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Correlation Between Grain Yield and Its Components In Dwarf Wheat

(*Triticum aestivum* L.)

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ABSTRACT

The simple, multiple, and partial correlation coefficients were estimated between grain yield and number of grains/m^2, the harvest index, and other yield components of the dwarf wheat cultivar, Sidi Misri 1 (*Triticum aestivum* L.). The simple correlation coefficients were highly significant between grain yield, on one hand, and number of grains/m^2 and harvest index on the other ($r = 0.973$ and 0.842, respectively). The multiple correlation coefficient was also highly significant between these variables ($R = 0.977$). Also, the partial correlation coefficients between grain yield and number of grains/m^2, when the effects of harvest index and grain size were removed, were found to be highly significant with values of 0.925 and 0.999, respectively.

A strong and positive linear relationship was demonstrated between grain yield and number of grains/m^2.

INTRODUCTION

The correlation between grain yield of wheat and its numerical components has received the attention of plant breeders as well as crop physiologists (1,2,4,5,7). However, the classical yield components, such as number of tillers, number of spikes, number of spikelets, number and weight of grains per spike, and the total number of grains per plant have long been considered, individually or collectively, as prediction indices for grain yield in wheat breeding programs (5). Due to the lack of a linear correlation, in most cases, between grain yield and many of these numerical yield components, much effort was made recently for testing other yield components which may have a direct and strong correlation with grain yield (2,4).

Fischer (5), Bingham (1), and Thorne (7) have emphasized the significance of the total number of grains per ground area and the ratio of grain weight to the total dry crop weight (called the harvest index) as better parameters affecting grain yield than other yield components. Positive correlations were reported between total grain yield and both harvest index and number of grains per ground area (4). Furthermore, the usefulness of these two parameters as predictors of grain yield in crop breeding and physiology research was stressed (2,4).

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The present paper deals with the estimation of simple, multiple, and partial correlation coefficients between grain yield and several yield components of the dwarf wheat cultivar, Sidi Misri 1 (*Triticum aestivum* L.).

MATERIALS AND METHODS

A field experiment was conducted in the 1972–73 growing season at the Faculty of Agriculture Farm at Tripoli, L.A.R., to study the effect of the nitrogen fertilization levels and soil water content on the growth and yield of the wheat cultivar, Sidi Misri 1 (*Triticum aestivum* L.). A previous article, covering the findings obtained, was recently published (3). Data from this experiment were used to estimate the number of grains per square meter and the harvest index as components of grain yield. Also, they were used for computing the simple, partial, and multiple correlation coefficients between grain yield and the various yield components.

The following equations, according to Steel and Torrie (6), were used for calculating the different correlation coefficients as follows:

I. Simple correlation coefficient (r) between any two variables; that is, X and Y:

$$r = \frac{S(XY) - \frac{(SX)(SY)}{n}}{\sqrt{S(X)^2 - \frac{(SX)^2}{n} \times S(Y)^2 - \frac{(SY)^2}{n}}}$$

II. Partial correlation coefficient ($r_{ab.c}$) between variable (a) and variable (b) when the effect of a third variable (c) was removed:

$$r_{ab.c} = \frac{r_{ab} - (r_{ac} \times r_{bc})}{\sqrt{[1 - (r_{ac})^2][1 - (r_{bc})^2]}}$$

where:

r_{ab}, r_{ac}, and r_{bc} are the values of the simple correlation coefficients between the variables: a and b, a and c, and b and c, respectively.

III. Multiple correlation coefficient ($R_{a.bc}$) between a dependent variable (a) and the independent variables (b) and (c):

$$R_{a.bc} = \sqrt{1 - [(1 - r_{ab}^2)(1 - r_{ac.b}^2)]}$$

where:

r_{ab} = simple correlation coefficient between variables (a) and (b).

$r_{ac.b}$ = partial correlation coefficient between variables (a) and (c) when the effect of variable (b) was removed.

RESULTS AND DISCUSSION

The mean values of the total yield (grain plus straw), grain yield, harvest index, number of grains per square meter, and the other components of grain yield are presented in Table 1. Each sample represents the average of three replicates and the variation between the different samples were due to the effect of nitrogen fertilization level and soil moisture content.

Table 1 Mean values of yield and yield components of dwarf wheat cultivar 'Sidi Misri 1.'

Sample	Total yield (straw + grain) (tons/ha)	Grain yield (tons/ha)	Harvest index (%)	Number of grains/m²	Number of grains/plant	Weight of grains/plant (g)	Number of spikes/plant	Number of grains/spike	Kernel size (g/1000 grains)
1	6.51	1.34	21	3292	53	2.17	2.20	28	40.7
2	11.17	2.66	24	6186	104	4.45	3.67	28	43.0
3	11.33	3.03	27	8324	140	5.03	3.27	42	36.4
4	12.65	3.32	26	7757	121	5.16	3.40	35	42.8
5	7.01	1.56	22	3467	60	2.73	2.27	25	45.0
6	9.51	2.23	23	5057	85	3.09	2.80	31	44.1
7	9.17	2.60	28	6452	146	5.83	4.53	33	40.3
8	9.00	2.28	25	5055	76	3.37	2.87	26	45.1
9	5.84	1.10	19	2564	70	3.00	3.33	24	42.9
10	9.84	2.71	28	6104	97	4.35	3.27	27	44.4
11	10.50	2.98	28	6773	163	5.89	5.47	31	44.0
12	9.34	2.89	31	6553	147	6.57	4.87	39	44.1

Simple correlation coefficients were calculated between total yield, grain yield, and harvest index, on one hand, and number of grains/m² and the other yield components (as given in Table 2) on the other. It is evident that grain yield was highly significantly correlated with total yield ($r = 0.939$), harvest index ($r = 0.842$), and number of grains/m² ($r = 0.973$). Simple correlation coefficients between grain yield and the number of grains/plant, weight of grains/plant, number of spikes/plant, and number of grains/spike were found to be significant, as indicated by their respective values of 0.821, 0.826, 0.582, and 0.698. However, the highest simple correlation coefficient was that between grain yield and number of grains/m². Most of the grain yield components were positively correlated with total yield, harvest index, and number of grains/m².

The kernel size, as estimated by the weight of 1,000 grains, showed non-significant negative correlation with total yield, grain yield, harvest index, and number of grains/m².

In order to separate the effects of harvest index and number of grains/m² on grain yield, the simple, partial, and multiple correlation coefficients were calculated between grain yield and both number of grains/m² and harvest index, as presented in Table 3. It is apparent that the simple correlation coefficients were highly significant between grain yield and both number of grains/m² and harvest index. The partial correlation coefficient was highly significant between grain yield and number of grains/m² ($r_{ab.c} = 0.925$). However, this coefficient was not significant between grain yield and harvest index ($r_{ac.b} = 0.449$). This indicates that grain yield was directly correlated with number of grains/m² irrespective of the effect of harvest index. Consequently, the number of grains/m² could be considered an effective and highly reliable indicator of grain yield in the present investigation. This conclusion may be further confirmed by the highly significant multiple correlation coefficient between grain yield, as a dependent variable, and both number of grains/m² and harvest index, as independent variables, whose value ($R = 0.977$) was more or less equivalent to the value of the simple correlation coefficient between grain yield and number of grains/m² ($r_{ab} = 0.973$) and to the value of the partial correlation between grain yield and number of grains/m² when the effect of harvest index was removed ($r_{ab.c} = 0.925$).

Table 2 Simple correlation coefficients (r) among various components of yield of dwarf wheat cultivar 'Sidi Misri 1'.

Parameter	Grain yield (tons/ha)	Harvest index (%)	Number of grains/m²	Number of grains/plant	Weight of grains/plant (g)	Number of spikes/plant	Number of grains/spike	Kernel Size (g/1000 grains)
Total yield (straw + grain) (tons/ha)	0.939**	0.616*	0.924**	0.658*	0.638*	0.384 NS	0.595*	−0.145 NS
Grain yield (tons/ha)	—	0.842**	0.973**	0.821**	0.826**	0.582*	0.698*	−0.148 NS
Harvest index (%)	—	—	0.802**	0.835**	0.891**	0.704*	0.665*	−0.058 NS
Number of grains/m²	—	—	—	0.832**	0.806**	0.531 NS	0.793**	−0.366 NS

*Significant at 5% level.
**Significant at 1% level.
NS = Not significant.

Table 3 Simple, partial, and multiple correlation coefficients among grain yield, harvest index, and number of grains per square meter.

Parameter	Simple correlation coefficient	Partial correlation coefficient	Multiple correlation coefficient
(a) Grain yield.	$r_{ab} = 0.973^{**}$	$r_{ab.c} = 0.925^{**}$	$R_{a.bc} = 0.977^{**}$
(b) Number of grains/m².	$r_{ac} = 0.842^{**}$	$r_{ac.b} = 0.449$ (NS)	
(c) Harvest index.	$r_{bc} = 0.802^{**}$		

** Significant at 1% level.
NS Not significant.

This positive and linear relationship between grain yield and number of grains/m² was clearly illustrated by the scatter diagram of Fig. 1 in which the regression lines were determined in the presence and absence of the grain size effect. The deviation of the regression line (line A) from the origin could be attributed to the negative correlation between number of grains/m² and grain size ($r = -0.366$). This finding was substantiated by two things: first, the very high value of the partial correlation coefficient between grain yield and number of grains/m² when the effect of grain size was removed ($r = 0.999$), and second, the closeness of the regression line (line B) to the point of origin when grain size was held constant.

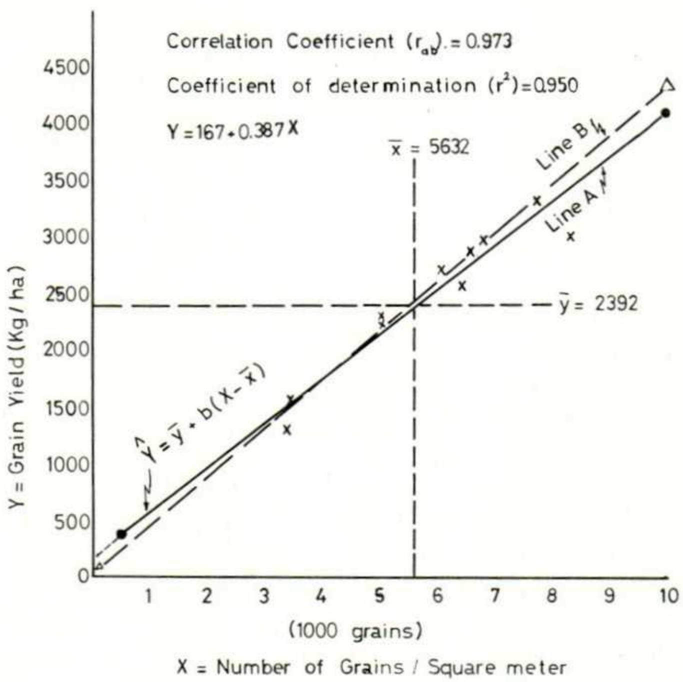

Fig. 1. Scatter diagram showing the relationship between grain yield and number of grains/m². Line A represents the regression line between the two parameters. Line B represents the association between the two parameters when grain size was held constant (partial corr. coeff. = 0.999). Slope of Line B = 0.427.

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