SOME RELATIONSHIPS IN F_1 STRAINS OF A-TESTER YELLOW DENT CORN

THESIS FOR THE DEGREE OF M. S.

Kishan Singh Gill

1930

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Thesis

Respectfully submitted in partial fulfillment for
the degree of Master of Science

at

Michigan State College of Agriculture
and Applied Science

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I

INTRODUCTION

The improvement of self-fertilized crops is much in control of the breeders, because such crops can easily be selected and isolated for homozygous characters, and if carefully handled can be kept relatively pure for these characters. But in the case of cross-fertilized crops, such as corn, the control of the male parentage is not so easy and for this reason, the improvement of such crops is rather difficult.

Corn is considered one of the most important crops of the world, especially of the United States of North America, and of Punjab, India. Because of its greater utilization in the United States, the plant-breeders in this country have been directing their attention for the last sixty years towards its improvement. Before this time only a few varieties of corn were known. Since then, hundreds of new varieties have been developed. This increase in the number of varieties is most probably the result of artificial mass selection in conjunction with natural selection. But for the last twenty or twenty-five years this system seems to have had a limited effect on the further improvement of corn. Various other systems have been tried out on adapted varieties, but none of them have proved to be of much value from a practical standpoint. The most efficacious

method of further increasing the yield of adapted varieties is yet unknown.

From the results of experiments obtained by Williams and Welton (27), in 1915, and Olson, Bull and Hayes (21), in 1918, we learn that selection of corn for ear type is not a means of improving yield. The statistical studies made by Richey and Willier (23), in 1925, do not show any significant relations between the ear characters and yield.

Garrison and Richey (9), in U.S.D.A. Bulletin 1341, reveal the fact that a decrease in vigor and productiveness similar to that following inbreeding may result from too close selection for a particular type of ear.

In 1927, Hayes and Garber (11:278) said, "Under certain conditions, selection of some particular characters appears worth while ....It is doubtful , however, whether under any circumstances continued selection for any particular ear type is desirable."

It is also known that but very little actual increase in production can be brought about and maintained permanently on improved varieties by ear-to-row breeding. Richey (22:10) declares, "It seems quite probable that the yield of an entirely unselected or unadapted variety could be improved by a few years' intelligent ear-to-row selection. However, in view of the expense,the uncertainty with which larger yields have been obtained,

and the small increases secured during a series of years in the most favorable cases, so far, there appears to be little to recommend ear-to-row breeding as a practical method of corn improvement".

Results of experiments conducted by Smith and Brunson (24) do not justify the use of ear-to-row breeding as a means of increasing the yielding ability of a well adapted variety of corn.

In 1876-82, Beal (2) of the Michigan State College of Agriculture at East Lansing, advocated the utilization of hybrids between varieties as a means of obtaining more vigorous types. This idea was strongly supported by McCluer (18) in 1892, by Morrow and Gardner (20) in 1893-94, according to Hayes and Garber (11) by East in 1908 and by Shull in 1908-9, and by Collins (4) in 1909-10. Hayes and Alexander (12) tested five F_1 crosses between Flint and Dent varieties of corn for four years, 1915-18 inclusive. Their results suggest that F_1 varietal crosses are a means of increasing yielding ability of corn.

In 1920, Griffee (10) made a review of the results of 146 F_1 crosses made at different stations in the country, and found that 58 per cent of these crosses out-yielded the higher-yielding parents. He states , (p.26), " The results of the test of F_1 crosses here reviewed are conclusive evidence that under present methods of corn breeding F_1 varietal crosses are a means of obtaining increased yields".

Jones, (14) at the Connecticut experiment station, tested 50 F_1 crosses and reports that 66 per cent of these crosses out-yielded the more productive parent. Collins, (4) from F_1 crosses of the Hopi, Hairy Mexican and Brownsville varieties with Chinese varieties obtained increases from 100 to 126 per cent above the average of the parent production. In 1925, Jones outlined the explanation of the increased vigor in F_1 crosses in a very descriptive way.

In 1927, Hayes and Garber (11) pointed out that in other tests by Hayes and Olson the F_1 crosses did not yield significantly higher than the average of the parents. They say, "Except for some special conditions, it appears that F_1 varietal crosses are of no material value as a means of increasing yielding ability, provided a broad method of breeding is used by the corn breeders without too close selection to type".

It is a well-known fact that the inbreeding of any open-pollinated corn usually results in a reduction in vigor and yield, and that crosses from such strains fail to retain, or maintain, the increased yield and vigor of the F_1 in the following generations. It is obvious therefore, that to use F_1 crosses most effectively there is a demand for a system by which the increased yield obtained by hybridization can be fully maintained.

The present-day breeders have come to realize

that it may be possible to approach this end by making single and double crosses each year between the standard inbred strains of corn. But it is advisable to determine the value of the F_1 crosses (strains) of the inbred parents before the double crosses are made, for all the F_1 crosses do not exceed the high-yielding parent. So far as the writer knows, there is only one way of determining this value. This is known as the variety test, which involves much time, labor and money. The necessity of some better system than this to determine the value of F_1 crosses is therefore obvious. The purpose of this investigation is to determine some such system.

It was thought that in the corn plant there might be a bond between certain of its physical characters by virtue of which, if one character varies, the other characters tend to move in the same or opposite directions, and that there might be a bond between a character at a certain stage of its development and the same character at another stage. If such a bond should exist, the characters would be said to be correlated (co-related). Such relationships (correlations) in F_1 strains of A-Tester Yellow Dent corn were determined with the hope that it might be possible to predict from the presence or value of certain characters in the early development of the plant the most probable values of associated characters, especially of yield, in its later development.

II

PREVIOUS INVESTIGATIONS

So far as the writer is aware, very little work has been done on the study of physical characters of the corn plant at different stages of its development for the purpose of determining whether there is any association of these characters from one stage to the next, with each other, and with the yield. However, in recent years some work has been reported on several characters, a few of which have some bearing on the problem under discussion. A brief review of these characters will be given.

Davenport (6) reported a correlation coefficient of .08±.005 between weight of ears and length of ears in Leaming corn.

According to Ewing (8), Brigham concluded that in the Longfellow variety of corn there is a relationship between the yield of corn and the weight of the plant, number of kernels, length of ear, and weight of cob, husks, suckers and leaves. He also found a correlation between yield and length of leaf and breadth of leaf. Furthermore, he reports that high yield was correlated with smaller number of inter-nodes and with thicker under and somewhat thicker upper nodes.

Ewing (8) goes on to say that Früwirth found that the weight of plant is correlated with weight of

ears, and weight of grain per plant is correlated with weight of plant, number of inter-nodes, and the length of ear.

Kempton (15), in 1926, found that there is a relationship of .408±.044 between the length of central spike and the height of plant in an F_1 cross of Algeria x Jala. He also reports a relationship of .346±.044 between height of plant and length of ear.

Craig, as cited by Ewing (8), reports a correlation between percentage of grain and total weight of plant. In this investigation the weight of plant was estimated by measuring the height of plant, diameter of stalk, and length and breadth of leaf.

Ewing at Cornell (8) made some studies on relationships in Funk's Ninety-Day corn, a yellow dent variety, and announced that there is a relationship between weight of grain(yield) and:

length of leaf	.393±.020
diameter of stalk	.292±.021
height of mature plant	.202±.025
height of seedlings.	.219±.037
number of inter-nodes	.228±.023
date of appearance of tassel	-.153±.023
date of appearance of silk	-.202±.023
number of branches in the tassel	-.009±.043

Brunson and Willier (3) have recently reported on the degree of relationships of yield with length of

ear (.001), with circumference of ear (-.056), with circumference of cob (-.074), with rows of kernels (-.050), with weight of 100 kernels (.084), with length of kernel (-.028), with breadth of kernel (.001), and with thickness of kernel (.023).

Jenkins (13) reports the relationships of characters in inbred lines and F_1 crosses of corn as follows:-

Yield with:	Inbred lines	F_1 crosses
date of tasseling	+.15 < 3 x P.E.	+.18 > 6 x P.E.
date of silking	-.26 > 5 x P.E.	+.16 > 5 x P.E.
height of plant	+.20 > 3 x P.E.	+.33 > 10 x P.E.
number of suckers per 100 plants	+.10 < 3 x P.E.	..0
length of ear	+.38 > 7 x P.E.	+.42 > 10 x P.E.
diameter of ear	+.32 > 10 x P.E.	+.25 > 8 x P.E.

Smith and Walworth (25) made a study of the relationship of seminal root development with yield of corn. A significant difference of 3.6±.6 pounds was found between the mean yield of 15 ears with high number of seminal roots and that of 15 ears with low unmber of seminal roots. The value of "r" was reported as .50±.09. From these results they concluded that the number of seminal roots may be used as a criterion for seed selection. This conclusion was questioned by Collins (3) and disapproved on the ground that the application of statistical methods in calculating the coefficient of correlation on the data, as obtained, was incorrect. The criticism was accepted

by Smith (26), but he still considered that the results suggested some positive relationship between number of seminal roots and yield.

Mangelsdorf and Goodsell (17) have recently summarized the conclusions on their experiments as follows:-

1. The number of seminal roots depends on the position of the seed on the ear, and the temperature and moisture during germination.

2. Four tests out of five showed no relationship between yield and seminal roots, while the fifth exhibited a slight degree of relationship (-.21±.06)

3. There is no relationship between the number of seminal roots and the height of plant in the greenhouse.

In summing up the study of the previous investigations mentioned here in this thesis it may be said that some of the results are of little real value, as no correlation coefficients are given; others, though the values of the coefficients are given, are not significantly greater than their probable errors; and the remainder though much larger than their probable errors are yet too small for predictable purposes. Most of the results, however, though unable to be used as criteria for selection, do indicate trends of relationship which may be of greater value with increased information.

III

MATERIAL

In 1922, Professor Spragg of this college obtained a variety of corn called A-Tester from Professor R.A.Emerson of the University of Cornell with the idea of producing pure strains of A-Tester Yellow Dent corn, which it was thought might be used for the development of a commercial variety of such corn for Michigan. Such strains were derived by Dr.K.M.Liu(16) at this station from crosses made between the A-Tester corn of Professor Emerson and some strains of Michigan-grown corn. The A-Tester of Professor Emerson was an inbred white flint corn. Its genetic constitution was aaCCRRyy. The Michigan strains used were yellow dents whose genetic constitution was AACCrrYY, AACcrrYY or AAccrrYY. The resulting strains of A-Tester Yellow Dent have the composition aaCCRR inherited from the A-Tester and the yellow character YY from the mother strains. Their total number is 38, and they have been inbred continuously for four generations. (It is an interesting fact that if these A-Tester Yellow Dent strains are pollinated by pollen from any common corn, the resulting hybrid seeds will become colored. This is due to the presence of A, C, and R factors in the hybrid kernels, where A comes from the pollen parent. Most of the commercial varieties of corn have the A factor present). In the summer of 1928 these 38 strains were crossed among themselves and the F_1

crosses of these strains were given to the writer for this investigation. The total number of these crosses was 673.

IV

EXPERIMENTAL METHODS

1. Method of handling the material.

In winter of 1929 the best looking ear from each cross was selected, out of which fifteen kernels were taken. Care was exercised in taking the kernels from different rows and different places on the circumference, yet leaving the butt and tip ends out, so as to have a representative sample of each strain. Ten of these kernels were put in one envelope and the remaining five in another envelope. Each of the envelopes was given the number of the cross which it contained. All of the 673 crosses were handled in this manner. The envelopes with five kernels were put in one box and the ones with the ten kernels into another box. Each of the samples was carefully weighed in grams, and the average weight per kernel was obtained for later computations. The five-kernel lot was used for the greenhouse experiment and the ten-kernel lot was saved for the field experiment.

The greenhouse planting was made on a bench filled with a uniform grade of garden soil. Before

General picture of the center of the field, showing the layout of planting. The stakes are on the check rows. The two rows on the left of the center check are much shorter than the adjacent plots while the two plots to the right of the center check are as tall as their adjacent plots. This difference in height was due to inheritance. The deficiencies in stand were caused by crows and pheasants early in the season.

planting, the soil was thoroughly moistened and worked, so as to ensure a high precentage of germination. Because of lack of space two greenhouse plantings were made, the first on January 20, and the second on March 2, 1929. Figure 1 represents the general layout of greenhouse planting. The rows were made from east to west, four inches apart, with a hand-marker, and the kernels were placed two inches apart in the row. White celluloid pot stakes were used to indicate the position of each strain on the bench. Checks of M.A.C. Yellow Dent were planted in every eighth row. The seedlings were visited every morning and care was taken to supply them with an optimum amount of moisture. The temperature was kept between 68° and 80° F. throughout the entire growing period. Measurements on height of plant were taken 15 days after planting, 15 days after germination (24 days after planting), 30 days after planting, and 30 days after germination (39 days after planting). The height was judged to be the distance, in inches, from the ground line to the highest leaf-tip when the leaves were stretched upward. On the 30th. day after germination the plants were pulled, roots freed of soil by shaking and the entire plant weighed in units of grams. All measurements were made on individual plants. Strains that had less than three plants in the greenhouse were discarded from the data and were not used in the field experiment.

The field planting was done on May 2, 1929, in a field that was thought to be fairly uniform in type and fertility with the exception of uneven topography, which in the later development of the plants proved to affect the results seriously. The general layout of the field planting is shown in figure 2. The field was divided into series each 11feet and 8 inches wide, with 14 inches of alley between the adjacent series. Each strain was planted in 1-row plots 42 inches apart with kernels 14 inches apart in the row. Checks of M.A.C. Yellow Dent were planted in every third plot. Unfortunately, many of the kernels were dug out by birds, and for this reason a number of strains failed to produce any plants. No data were taken on strains that produced less than four plants. The crop was given thorough cultivation throughout the early part of the growing season. The plants were visited every day during the entire period of tasseling and silking. The following individual plant notes on the field experiment were taken:- Height of plant from ground-line to the base of tassel at emergence of tassel, to the tip of the largest leaf (as in the greenhouse) at emergence of tassel, and to the base of tassel at full maturity; and the dates of emergence of tassel and silk. The tassel was regarded "emerged" when its base could first be seen, and the silks were considered "emerged" when they began to appear out of the husks. The date of ripening was also

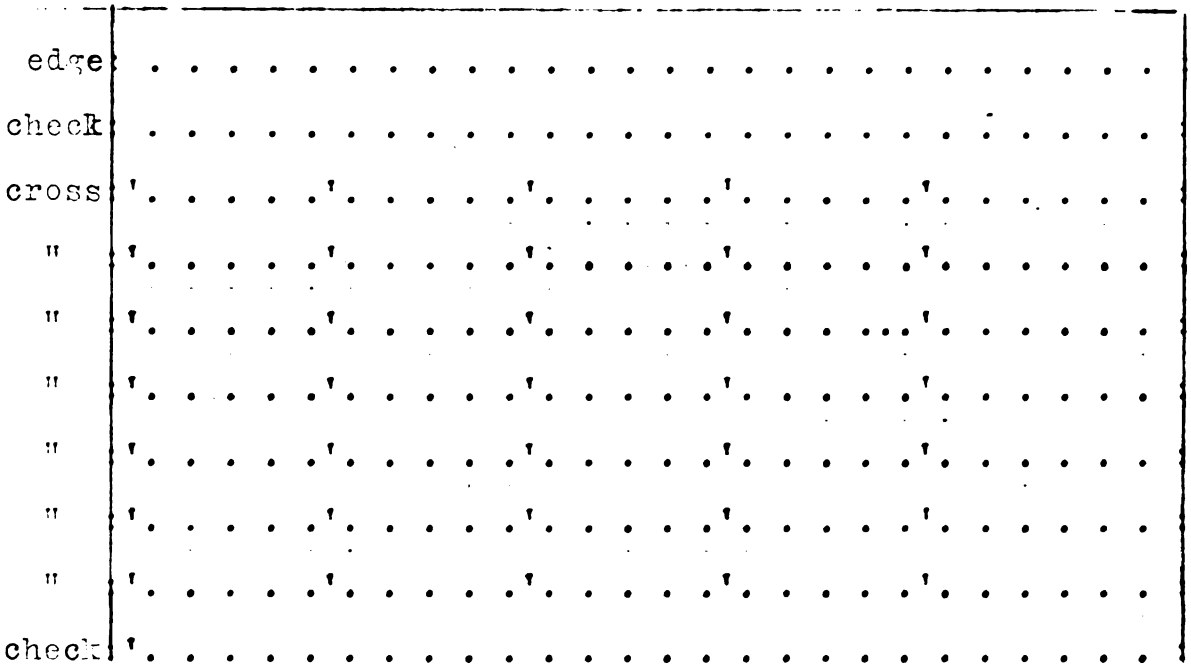


Figure 1 showing the general layout of greenhouse planting. The sign (') indicates the position of stake bearing the number of the cross planted after it.

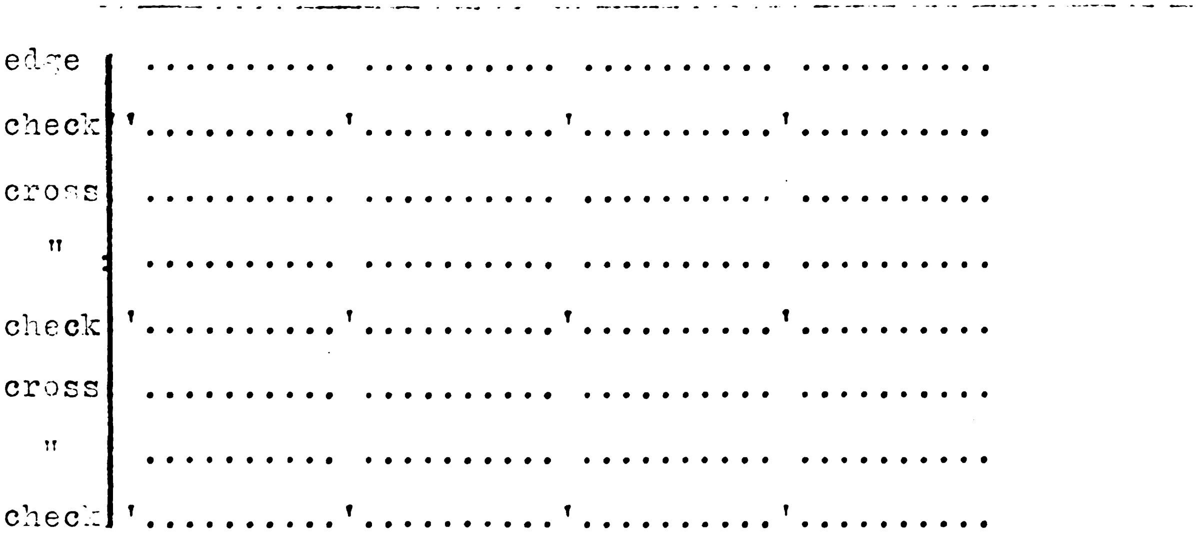
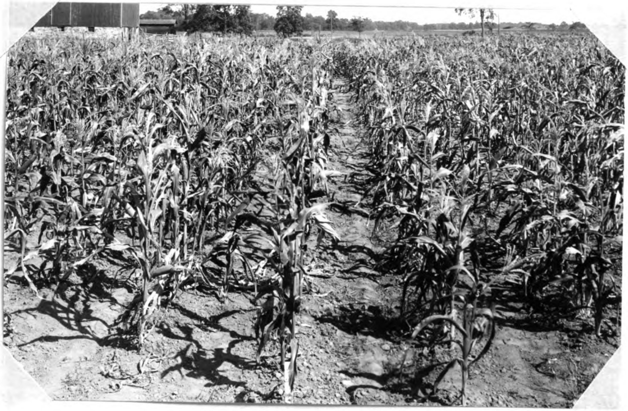


Figure 2 showing the arrangement of field planting. Sign (') indicates the position of stake showing the location of the check rows.



General picture of south half of field. The row in the center, with stake, is check. The two plots to the left of the center show a better stand than those on the right.

taken but was not used in the calculations because of its uncertainty. The crop was husked during the first and second weeks of October. The ears were put into white cloth bags of uniform size, The bags with ears were then weighed (correction for weight of bag made) and taken to the laboratory, where they were hung on wires and left until the ears were air dry. This required about four weeks. The ears were then weighed and shelled. The weight of shelled grain was also taken.

On account of dry weather throughout the season many of the strains on the high spots in the field remained barren. Strains that failed to have four plants with good ears were discarded from all calculations. A great deal of damage was done to the ears of some of the strains by blackbirds, crows and squirrels. All of those plots which had ears that were badly eaten were omitted from the yield calculations only.

2. Method of computing the relationships.

All of the data on individual plants in each cross were first added and then divided by the number of plants in that cross. The resulting average values per plant were then transferred onto individual cards. The cards were sorted into groups according to the magnitudes of one of the characters. Each of these groups was again sorted into further sub-groups according to the classes of the other character being considered. The frequencies of these sub-groups were then directly recorded on a coefficient of correlation table. The relationships were computed by the use of the diagonal method as outlined by Crum and Patton (6) and modified by the Farm Crops department of Michigan State College. The computations were carried to five decimal places but are reported to only three places for the sake of brevity.

Because of the fact that there was a radical difference in the amount of sunlight during the period in which the two plantings in the greenhouse were grown, the individuals of the second planting grew decidedly taller and more vigorous than those of the first planting. This difference was big enough to confuse the intra-class and inter-class coefficients, if the two plantings had been considered as a single group. In order to avoid this sort of confusion, the data of each planting were computed separately. The average value of relationship was then determined by the super-imposing-the-means method.

This method was recently worked out by the Farm Crops department of Michigan State College, and in its application requires (1) that the tables to be combined must involve the same characters and must give a logically homogeneous population, and (2) that the mid-class values of the dependent variable in all of the populations combined must be equal or pertain to the same series, with a similar condition holding for the independent variable. There are two ways of super-imposing-the-means, which may be named as method-A and method-B.

Method-A consists of combining two or more groups of data by transferring the frequencies from the different tables onto a single table by putting the classes containing the means at the same point and from the combined table computing the value of "r" in the usual manner. In table 1 parts a and b are the two tables representing the two different groups of data, first planting and second planting, respectively. Part c represents the combined population of two groups of data by method-A of super-imposing-the-means. In other words, this method requires the use of another table and the lengthy process of determining the value of "r" for the combined data. Because this difficulty was realized, and in order to avoid this, a simpler procedure was outlined for combining populations whose coefficients had already been calculated and is here distinguished as method-B. In the following steps the deviations, d_x or d_y, are considered to be from their respective means, M_x and M_y. If the original calculations were made by using the guess method, then the corrected values of the summed squared-deviations are used. From the separate tables we have

$$S.D.^2_{x_1} = \frac{S(d^2_{x_1})}{n_1};\ S.D.^2_{x_1} = \frac{S(d^2_{x_2})}{n_2};\ldots S.D.^2_{x_m} = \frac{S(d^2_{x_m})}{n_m},$$

$$S.D._{y_1}^2 = \frac{S(d^2_{y_1})}{n_1},\ S.D._{y_2}^2 = \frac{S(d^2_{y_2})}{n_2},\ \ldots.S.D._{y_m}^2 = \frac{S(d^2_{y_m})}{n_m},$$

and

$$S.D._{z_1}^2 = \frac{S(d^2_{z_1})}{n_1},\ S.D._{z_2}^2 = \frac{S(d^2_{z_2})}{n_2},\ \ldots\ S.D._{z_m}^2 = \frac{S(d^2_{z_m})}{n_m},$$

in which m indicates the number of tables or populations combined, and $n_1, n_2, \ldots.n_m$ the numbers of individuals in each sub-population.

Since by hypothesis $M_{x_1} = M_{x_2} = \ldots\ldots.= M_{x_m}$ and

$M_{y_1} = M_{y_2} = \ldots\ldots.= M_{y_m}$ and $n_1 + n_2 + \ldots.+ n_m = N$, then

$$S.D._x^2 = \frac{S(d^2_{x_1}) + S(d^2_{x_2}) + \ldots\ldots + S(d^2_{x_m})}{n_1 + n_2 \ldots\ldots.+ n_m} = \frac{S(d^2_x)}{N},$$

and

$$S.D._y^2 = \frac{S(d^2_{y_1}) + S(d^2_{y_2}) + \ldots\ldots + S(d^2_{y_m})}{n_1 + n_2 \ldots\ldots.+ n_m} = \frac{S(d^2_y)}{N}.$$

Similarly

$$S.D._z^2 = \frac{S(d^2_{z_1}) + S(d^2_{z_2}) + \ldots\ldots + S(d^2_{z_m})}{n_1 + n_2 \ldots\ldots\ldots + n_m} = \frac{S(d^2_z)}{N}.$$

for each direction in which z is calculated.

Considering only the diagonals with negative slope the value of "r" for one of the separate tables is

$$r_{x_1y_1} = \frac{S.D._{z_1}^2 - (S.D._{x_1}^2 + S.D._{y_1}^2)}{2\ S.D._{x_1} \times S.D._{y_1}}.$$ Substituting the

new values for the standard deviations the value of the

coefficient becomes $r_{x_1 y_1} = \frac{S.D._z^2 - (S.D._x^2 + S.D._y^2)}{2\ S.D._x \times S.D._y}$.

Similarly when the slope of the diagonals is positive,

$$r_{x_1 y_1} = \frac{(S.D._x^2 + S.D._y^2) - S.D._z^2}{2\ S.D._x \times S.D._y} .$$

Example 1 shows a convenient method of arranging the necessary data which, in this case, are taken from table 1, parts a and b.

The value of the coefficient by method-A (table 1, part c) was .5021, and by method-B (example 1) .5143. The difference between the two coefficients is due to the error introduced into method-A by the fact that actually the mid-classes containing the means are super-imposed and not the actual means, while in method-B the means are actually super-imposed. The difference is slight when compared to the probable error and of not enough importance to warrant correction.

Table 1, part a

Average height of plant 15 days after germination (First planting).

Average weight of kernel planted in the green house

X	Y 4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	
.10		1	1	3									5
.11	1	1	1	3	1								7
.12		1	3	3	4	1	1						13
.13			1	1	5	2	2	1					12
.14	1			11	4	3	2	2					23
.15			3	5	6	8	5	3	2	2			34
.16			2	3	5	4	5	1	4	1			25
.17			1	1	3	7	3	1	2	2			19
.18					3	1	5	1		1			12
.19					1	5	7	6	5	1	1	1	27
.20				2	4	3	2	6	2	1			18
.21				1		1	1	1	1	4	2		12
.22						4	3	2	8	1	2		15
.23					1	1	2	2	3		1		10
.24					1		2	1		2	1		7
.25						1	1		2		1		5
.26						1		1					2
.27											1		1
.28												1	1
	2	5	12	33	38	42	41	28	23	15	9	2	248

Relationship between average weight of kernel planted in the green house and average height of plant 15 days after germination.

r = .535 ± .023

Table 1, part b

Average height of plant 15 days after germination
Second planting.

Y	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5	
X																	
.10	1			1	1	1											4
.11				2	2	2			4								10
.12					1	4	1	4	2	1							13
.13				1	1	2	2	2	1	1	1						11
.14			1	1	3	4	2	4	1	1	1						18
.15				1		3	4	4	2		2				1		17
.16						1	2		7	1	2		1				14
.17					3	2	1	1	3		2	1					13
.18				1		3	1	4	5	4	4	3	1				26
.19						1	1	2	4	2	3	2	1	1			17
.20						1	2		1	1	2	2		1			10
.21						1	1		3	3	2			1	1		12
.22					1	2		2	1	1	3	1	2		1		14
.23					1	4			2	1	1		1				9
.24					1			2	2	2	3			1	1	1	13
.25								1									1
.26								1	1	1	1					1	5
.27																	-
.28											1						1
	1	-	1	7	13	31	17	27	39	19	28	9	6	4	4	2	208

Relationship between average weight of ~~corn~~ kernel and average height of plant 15 days after germination. r= .457 ± .022

Table 1, part c

Average height of plant 15 days
after germination

Average weight of kernel planted in the green house.

				4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	
Y	-8	-7	-6	-5	-4	-3	-2	-1	M	1	2	3	4	5	6	7	
	-6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5	
X																	
.10	1			1	2	2	3										9
.11				3	3	3	3	1	4								17
.12					2	7	4	8	3	2							26
.13				1	1	3	3	7	3	3	2						23
.14			1	2	3	4	13	8	4	3	3						41
.15				1		6	9	10	10	5	5	2	2		1		51
.16						3	5	5	11	6	3	4	2				39
.17					3	3	1	4	10	3	3	3	2				32
.18				1		3	2	7	6	9	5	3	2				38
.19						1	1	3	9	9	9	7	2	2	1		44
.20						1	2	4	4	3	8	4	1	1			28
.21						1	3		4	4	3	1	4	3	1		24
.22					1	2	1	2	5	4	5	3	3	2	1		29
.23						4		1	3	3	3	3	1	1			19
.24					1			3	2	4	4		2	2	1	1	20
.25								1	1	1		2		1			6
.26								1	2	1	2					1	7
.27														1			1
.28											1				1		2
	1	-	1	9	16	43	50	65	81	60	53	33	21	13	6	2	456

Relationship between average height of plant 15 days after germination and average weight of kernel planted in the green house. r= .502 ± .024

First and second planting combined by super-imposing the means.

Example 1

Arrangement of data from table 1 for super-imposing the mean by method-B

Character X = kernel weight						Character Y = Height 15 days after germination			Slope of diagonal negative	Slope of diagonal positive
Plot	No. of plants	actual mean	mid value	N = population	$S(d_x^2)$	actual mean	mid-value	$S(d_y^2)$	$S(d_z^2)$	$S(d_z^2)$
a	1	.1758	.17	243	3611.5515	9.8079	9.5	1213.9041	8373.5373	7374.7030
b	2	.1757	.19	203	3511.0570	14.1578	14.15	1422.7641	[illegible]	[illegible]
Adding				450	7123.3384			2616.7378	5503.1524	14155.0001
Dividing by N =450					15.83085			5.81530	11.5550	31.4[illegible]

S.D.$_x$=3.9855 S.D.$_y$=2.432

$$r = \frac{(15.83075 + 5.81530) - 11.5550}{2(3.955 \times 2.432)} = \frac{9.9[illegible]}{19.27[illegible]} = + .514[illegible]$$

$$r = \frac{31.4[illegible] - 21.[illegible]}{19.27[illegible]} = \frac{9.9[illegible]}{19.27[illegible]} = + .5143$$

This is a view of the north end of the field. The row on the extreme left was an edge row: the next was a check. Then two rows of crosses and another check. The effects of soil variability and the long dry spell are shown in this picture; the plants were spindling and not nearly as thrifty as those at the south end of the field. This was true of both checks and crosses.

V

RELATIONSHIPS

1. Relationship between average weight of kernel planted in the greenhouse and average weight of kernel planted in the field:_(Table 2)

In order to determine the difference between the two samples of seed the correlation coefficient was determined and the value of "r" was found to be .976±.002. This indicates that the two samples of seed were so very much alike that the investigator may use either kernel weight for subsequent calculations. The weight of kernel planted in the greenhouse was used in computing the relation of weight of seed kernel with other characters.

Table 2.

Average weight per kernel planted in the field.

Average weight per kernel planted in the greenhouse.

Y	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
X																					
10	7	1	1																		9
11		10	6	1																	17
12		3	10	13																	26
13			3	8	12																23
14			1	5	18	13	4														41
15					7	28	16														51
16					1	4	24	9		1											39
17						1	3	12	13	2	1										32
18								7	20	10	1										38
19								1	1	22	13	6		1							44
20									1	7	6	10	4								28
21										1	3	11	6	3							24
22												3	15	9	2						29
23													6	6	7						19
24													1	4	7	7	1				20
25															1	1	3		1		6
26															1	1	2	2	1		7
27																		1			1
28																		1		1	2
	7	14	21	27	38	46	47	29	35	43	24	30	32	23	18	9	6	4	2	1	456

Relationship between average weight of seed kernel planted in the greenhouse and average weight of seed kernel planted in the field r = .[illegible]76± .00[illegible].

2. Relationships between weight of seed kernel and plant characters other than yield._(Table 3)

Looking at table 3, showing the relationships between weight of seed kernel and plant characters other than yield, we find that in the first planting the relationship is smaller at 15 days after planting than it is in the succeeding stages. This may be due to the fact that the food requirement of the plant up to this time and stage of its growth is comparatively less than later, and that there is a sufficient amount of food present in both the smaller and the larger kernels. From 15 days after planting up to 30 days after planting, the relationship tends to become stronger, showing that the larger the seed the greater the growth of the plant, and that those plants that still get some of their food nutrients from the seed grow taller than those plants from whose kernels the food nutrients have been exhausted. By 30 days after germination the relationship begins to become less pronounced, which may be due to the fact that all the food nutrients that were present in the seed have been used up before this time, and that the root system is so fully established that the plant draws all its food nutrients from the soil. The same is true in the second planting, except that in this case, the growth of the plants, due to the increased amount of sunlight, seems to have been so much more active than in the first planting, that the plant root system became established at an earlier

Table 3.

Relationships between weight of kernel and plant characters other than yield.

Weight of seed kernel with	Greenhouse plantings		
	1st.	2nd.	1st.&.2nd. combined(1)
Average height of plant:			
15 days after planting	.306±.039	.427±.038	.370±.027
15 " " germination	.535±.021	.457±.022	.515±.025
30 " " planting	.527±.023	.425±.031	.505±.024
30 " " germination	.570±.027	.314±.042	.477±.024
Average weight of plant			
30 days after germ.(2)	.431±.033	.410±.039	

Field planting

Average height of plant:

at emergence of tassel --- -- ----- .209±.031

at full maturity- ---------------- .169±.037

(1) The two populations were combined by the B-method of super-imposing-the-means.

(2) These two populations could not be combined because of the fact that their class intervals were not the same.

time, and that the food nutrients in the seed became exhausted somewhere between 15 days after germination and 30 days after planting.

In summing up the relation of size of seed kernel to height of plant in the greenhouse we may say that the weight of seed has some influence on the size of plant so long as the food nutrients present in the former are not exhausted. But as soon as the plant begins to live wholly on the soil nutrients, the size of the seed ceases to show its influence on the growth of the plant.

The weight of seed kernel and the weight of plant at 30 days after germination exhibited a coefficient of correlation of .491±.033 in the case of the first planting, and of .413±.039 in the case of second planting. This result shows that there is some relationship between these two characters.

In field planting the coefficient of correlation obtained between weight of seed kernel and height of plant was .209±.031 at the time of emergence of tassel, and .169±.037 at the time of maturity. From the field data we find that the relationships between seed weight and plant height, though statistically significant, are too small to justify the selection of seed on the basis of its weight.

3. Inter-relations between heights.

(Tables 4-13 inclusive)

The relationship of height of plant 15 days after planting to the height 15 days after germination was .813±.015 (table 4); to height 30 days after planting .799±.016 (table 5); to height 30 days after germination .767±.019 (table 6); to height at emergence of tassel -.003±.032 (table 7); and to height at maturity .013±.032 (table 8).

From table 4,5, and 6, we may safely say that the height of plant 15 days after planting has a marked influence on the height up to the 30th. day after germination, although the degree of influence tends to drop down from one stage to the next. Tables 7 and 8 show no evidence of relationship between height at 15 days after planting and the height at emergence of tassel or height at maturity. In fact, in one case, the "r" is negative though not significant.

Average height 15 days after planting gave a correlation coefficient of .813±.015 with height 15 days after germination (table 4). Height 15 days after germination exhibited a relationship .941±.005 with height 30 days after planting (table 9). Height 30 days after planting with height 30 days after germination gave a coefficient of correlation of .942±.005 (table 10). A relationship of .142±.050 was found between height 30 days after germination in the greenhouse and height to tassel base at emergence of tassel in the field (table 11). Height to tassel base at emergence of tassel was found to exhibit a relationship of .384±.009 with height to leaf tip at emergence of tassel (table 12), and of .943±.004 with height to tassel base at maturity (table 13).

The results indicate a strong bond between heights of plant from one stage to the next in the greenhouse. A similar bond exists between the heights of plant in the field. But the results offer no evidence of bond between last stage of growth in the greenhouse and first stage of growth in the field. No better explanation for this fact can be offered than that of environmental factors, such as seasonal variation (temperature, moisture, humidity, light, etc.), place variation, and damage by mice, squirrels, blackbirds and crows.

Table 4.

Average height of plant 15 days
after germination.

Average height of plant 15
days after planting.

Y	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	
X													
1.7	2												2
2.2		3	5	5	1								14
2.7			5	15	11	6							37
3.2			2	9	18	18	8	8					63
3.7				4	8	16	19	6	6				59
4.2						2	12	8	8	5	1		36
4.7							2	4	7	4	2	2	21
5.2								2		3	3		8
5.7									2	2	1		5
6.2													-
6.7											1		1
7.2											1		1
7.7											1		1
	2	3	12	33	38	42	41	28	23	14	10	2	248

Relationship between average height of plant 15 days after germination and average height of plant 15 days after planting r = .813 ± .015

-Table 5

Average height of plant 30 days after planting
(first planting)

Average height of plant 15 days after planting.

X	Y 6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5	22.5	23.5	
1.7	1	1																	2
2.2		1	1	2	4	3	3												14
2.7				1	3	11	10	4	6	2									37
3.2						2	9	16	16	10	7	3							63
3.7						1	4	5	14	15	9	2	6	3					59
4.2										6	7	9	7	3	3		1		36
4.7										1	1	7	4	2	2	1	2	1	21
5.2											1	1	1	1	2	2			8
5.7											1			2	2				5
6.2																			-
6.7														1					1
7.2													1						1
7.7																1			1
	1	2	1	3	7	17	26	25	36	34	26	22	19	12	9	4	3	1	248

Relationship between average height of plant 15 days after planting and average height of plant 30 days after planting. r = .739 ± .016

Table 61

Average height of plant 30 days
after germination.

Average height of plant
15 days after planting.

X	Y 11	13	15	17	19	21	23	25	27	29	31	
1.7	2											2
2.2	1	2	3	6	2							14
2.7			3	14	12	6	2					37
3.2				3	24	22	10	4				63
3.7				2	5	21	17	7	6	1		59
4.2						2	12	12	8	2		36
4.7							5	7	3	3	3	21
5.2							1	2		5		8
5.7						1			3		1	5
6.2												-
6.7										1		1
7.2							1					1
7.7											1	1
	3	2	6	25	43	52	48	32	20	12	5	248

Relationship between average height of plant 15 days after planting and average height of plant 30 days after germination. r = .767 ± .018

Table 7.

Average height of plant at emergence of tassel

Average height of plant 15 days after planting

	X		Y 22	25	28	31	34	37	40	43	46	49	52	55	58	61	64	
	-6									1								1
	-5							1		1	2	2						6
1.7	-4							1	2	3		2	1		1			10
2.2	-3	4.7						3	3	6	6	5	3	1				27
2.7	-2	5.2			1	1	4	4	6	7	11	7	8	6				55
3.2	-1	5.7					4	6	15	17	21	14	13	5	3	1	1	100
3.7	M	6.2				1	5	5	15	16	20	13	8	7	1	1		92
4.2	1	6.7			2	1	2	5	10	11	8	5	9	6	1			60
4.7	2	7.2			1	2	2	7	10	5	6	10	1	3				47
5.2	3	7.7						2	3	1	6	5	3	2				22
5.7	4	8.2					3	1		1	5	1	1	1				13
6.2	5	8.7							2	4	1		2		1			10
6.7	6	9.2							1	1	4	1						7
8.2	7	9.7			1											1		2
8.7	8	10.2								1				1	1			3
9.2	9	10.7																-
9.7	10	11.2											1					1
					5	5	20	35	67	75	90	65	50	32	8	3	1	456

Relationship between average height of plant 15 days after planting and average height of plant at emergence of tassel r =.003 ± .032

Table 8.

Average height of plant at maturity

Average height of plant 15 days after planting	X		Y 23	31	34	37	40	43	46	49	52	55	58	61	64	67	70	73	
	-6	3.2								1									1
	-5	3.7						1		2	1	2							6
1.7	-4	4.2						3	2	1			3	1					10
2.2	-3	4.7				1	2	2	5	7	1	4	4		1				27
2.7	-2	5.2		1	1	4	4	4	7	5	7	10	6	4	2				55
3.2	-1	5.7				1	5	12	12	17	18	11	10	7	4	1	1		100
3.7	M	6.2			1	3	6	10	12	21	14	8	11	5	1	1	1		92
4.2	1	6.7	1	2			7	3	10	11	3	8	7	7	1				60
4.7	2	7.2			1	4	6	6	6	5	8	6	3	2					47
5.2	3	7.7						3	1	5	3	3	5		1	1			22
5.7	4	8.2				1	3			1	4	2	1		1				13
6.2	5	8.7					1	1		5			1	2					10
6.7	6	9.2						1		1	5								7
7.2	7	9.7		1												1			2
7.7	8	10.2							1				1			1			3
	9	10.7																	-
	10	11.2											1						1
			1	4	3	14	33	46	56	82	64	54	53	28	11	5	2		456

Relationship between average height of plant 15 days after planting and average height of plant at maturity

r = .013 ± .032

Table 9.

Average height of plant 30 days after planting.

Average height of plant 15 days after germination.

X \ Y	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5	22.5	23.5	
4.5	1	1																	2
5.5		1	1	1															3
6.5				2	3	5	2												12
7.5					4	11	11	5	2										33
8.5						1	11	14	11	1									38
9.5								6	19	14	3								42
10.5							2		4	18	12	3	2						41
11.5										1	10	11	5		1				28
12.5											1	7	10	3	2				23
13.5												1	2	6	6				15
14.5													1	2		4	2		9
15.5																	1	1	2
	1	2	1	3	7	17	26	25	36	34	26	22	20	11	9	4	3	1	248

Relationship between average height of plant 15 days after germination and average height of plant 30 days after planting r = .941 ± .005.

Table 10.

Average height of plant 30
days after germination.

Average height of plant 30
days after planting.

X	Y	11	13	15	17	19	21	23	25	27	29	31	
6.5		1											1
7.5		2											2
8.5				1									1
9.5			2	1									3
10.5				3	4								7
11.5				1	14	2							17
12.5					7	16	2		1				26
13.5						16	7	1	1				25
14.5						7	23	6					36
15.5						2	18	14					34
16.5							2	17	7				26
17.5								7	14	1			22
18.5								3	7	9	1		20
19.5									2	7	2		11
20.5										3	5	1	9
21.5											3	1	4
22.5											1	2	3
23.5												1	1
24.5													
		3	2	6	25	43	52	48	32	20	12	5	248

Relationship between average height of plant 30 days after planting and average height of plant 30 days after germination. r = .323 ± .005

Table 11.

Average height of plant to thebase
of tassel at emergence of tassel.

Average height of plant 30
days after germination.

Y	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	
X																			
12				1															1
14					1			1	1				1						4
16			3		1	1	1	1	1	2		2		1					12
18			1		3	5	1	3	5	5	1								24
20	1		1	2	3	5	7	7	3	2	4	1	1						37
22			1	2	2	4	6	2	10	1	2	3	2	1	1				37
24				2		4	2	3	6	6		1	1	2				1	23
26		1	2	2			1	2	1	2	2	1							14
28				2			1			1		1	1	2					9
30				1	1				1		1		1		1				7
32					1														1
	1	1	8	12	12	19	29	19	27	21	10	9	7	6	2	-	-	1	174

Relationship between

average height of plant at 30 days after
germination and average height at emergence of tassel.

r= .142 ± .050

Table 12.

Average height of plant to the tip of the largest leaf of plant at emergence of tassel. 75.5

Y	45.5	47.5	49.5	51.5	53.5	55.5	57.5	59.5	61.5	63.5	65.5	67.5	69.5	71.5	73.5	75.5	77.5	79.5	81.5	
28	1			3																3
31			1		1	3														[illegible]
34				1		7	5	3												16
37				3	1	4	3	11	5	3										30
40				1			6	11	10	3	5	1		1						[illegible]
43					1			3	3	3	10	3	3	1						43
46								1	3	3	7	15	3	6						[illegible]
49											1	3	3	6	6					37
52													1		7	3	1	3		13
55							1								5	6	1	4	3	14
58																	1	1	1	5
61																				-
64																1				1
	1	-	1	3	5	15	15	23	25	[illegible]	[illegible]	30	12	[illegible]	[illegible]	18	5	7	3	240

Relationship between average height of plant to the tip of its largest leaf and the average height to the base of tassel at emergence of tassel r = .[illegible] ±.[illegible]

Table 13

Average height of plant to the base of tassel at maturity.

Average height of plant to the base of tassel on emergence of tassel

X \ Y	23	31	34	37	40	43	46	49	52	55	58	61	64	67	70	78	
23	1	2	1	1													5
31		2	1	2													5
34			1	9	9	1											20
37				2	16	15	2										35
40					8	23	24	5	2								67
43						2	25	45	3								75
46							5	31	39	13	2						90
49								1	20	27	15	2					65
52										13	27	3	2				50
55										1	8	14	8	1			32
58											1	4	1	2			8
61														1	2		3
64														1			1
	1	4	3	14	33	46	56	82	64	54	53	23	11	5	2		456

Relationship between height of plant on emergence of tassel and height of plant at maturity. r= .943 $\pm$ .004

4. Relationship between height of plant 30 days after germination and weight of plant 30 days after germination._ (Table 14).

A coefficient of .828±.013 was found to exist between height of plant 30 days after germination and green weight of plant 30 days after germination. These data indicate that vigor of plant as measured by weight of plant is dependent upon the height of plant to an extent of about 70 per cent. The rest of the weight depends on other characters,such as root development, length of leaf, breadth of leaf, and number of leaves.

Table 14.

Average green weight of plant
at harvest (30 days after germination)

Average height of plant
30 days after germination.

X	Y 33	5	7	9	11	13	15	17	19	21	23	25	27	
11	3													3
13	1	1												2
15	2	3		1										6
17	1	8	10	5		1								25
19		6	13	17	5	1	1							43
21			12	18	15	5	2							52
23			2	16	12	12	3	3						48
25				2	10	10	5	2	3					32
27					4	4	5	4	2	1				20
29						1	1	6	2	1	1			12
31									1	1		2	1	5
	7	18	37	59	46	34	17	15	8	3	1	2	1	248

Relationship between average height of plant 30 days after germination and average green weight of plant 30 days after germination(at harvest) r = .[illegible] ±.01[illegible].

5. Relationship between weight of plant 30 days after germination and height of plant at maturity._ (Table 15).

A coefficient of correlation between average weight of plant 30 days after germination and average height of plant at maturity was found to be only .079±.031, which indicates no relationship between weight of plant in the greenhouse and height of plant at maturity in the field.

We may again conclude here that the vigor of plant as measured by its weight in the greenhouse cannot be used as means of determining the height of the plant at maturity in the field.

Table 15.

Average height of plant to the base of tassel at maturity.

Average weight of green plant 30 days after germination (at harvest)

	X	Y	28	31	34	37	40	43	46	49	52	55	58	61	64	67	70	
4.5	-4						1	1		1								3
8.5	-3		1					1	3	3		1	2	1	1			13
12.5	-2			1			1	2	4	6	12	7	7		2			42
16.5	-1	4.5		2	2	4	6	7	7	13	13	13	10	8	2			87
20.5	M	8.5		1	1	5	12	22	20	28	16	11	14	9	5	1	1	146
24.5	1	12.5				5	11	4	18	18	9	11	7	6				89
28.5	2	16.5					1	4	2	7	6	9	6	1	1	2	1	40
32.5	3	20.5						5	1	5	4	2	2	3				22
36.5	4	24.5					1			1	1		4			1		8
40.5	5								1		1		1					3
44.5	6										1					1		2
48.5	7																	-
52.5	8										1							1
			1	4	3	14	33	46	56	82	64	54	53	28	11	5	2	456

First and second plantings combined by super-imposing their means. r = .079 ± .031

6. Relationships between weight of dry ears per plant and plant characters._(Tables 16-24 inclusive).

Weight of seed kernel with weight of dry ears per plant (table 16). The coefficient of correlation between these two characters is .164±.037, which indicates only a slight relationship between yield of dry ears per plant and weight of seed kernel. This table represents the data of both plantings which were combined directly.

The average dry weight of ears per plant showed a relationship of .113±.050 with height of plant 15 days after planting (table 17); of .154±.050 with height 15 days after germination (table 18): of .206±.050 with height 30 days after planting (table 19); of.282±.047 with height 30 days after germination (table 20); of .461±.040 with height to tip of leaf at emergence of tassel (table 21); of .450±.038 with height to base of tassel at emergence of tassel (table 22); and of .540±.036 with height to tassel base at maturity (table 23).

These results indicate that there is some relationship between height of plant and weight of ears per plant.

The weight of plant 30 days after germination exhibited a correlation of .362±.050 with weight of ears per plant (table 24). This shows that there is some relationship between vigor of plant as measured by its weight and the weight of ears per plant, though not great enough to be considered of much value for predictable purposes.

Table 16

Average weight of dry ears per plant

Average weight of kernel planted in the field.

Y	7	22	37	52	67	82	97	112	127	142	157	172	187	202	217	232	247	262	277	
X																				
.10		1			4				1											6
.11			1	3	1	4	1	2			1									13
.12			1	1	1	4			2	1	1	1					1			13
.13		1		2	3	2	3	1	3	1	1									17
.14		1	1	5	5	9	4	3	1		1			1	1					32
.15				3	7	7	7	4	1	1	1					1				32
.16			3	4	7	2	4	2	3	2	2	1	1							31
.17			1	2	4	4	7	1	2					1						22
.18			1	4	2	6	1	5	2	1	2	1		1						26
.19			3	2	4	6	2	3	3	2		1	1		1					28
.20				4		6	1	2	2					1						16
.21				3	3	3	2	2	2	1	3	2			1					22
.22					2	3	4	2	1		4	1	2	1	2					22
.23				1	1	1	4	2		1	1		1	1					1	14
.24	1		1		3	3	2	2						1						13
.25					2	2														4
.26				1			1	2		1	1									6
.27						2		1			1									4
.28					1															1
	1	3	12	55	50	64	43	34	23	11	19	7	5	7	5	1	1	-	1	322

Relationship between weight of kernel planted in the field and average weight of dry ears of corn per plant

$r = .164 \pm .037$

Table 17

Average height of plant 15 days after planting.

Average dry weight of ears perplant.

Y	.2	.7	.12	.17	2.2	2.7	3.2	3.7	4.2	4.7	5.2	5.7	
X													
14							1						1
29						2			1				3
44						2	3	2				1	8
59					1	5	6	7	1	4	2	2	23
74					2	6	11	10	3	1	1		54
89				1	6	6	14	12	4	3	1	1	48
104						3	8	6	4	1			22
119						2	3	4	5			2	16
134						1	2	2	1	1	1		8
149							1	1					2
164							1						1
179													2
194										1			1
				1	9	27	50	44	21	11	5	6	174

Relationship between average dry weight of ears per plant and average height of plant 15 days after planting r = .113 ± .050

Table 15

Average height of plant 15 after germination.

Average dry weight of ears per plant.

Y	4	5	6	7	8	9	10	11	12	13	14	15	
X													
14								1					1
29				2			1						3
44				2	1	2	2		1				8
59			2	5	3	4	3	2	5	2	2		28
74		1	2	6	8	4	7	3	1	1	1		34
89	1	1	4	9	7	9	6	5	1	3	1	1	48
104			1	3	3	5	7	2			1		22
119					2	3	4	2	3		2		16
134				1	1	2	1	2		1			8
149					1	1							2
164							1						1
179						1				1			2
194												1	1
	1	2	9	28	26	31	32	17	11	8	7	2	174

Relationship between average weight of dry ears per plant and average height of plant 15 days after germination

r = .134 ± .050

Table 19

Height of plant 30days after planting.

Average dry weight of ears per plant.

Y	8	10	12	14	16	18	20	22	24	
X										
14					1					1
29			2		1					3
44			3	1	4					8
59		1	5	3	4	4	5	1		23
74	1	3	8	3	9	2	3			34
89	1	3	11	15	10	4	2	1	1	48
104			5	5	8	3		1		22
119				3	5	5	1	2		16
134		1		2	2	2	1			8
149				1	1					2
164					1					1
179					1		1			2
194								1		1
	2	8	34	43	47	20	13	6	1	174

Relation between average weight of ears per plant and average height of plant 40 days after planting r = .303 ± .050

Table 20

Average height of plant 30 days after germination.

Average dry weight of ears per plant.

X	Y 12	14	16	18	20	22	24	26	28	30	32	
14						1						1
29			1	1	1							3
44			1	1	4	2						8
59		1	2	4	7	3	3	3	5			28
74		2	3	4	12	5	5	1	1	1		34
89	1	1	4	10	5	12	9	3	1	1	1	48
104				4	5	7	4	1		1		22
119						5	3	4	1	3		16
134			1		2	1	2	2				8
149					1		1					2
164						1						1
179							1		1			2
194										1		1
	1	4	12	24	37	37	28	14	9	7	1	174

Relationship between average weight of ears per plant and average height of plant 30 days after germination

$r = .222 \pm .047$

Table 21.

Average height of plant to the tip of its largest leaf at emergence of tassel

Average dry weight of ears per plant

grams

F	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	
14										1												1
[illegible]					1	2																[illegible]
[illegible]				2		1		3	1	2												[illegible]
[illegible]						5	3	[illegible]	3	1	3	[illegible]	1	1							1	[illegible]
7							3	3	4	2	4	3	2	3	3	5						[illegible]
[illegible]					1	2	1	1	3	6	1	[illegible]	7	[illegible]	3	1	1	2				[illegible]
101							[illegible]	1	1	[illegible]	[illegible]	[illegible]	[illegible]	1	1	1	1		1			23
[illegible]										1		3	3	5	3	1	1	1	1			16
[illegible]								1	1		1	1	1	1	2							6
[illegible]														3								3
[illegible]																		1				1
[illegible]															1			1				2
[illegible]									1													1
				2	2	10	6	22	26	13	16	25	16	15	12	6	3	5	2	-	1	

Relationship between average dry weight of ears per plant and average height of plant to the tip of its largest leaf at the time of the emergence of tassel r = .431 ±.046

Table 22'

Average height of plant to the base of tassel at emergence of tassel.

Average dry weight of ears per plant

Y	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	
X																			
14						1													1
29	1		1		1														3
44			3	2		3													8
59		1	3	6	1	4	6	1	3	2		1							28
74				2	5	5	4	5	3	3	3	2		1				1	34
89			1	1	3	4	4	10	8	8	3	2	3	1					48
104					1	2	4	1	9	2			2	1					22
119								1	3	4	3	2	1	1	1				16
134					1		1	1	1	1		2		1					8
149										1	1								2
164															1				1
179													1	1					2
194				1															1
	1	1	8	12	12	19	19	19	27	21	10	9	7	6	2	-	-	1	174

Relationship between average dry weight of ears per plant and average height of plant to tassel base at emergence of tassel r = .450 ±.033

Table 35

Average height of plant at maturity.

Average dry weight of ears per plant

X	Y 32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	
14						1														1
29	1	1			1															3
44				2	1	3	1	1												8
59			2	3	4	2	4	5	3	2	1	1	1							28
74					1	3	8	3	2	5	5		4	1	1				1	34
89				1		1	6	3	6	10	5	6	3	5		2				48
104					1		1	6	1	3	1	4	2		1	1	1			22
119										3	1	1	3	4	2	2				16
134						1		1		1		1	1	2		1				8
149												1	1							2
164																1				1
179															1	1				2
194						1														1
	1	1	2	6	8	12	20	19	12	24	13	14	15	12	5	8	1	-	1	174

Relationship between average weight of dry ears per plant and average height of plant to tassel at maturity

r = .542 ± .033

Table 24.

Average green weight per plant at 30 days after germination

Average dry weight of ears per plant

Ý 2	2	4	6	8	10	12	14	16	18	20	22	24	26	28
X														
14						1								1
29			2	1										3
44			3	2	2	1								8
59		2	2	5	19	4	4	1		1				28
74		4	4	15	12	3	2	3						34
89	1	1	3	5	11	8	5	2	1	1				48
104			3	1	7	2	3				2			22
119				2	4	2	2	3	1	1			2	16
134		1				2	2			1				8
149				1	1			1						2
164														1
179							1			1				2
194													1	1
	1	8	17	38	46	23	19	10	2	5	2	-	3	174

Relationship betwsen average weight of dry ears per plant and average green weight of plant 30 days after germination $r = .362 \pm .050$

7. Summary of relationships between weight of dry ears per plant and other characters._

(Table 25)

Looking at column four in table 25 we find that the yield of dry ears per plant is correlated significantly and positively with the height of plant at different stages of its growth, and with weight of plant at 30 days after germination. These results agree with the cited results obtained by Brigham, Craig, Früwirth and Ewing.

The weight of dry ears per plant gave a negative and significant correlation with number of days from planting to emergence of tassel (-.556±.033), and with number of days from planting to emergence of silk (-.467±.030). These results indicate that there is some relationship between these characters. Ewing (8) has likewise found some association between these characters.

Table 25

Summary of relationships between the yield of dry ears per plant and other characters

Average weight of dry ears per plant with average:	First planting	second planting	Both populations combined by method-B
weight of seed kernel	164±.037		
height of plant 15 days after planting	.115±.050	.206±.054	.1722±.0355
" " " 15 " " germination	.154±.050	.215±.053	.1901±.0364
" " " 30 " " planting	.206±.050	.137±.054	.1912±.0364
" " " 30 " " germination	.332±.047	.259±.053	.2514±.0354
weight " " 30 " " "	.332±.050	.290±.053	.3304±.0348
height " " to tip of leaf at emergence of tassel(*)	.461±.040	.506±.042	.
" " " to base of tassel at emergence of tassel	.450±.033	.557±.051	.5041±.0333
" " " to tassel base at maturity	.543±.036	.616±.035	.5624±.0258
number of days of tasseling	- .246±.043	-.452±.044	-.3560±.0330
" " " " silking	-. 369±.044	-.550±.039	-.4674±.0295

(*) These two populations were not combined because their **class intervals were different.**

VI

SUMMARY AND CONCLUSIONS

The purpose of this investigation was to determine some system of testing the producing power of F_1 strains of corn by growing the strains in the greenhouse.

It was thought that there might be a close relationship between certain of the physical characters of the corn plant at different stages of its development, and that these characters might be associated with high yielding power. In order to determine such relationships 673 F_1 strains of A-Tester Yellow Dent corn were planted in the greenhouse and also in the field.

In the greenhouse, on account of lack of space, two plantings were made. Because of the greater amount of sunlight the plants of the second planting grew much taller and more vigorously than those of the first planting. For this reason the data of the two plantings were computed separately and the average value of "r" was obtained by super-imposing-the-means method.

Positive and statistically significant correlations were found to exist between weight of seed kernel and the plant characters concerned, but the relationships were not strong enough to warrant the use of seed selection on the basis of its size. However, the data suggest that the larger size of seed would be of some value to the plant up to about 30 days after planting.

The data presented here show that there is a relationship between height of plant from one stage to the next in the greenhouse. These data also show a great degree of relationship between heights of plant in the field. But there is no evidence of relationship between heights in the greenhouse and heights in the field. Hence the height of plant in the greenhouse cannot be used as a criterion of selection for height of plant in the field.

The yield of dry ears per plant shows a positive and significant correlation with height of plant at different stages of its growth in the greenhouse, but the degree of relationship is not great enough to be considered as an index for selection.

A correlation of .504±.028 between the height of plant at emergence of tassel and dry weight of ears suggests that this height may be of some value for the elimination of low-yielding crosses before pollination.

The dates of appearance of tassel and silk show some relationship with weight of ears, but the value of "r" is not great enough to be used for predictable purposes.

The study of the F_1 strains of corn in the greenhouse could not be used as a means of determining the value of such strains in the field.

The writer is of the opinion that a similar

study, under field conditions,might reveal the true value of these characters.

ACKNOWLEDGEMENT

Acknowledgements are due to Professor E.E. Down and Mr. H.M. Brown for valuable suggestions on the layout of the experiment,for source of material and for criticisms and suggestions throughout the work. The author is indebted to Mr. F.H. Clark for criticisms on the manuscript; to Mr. J.A. Thompson for assistance in carrying out of the experiment. Thanks are due to Professor E.E. Down, Mr.H.M. Brown and Mr. F.H. Clark for the final review of the thesis.

VII.

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