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Inheritance of Seed Weight and its Relation to Grain Yield of Oats[1]

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Abstract. In 3 oat crosses seed weight appeared to be inherited as a quantitative character. Each of the crosses showed transgressive segregation. In 6 crosses, the correlations between yield and seed weight were all positive, but only 4 were significant.

In simulated selection experiments, the efficiency of selection for yield was compared when only yield or when yield plus seed weight were used as the selection criterion. In general, the addition of seed weight as a selection criterion decreased the gain in yield.

Introduction

Much research conducted by cereal breeders is directed toward developing greater efficiency in selection for seed yield. Since the heritability of yield is low, especially in early generations after hybridization, a common approach to improving selection efficiency is to search for attributes correlated with yield and also highly heritable. Seed weight may be such an attribute. It is a component of yield (1) and shows a relatively low genotype x environment interaction (4).

A partial summary of correlations between seed weight and grain yield in wheat and oats reported in the literature is given in Table 1. In general, the correlations for wheat appear to be somewhat larger than those for oats. The authors conclude that seed weight is of less value in explaining the variability of yield than is any other yield component. In each of these studies, except the one by Immer and Stevenson (5) the variability was measured either among variety means or single plants within varieties. Where variety means were used, the correlations would be related to the sample of varieties, and, where plants within

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Table 1. Reported correlations between seed weight and grain yield of wheat and oats

Crop and correlation	Significance	Reference
Wheat:		
+.69	**	Waldron (9)
+.24 to +.65	all **	Quisenberry (8)
+.38	**	Bridgford and Bonnett (2)
Oats:		
+.04 to +.22	n.s.	Love and Leighty (6)
+.11	n.s.	Fore and Woodworth (3)
+.58 to .+89+	all **	Immer and Stevenson (5)

+ Correlations between "plumpness" and yield.

varieties were used, they would represent environmental expressions. A more logical source material would be randomly chosen strains from a hybrid population.

From a study of 12 oat crosses, Murphy (7) concluded that groat weight was inherited as a quantitative character. The frequency distributions of F_2 segregates were normal.

This study reports on the inheritance and the relation between seed weight and yield in oats. The data were collected from a series of experiments conducted from 1956-1959 at the Agronomy Farm at Ames, Iowa.

Methods and Materials

The materials for this study were F_2 derived lines from 8 oat crosses, C220 (Minland x Cherokee), C221 (Mo. 0-205 x Cherokee), C234 (Uton x Mo. 0-205), C247 (Andrew x Simcoe), C257 (Andrew x Cherokee), C311 (Andrew x P.I. 174544), C368 (Bonham x Garry), and C370 (Clintland x Garry). The number of lines used from each cross was variable.

The experimental design used for testing the oat lines was a randomized block, with 2 replications in 1956 and 1957 and with 4 and 8 replications in 1958 and 1959, respectively. Each plot was a single 8-foot row, with a 1-foot spacing between rows in the first 2 years and a hill occupying 1 square foot in the last 2 years. Grain yields were taken on all plots each year. The seed weights were taken from a 100-seed sample from each of 2 replications in 1956, 1957, and 1958.

Experimental Results

The frequency distributions for 100-seed weights of the F_2 derived lines from the crosses C221, C220, and C257 and their respective parents are presented in Table 2. Only in C221 did the parent varieties differ by much in 100-seed weight. In each cross,

Table 2. Frequency distributions of 100-seed weights for 4 oat varieties and F_2 derived lines from 3 crosses among them

	Class intervals (gms.)																	
Parent or cross	2.00 — 2.09	2.10 — 2.19	2.20 — 2.29	2.30 — 2.39	2.40 — 2.49	2.50 — 2.59	2.60 — 2.69	2.70 — 2.79	2.80 — 2.89	2.90 — 2.99	3.00 — 3.09	3.10 — 3.19	3.20 — 3.29	3.30 — 3.39	3.40 — 3.49	3.50 — 3.59	No lines	Mean 100-seed weights for parent or cross (gms.)
Mo. 0-205		1	1	2	1												5	2.31
C221	2	4	21	28	39	35	30	15	7	2	2						185	2.50
Cherokee						2	2	1									5	2.63
Minland							1	2	2								5	2.77
C220	1	3	10	8	25	23	21	48	37	26	12	5	7	1		1	228	2.72
Cherokee							3			2							5	2.77
Andrew							2		2	1							5	2.79
C257			1	5	15	45	51	49	33	8	7	1					215	2.68
Cherokee						1	2	2									5	2.66

there appears to be transgressive segregation. This was most pronounced in C220 where the two parents were equal in seed weight. The segregation in C257 was not as great as in C220. The difference in range of segregates from C220 to C257 indicates (a) that Andrew and Cherokee have similar gene systems for seed-weight expression whereas Minland and Cherokee do not or (b) that the number of genes by which Andrew and Cherokee differ for expression of this character is larger than the number by which Minland and Cherokee differ. The distribution of F_2 segregates from C221 shows a few segregates transgressing each parent. All 3 distributions were symmetrical, indicating that 100-seed weight was quantitative in inheritance.

The relation between 100-seed weight and grain yield in oats was studied in 2 ways: (a) through correlations and regressions between the 2 characters (Table 3) and (b) simulated-selection experiments (table 4). The regressions and correltions were significant for 4 of the crosses and nonsignificant for 2 (Table 3). However, all correlations were positive.

Table 3. Regressions and correlations of oat-grain yields on 100-seed weights

Cross	Degrees of freedom	Regression+	Correlation	Range of weights per 100 seeds
				(gms.)
C257	20	11.9**	+.54**	2.30–3.10
C221	18	7.8	+.40	2.27–2.72
C220	22	7.9**	+.58**	2.10–2.95
C311	20	15.2**	+.74**	2.66–3.21
C368	29	9.4*	+.40*	2.54–3.10
C370	25	4.8	+.29	2.54–3.13

+gms. of yield per plot for each 1.0 gm. per 100 seeds.

In the simulated-selection experiments, a comparison was made between actual yield gains from selection when either yield alone or yield plus seed weight was used as the selection criterion. The hypothetical selected samples were taken in 1956 and 1958, and the corresponding actual gains were determined in 1957 and 1959, respectively. For each cross the actual gain realized when only yield was used as the selection criterion was equated to 100%, and the actual gain from yield plus seed weight was calculated as a percentage of the yield-only category. The comparative efficiency of selection for grain yield ranged from an uninterpretable one as in C257 to C370, where the gain was increased 24% by adding seed weight as a selection criterion. In all other crosses, the efficiency of selection with 2 attributes was less than when only yield was used. Both the correlations and simulated-selection experiments corroborate earlier pub-

Table 4. Efficiency of selection for grain yield in oat crosses when yield and yield + seed weight are used as the selection criteria

Years and cross	Selection criteria	Actual gain	Efficiency of selection
1956 and 1957:			
C247	Yield	3.3	100
	Yield + seed weight	0.5	15
C234	Yield	16.0	100
	Yield + seed weight	9.7	61
1958 and 1959:			
C221	Yield	6.2	100
	Yield + seed weight	5.8	94
C368	Yield	9.3	100
	Yield + seed weight	−0.1	—
C370	Yield	5.0	100
	Yield + seed weight	6.2	124
C257	Yield	−3.3	—
	Yield + seed weight	11.1	—
C221	Yield	7.5	100
	Yield + seed weight	2.6	35

lished reports. Even though seed weight is a component of grain yield and is more or less positively correlated with it, the degree of covariation between these 2 characters is small. Seed weight would be of little value in selecting for improved yield. The low degree of covariation between grain yield and seed weight shows that an oat variety could be derived with any combination of these 2 attributes.

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