THE BLACKMAN INTERPRETATION OF PLANT GROWTH

HARRY J. FULLER

University of Illinois, Urbana, Illinois

V. H. Blackman in 1919 suggested that plant growth, as measured by dry weight increase, could be interpreted on the basis of the compound-interest law, which is represented by the formula

$$W_1 = W_0 e^{rt},$$

in which W_1 is the final dry weight of the plant, W_0 is the initial weight of the growing tissue (e.g., a seed), r the rate of growth (interest), t the time during which growth has occurred, and e the base of natural logarithms. The value r Blackman described as the "efficiency index of dry weight production." It is essentially the average daily rate of growth during a given period measured in terms of days. Blackman reported experiments which showed a correspondence of plant growth with this law.

If the correspondence is valid, the final dry weight achieved by a plant during its growth period depends upon: 1. The dry weight of the original tissue (e.g., a seed); 2. The rate of increase (r); 3. The length of the growth period. The experiments reported here were designed to: 1. Determine the r values of Alaska peas, Hubbard squash, and sunflower; 2. Determine whether or not there is a correlation between the dry weight of seeds and the ultimate dry weight of the plants which grow from them; 3. Determine the extent of such correlation.

Seeds of the three species were separated into two groups, in one of which one cotyledon was removed or a portion of it cut away, in the other of which none of the food storage tissue was removed. Twenty-four seeds were used in each group. The seed coats were removed in both sets, since seed coat material is not available as a source of food for growth. The seeds were weighed carefully and were then planted in sterilized soil in 4-inch pots, which were watered daily with 80 cc. of sterile tap-water until the

TABLE I. WEIGHTS AND CORRELATIONS.

	Peas	Squash	Sunflower
Average dry wt. of whole seeds	.1615g.	.1871g.	.0055g.
Average dry wt. of cut seeds	.0933	.0950	.0266
Average dry wt. of plants from whole seeds	.3432	5.803	3.582
Average dry wt. of plants from cut seeds	.2759	6.061	2.715
Growth period (days)	50	53	47
Correlation coefficients	.4311	.008	.484

TABLE II—EFFICIENCY INDICES (r VALUES)

	Peas	Squash	Sunflower
Plants from whole seeds	.0307 (3.07%)	.0348 (3.48%)	.0843 (8.43%)
Plants from cut seeds	.0303 (3.03%)	.0298 (2.98%)	.0457 (4.57%)

epicotyls had appeared above the surface of the soil. From this time on, the plants were watered daily with the same quantity of unsterilized tap-water. The plants were allowed to grow until the first flower buds appeared, after which they were completely dried and weighed.

The dry weights of the plants were compared with those of the seeds from which they grew, and the correlation coefficients were determined from the formula.

$$C = \frac{\Sigma xy}{\sqrt{(\Sigma x^2)\ (\Sigma y^2)}}$$, in which x represents the deviations of the seed weights from the average, y the deviations of the plant weights from the average, and C the coefficient of correlation. A coefficient between 0 and 1 indicates a positive correlation, a value between 0 and −1 indicates a lack of correlation.

The r values were determined according to the transposed formula

$$r = \frac{1}{t} \log_e \frac{W_1}{W_2}$$

A summary of the weight data and the correlation coefficient are presented in Table I, and the r values are indicated in Table II.

The results of the experiments may be summarized as follows:

1. The efficiency indices of Alaska peas, Hubbard squash, and sunflower (*Helianthus annuus*) are stated.

2. There is a striking constancy in the efficiency indices of the plants grown from the whole and the cut seeds. In squash and sunflower, the higher indices of the plants from the cut seeds are possibly attributable to inequalities in external conditions during growth, or to wound acceleration in the early stages of seedling development, an advantage which persisted throughout the growth period.

3. There is a positive correlation between seed weight and plant weight of peas and sunflower, though the correlation coefficient is low. In the squash, there was little variation in the average final weights of the plants, despite considerable differences in seed weights. Thus, it appears that in squash there is little correlation, if any, between seed weight (at least within the limits used) and final weight achieved by the plants which grew from the seeds. Since external conditions were kept as uniform as possible, it is scarcely possible that variations in these conditions could have induced markedly different growth phenomena. The possibility of wound stimulation, mentioned above, might be emphasized once more in this connection.