respectively [1–2]. Seed size in wheat, as in many other crops, has been reported to be an important component affecting grain yield and its attributes [3–7]. The present study has been undertaken to quantify the effect of nongenetic variation in seed size on growth, grain yield and its components.

MATERIALS AND METHODS

Bulk seed of two prominent wheat varieties C 591 and Hy 65 was divided into four discrete classes. Average seed weight of each grade was as under:

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Grades of seed size in two wheat varieties

Variety	1000-grain weight in different grades (g)			
	bold seed	medium bold seed	medium small seed	small seed
Hy 65	50.4	35.8	22.2	11.1
C 591	52.0	36.1	22.1	10.3

Seeds of these eight groups were grown in 5 m long 3-row plots in randomized block design with four replications at Agricultural Research Station, Sriganganagar. Observation were recorded on 10 random plants in the central row of each seed group (treatment). Data on plant height, number of tillers, number of green leaves and single leaf area were recorded at three-week intervals from sowing in the first year. Observation on grain yield and its components were recorded in both seasons, and the data were analysed statistically [8].

RESULTS AND DISCUSSION

Bigger seeds produced taller plants with higher number of tillers and more photosynthetic area per plant than those from the smaller seeds of the same genotype. The

Table 1. Effect of seed size and variety on growth of wheat plants

Variety	Seed size	Plant height (cm)					No. of tillers/plant			
		3 weeks	6 weeks	9 weeks	12 weeks	15 weeks	6 weeks	9 weeks	12 weeks	15 weeks
C 591	Bold	6.4	18.3	37.4	81.8	144.1	3.0	10.0	11.0	10.0
C 591	Medium bold	3.2	16.3	28.1	79.8	129.7	2.7	8.4	9.7	8.9
C 591	Medium small	1.9	14.0	31.7	71.5	125.4	2.6	5.9	9.4	9.7
C 591	Small	1.1	10.7	25.9	53.9	127.3	1.1	4.4	6.9	8.4
C 591	Mean	3.15	14.77	33.27	71.75	131.62	2.35	7.25	9.25	9.27
Hy 65	Bold	5.5	18.4	41.2	88.3	136.9	3.4	10.6	10.8	10.6
Hy 65	Medium bold	4.3	17.0	37.2	83.5	129.7	2.8	9.1	11.2	11.1
Hy 65	Medium small	3.3	16.0	37.2	78.5	128.7	2.9	8.5	10.0	9.9
Hy 65	Small	1.2	10.6	27.6	60.7	115.5	1.2	4.1	6.7	6.8
Hy 65	Mean	3.57	15.40	35.80	77.80	127.70	2.56	8.07	9.67	9.60
S.E. (±)		0.24	0.60	1.18	1.65	3.20	1.8	0.51	0.44	0.48
CD (0.05%) (variety mean)		0.35	NS	1.73	2.42	NS	NS	0.73	NS	NS
CD (0.05%) (variety x seed weight)		0.77	NS	NS	NS	NS	NS	NS	NS	1.41
Mean of seed grades										
	Bold	5.95	18.35	38.30	85.5	140.50	3.17	10.45	10.90	10.35
	Medium bold	3.75	16.65	81.65	81.65	129.17	2.76	8.75	10.45	10.00
	Medium small	2.60	15.00	34.45	75.60	127.05	2.72	7.20	9.70	9.80
	Small	1.15	10.65	26.75	57.30	121.40	1.16	4.25	6.80	7.60
CD (0.05%) (seed weight)		0.50	1.24	2.40	3.44	6.69	0.36	1.04	0.91	1.00

differences between various seed categories were much higher in the initial stages of plant growth. Three weeks after sowing (observation I) the seedlings developed from bold seeds were five times taller, with more than twice leaf number as well as leaf area than the small seeded counterpart (Table 1). Tiller development in wheat starts about 25 days after sowing. Almost at the same time, the mother shoot also differentiates. As both of these processes are dependent on photosynthate availability, tiller development was much faster in the seedlings from bold seeds. On the other hand, due to less photosynthetic area in seedlings developing from small seeds, there was a severe competition for food material between the growing spike and developing tillers. Delay in tiller initiation and prolonged tillering in the small seeded counterpart could be due to the said competition.

Although small seeds germinated normally, the initial setback in growth could not be mitigated in the entire plant life. These effects are likely to be more pronounced when such plants have competition with the neighbouring vigorous plants in a population produced from the bold seeds. Significance of variety x seed weight interaction further indicated that nongenetic variation in seed size could grossly vitiate growth analysis.

Pooled analysis of variance also indicated that nongenetic variation in seed size had a considerable influence on grain yield and its attributes (Table 2). The magnitude of variation

at different stages of development (weeks after sowing)

No. of leaves/plant					Leaf area (cm^2)				
3 weeks	6 weeks	9 weeks	12 weeks	15 weeks	3 weeks	6 weeks	9 weeks	12 weeks	15 weeks
4.2	7.6	34.6	54.7	43.8	6.8	11.9	32.1	32.2	38.8
3.5	6.9	26.9	48.6	34.9	4.6	10.6	30.4	33.0	32.6
2.5	6.2	25.2	44.4	39.4	4.8	7.1	25.5	30.4	32.4
2.0	3.6	16.1	31.7	34.1	3.2	3.9	18.9	24.7	23.7
3.05	6.08	25.70	44.65	38.05	4.85	8.37	26.72	30.07	30.62
3.7	7.9	31.0	50.7	47.7	6.8	12.4	33.7	37.7	38.1
2.8	7.3	34.9	51.5	51.7	5.3	10.9	30.7	34.2	29.5
2.7	7.0	28.4	47.2	45.5	3.9	9.7	27.3	33.33	31.2
2.0	3.9	15.8	29.6	30.6	3.1	4.1	19.6	25.3	26.0
2.80	6.52	27.55	44.75	43.88	4.77	9.27	28.25	32.62	31.20
0.13	0.38	1.72	2.25	3.05	1.0	0.91	1.64	1.67	2.12
0.19	NS	NS	NS	4.46	NS	NS	NS	2.43	NS
0.39	NS	5.00	NS	8.95	NS	NS	NS	NS	NS
over varieties									
3.95	7.75	32.80	52.7	45.75	6.80	12.15	32.90	34.95	35.95
3.15	7.10	30.90	50.05	48.30	4.95	10.75	30.55	33.60	31.05
2.60	6.60	26.80	45.80	42.45	4.35	8.40	26.40	31.85	31.80
2.00	3.75	15.95	30.65	32.35	3.15	4.00	19.25	25.00	24.85
2.27	0.79	3.59	4.68	6.35	2.07	1.87	3.39	3.47	4.38

Table 2. Pooled analysis of variance (M.S.S.) for grain yield and its components in wheat

Source	d.f.	No. of ears	Spikelets per ear	Grains per ear	1000-grain weight	Yield per plant
Replications in years	6	0.28	0.81	10.24	0.37	0.20
Years	1	0.68	1.76	344.11	5.76	11.22
Varieties	1	1.89	0.14	110.25	3.24	19.70
Seed weights	3	9.98	21.50	43.04	1.23	66.71
Seed weight x variety	3	0.21	1.38	67.13	0.83	6.68
Seed weight x year	3	0.05	0.48	6.93	0.03	0.14
Variety x year	1	0.13	1.61	2.44	0.03	0.57
Seed weight x variety x year	3	0.03	0.02	5.10	0.81	0.19
Pooled error	42	0.30	2.57	10.77	0.26	0.32

induced by various seed size categories was much higher for number of ears/plant, spikelets/ear, and grain yield. This might be one reason for the low heritability of these characters frequently reported from various genetic studies. Genotypic variance are estimated by deducting environmental variation and genotype x environment interactions from the phenotypic variance. To remove environmental variance the replicated experiments are repeated over locations and years. In the present study, higher mean sums of squares (MSS) due to seed weight in comparison to the MSS due to years revealed that intragenotypic variations in seed weight could induce greater bias to the estimate of genotypic variance than the climatic variations in different years. Further, significant mean squares for seed weight x variety and seed weight x year interactions would inflate the various genetic parameters to an unknown degree. The means for various characters are given in Table 3.

Effects of nongenetic variation in seed size were equally manifested in grain yield and its components. The vigorous and quick growing plants from bold seeds produced much larger number of ears and 2-fold increase in grain yield than their small- seeded counterparts. Highly significant differences between categories of seed size were also observed for spikelets/ear and grains/ear. However, the influence of initial seed size on grain number/spike was lower than on ear bearing tillers. Similarly, though grain size in the progenies from the small-seeded counterpart was significantly lower than in the bolder seeded categories, the magnitude of difference was much less than for the other components studied. This confirms the observations of Bremner and Rawson [9] that grains themselves exert a controlling influence on assimilates and the assimilate drawing capacity is positively related to the number of grains.

Table 3. Effect of seed weight and variety on grain yield and its components in wheat

Variety	Seed size	No. of ears/plant			No. of spikelets/ear			No. of grains/ear			1000-grain weight			Grain yield/plant (g)		
		I year	II year	mean	I year	II year	mean	I year	II year	mean	I year	II year	mean	I year	II year	mean
C591	B	8.4	8.1	8.2	18.2	20.5	19.3	45.0	51.7	48.3	44.4	44.5	44.4	17.1	18.6	17.8
C591	MB	7.3	6.9	7.1	16.5	16.7	16.6	37.6	50.2	43.9	46.4	45.0	45.7	12.8	15.7	14.2
C591	MS	6.6	6.4	6.5	14.5	15.7	15.1	29.0	40.0	34.5	47.2	44.9	46.0	9.1	11.4	10.2
C591	S	4.7	4.7	4.7	12.7	14.0	13.3	28.6	37.8	33.2	44.8	43.9	44.3	6.3	7.8	7.1
	Mean	6.7	6.5	6.6	15.4	16.7	16.0	35.0	44.9	39.9	45.7	44.5	45.1	11.3	13.3	12.3
HY65	B	8.8	8.6	8.7	17.5	18.0	17.3	41.9	47.8	44.8	47.6	45.4	46.5	17.7	18.7	18.2
HY65	MB	8.9	7.9	8.4	17.2	10.0	17.6	38.8	49.0	43.9	47.1	45.7	46.4	16.3	17.7	17.0
HY65	MS	7.6	6.9	7.2	16.0	15.7	15.8	44.4	49.0	46.7	46.0	45.8	45.9	14.6	15.5	15.0
HY65	S	5.2	4.7	4.9	12.7	13.2	12.9	38.5	42.5	40.5	46.0	47.7	45.3	9.1	11.0	10.0
	Mean	7.6	7.0	7.3	15.8	16.2	16.0	40.9	47.1	44.0	46.6	45.4	46.0	14.4	15.7	15.0
	S.E.	0.3	0.2	0.3	0.6	1.0	1.0	2.1	1.0	2.2	0.3	0.2	0.3	0.3	0.2	0.4
CD (0.05) (variety)		0.5	0.3	0.6	NS	NS	NS	3.0	NS	3.1	0.5	0.2	0.5	0.5	0.3	0.5
CD (0.05) (variety x seed weight)		NS	0.6	NS	NS	NS		6.1	3.0	6.3	1.0	NS	0.9	1.0	0.6	1.1
Mean of seed grades																
	B	8.6	8.3	8.4	17.8	19.2	18.5	43.4	49.7	46.5	46.0	44.9	45.5	17.4	18.6	18.0
	MB	8.1	7.4	7.7	16.8	17.3	17.0	38.2	49.6	43.9	46.7	45.3	46.0	14.5	16.7	15.6
	MS	7.1	6.6	6.8	15.2	15.7	15.4	36.7	44.5	40.5	46.6	45.3	45.9	11.8	13.4	12.6
	S	4.9	4.7	4.8	12.7	13.6	13.1	33.5	40.2	36.9	45.4	44.2	44.8	7.7	9.4	8.5
CD (0.05)		0.7	0.4	0.8	1.3	2.0	2.1	4.3	2.5	4.5	0.7	0.4	0.7	0.8	0.4	0.8

B—bold, MB—medium bold, MS—medium small, S—small.

Small and shrunken seeds are usually encountered in plant breeding experiments, particularly due to drought, early lodging, wide crosses, late maturity, plant diseases, etc. The present study demonstrates that plants should also be retained or discarded in the early segregating generations depending on whether they are produced from bolder or smaller seed (nongenetic) and not necessarily on the basis of their production potential alone. This would also be true for preliminary tests where the entries are rejected after only one season of testing. Similarly, the estimates of various genetic parameters would be biased to an unknown proportion if proper attention is not paid to the nongenetic variation in seed size.

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