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EAR CHARACTERS AND PRODUCTIVENESS OF CORN

Many teachers of agriculture arrange for corn shows as a part of the community activity of the high school department of agriculture. In some communities the winter corn show has become one of the traditional institutions which is planned for and looked forward to throughout the year. From the standpoint of education the corn shows have played a unique and important role in the development of corn growing in Minnesota. A query that naturally arises, however, in connection with the competitive exhibition of corn is one that is concerned with the relationship which exists between the visible characters which make a sample a prize winner evaluated in terms of corn score card and the productiveness of the sample and its progeny when grown under field conditions. Scientific investigations carried on during recent years at a number of experiment stations indicate that "within the conventional limits of a variety of corn, no variation in the visible structures or characters of a normal, healthy plant is a reliable index of the relative ability of its progeny to yield."*

It is the purpose of this issue of the *Visitor* to make available to teachers a summary of the results from experiments designed to show the relationship between ear characters and yield of corn. In doing this there is no thought of discouraging corn shows because we believe they have great educational value. The data presented are designed to clear up the apparent misunderstanding regarding the possible value of show corn for breeding purposes. With this idea in mind, Mr. F. H. Steinmetz, member of the staff of the farm crops division, University of Minnesota, has prepared the following brief summary of recent investigations by experiment station workers. A. M. F.

The Results of Seed Corn Selection by Use of the Score Card

Formerly the method recommended by various experiment stations for the selection of seed corn was based upon score cards of various types. The use of these score cards has been brought into question by numerous investigators, and at present there are ample data to indicate that the use of such a method for seed corn selection has not brought satisfactory returns expressed in yields per acre.

At the Nebraska station, corn investigations have been carried on for many years, one phase of which has been a study of the score card type of seed corn. Table I is a copy of Table 49 taken from the Nebraska Agricultural Experiment Station Research Bulletin 20.

TABLE I.—RELATION OF EAR TYPE TO YIELD OF CORN
(Annual Bulk Selection of Nebraska White Prize) six years, 1914-1917, 1920-1921

Type of Ear Planted	Yield of Grain Per Acre						
	1914	1915	1916	1917	1920	1921	Average
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
1. Long, large, rough	30.0	65.3	64.4	45.9	55.2	64.0	54.1
2. Short, large, rough	44.4	68.9	65.1	49.9	51.5	63.8	57.3
3. Short, slender, smooth	45.0	72.6	60.1	49.2	50.4	65.5	57.1
4. Long, slender, smooth	48.7	66.4	65.2	54.9	56.0	63.2	59.1
5. Ordinary Nebraska White Prize	48.7	64.8	65.5	53.5	53.7	63.7	58.3

The author makes the following comment relative to the above data:

"In the six-year comparison with long, slender, smooth ears, the long, large, rough ears averaged 5.0 bushels less per acre, ripened four days later, and had a 4.7 per cent greater shrinkage of ear corn. Short, slender, smooth ears and short,

* W. C. Etheridge. Characters Connected with the Yield of the Corn Plant. Research Bulletin 46, University of Missouri, Columbia.

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large, rough ears yielded pactically alike, and intermediate between the other two types. The long, slender, smooth type of ear surpassed all the others and yielded 0.8 bushel more than the original corn, which is a natural mixture of rough, smooth, and intermediate types. These data do not indicate what difference would have resulted from prolonged continued selection."

Table II, which is also taken from the Nebraska Agricultural Experiment Station Research Bulletin 20, gives a similar comparison for another variety.

TABLE II.—LONG, SMOOTH COMPARED WITH STANDARD MEDIUM ROUGH TYPE OF REID'S YELLOW DENT. 1905-1910.*

Ear Type	Yield of Grain Per Acre						
	1905	1906	1907	1908	1909	1910	Average
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Long, smooth type	69.7	47.2	69.9	56.8	37.9	62.6	57.3
Standard medium rough type	59.4	51.4	64.1	51.2	35.6	58.4	53.3

The author makes the following comment on the above table:

"The smooth surpassed the rough type 4.0 bushels per acre. This was a test of continuous selection in which seed for the smooth type was repeatedly selected from the smooth type of the preceding year."

Investigations at the Kansas Experiment Station

The following table gives a summary of the tests made at Kansas Station from 1905 to 1909, inclusive, taken from the Journal of the American Society of Agronomy, Vol. 8, pp. 188-196, 1916.

TABLE III.—A SUMMARY OF DATA ON THE RELATIONSHIP BETWEEN AVERAGE LENGTH OF EAR, AVERAGE CIRCUMFERENCE OF EAR, INDENTATION OF KERNEL, AND AVERAGE YIELD

Comparison	Average	No. of Years 1905-09	No. of Varieties	Average Yield
Relation of length of seed ear to yield	Length			
Long ears	9.32 in.	5	9	48.18
Medium ears	8.69 in.	5	9	48.45
Short ears	8.11 in.	5	9	48.18
Relation of circumference to yield	Circum.			
Large ears	7.36 in.	5	9	47.93
Medium ears	7.01 in.	5	9	49.33
Small ears	6.60 in.	5	9	49.58
Relation of indentation to yield				
Very rough	.....	5	8	49.22
Medium rough	.....	5	8	52.59
Smooth and wrinkled dent	.....	5	8	53.46

TABLE IV.—YIELDS FROM SEED EARS WITH WELL FILLED, MEDIUM FILLED, AND POORLY FILLED TIPS

Character of Tips	No. of Ears	Average Yield
Well filled	308	51.65
Medium filled	478	51.76
Poorly filled	216	51.77

TABLE V.—YIELDS FROM SEED EARS WITH WELL ROUNDED, PARTIALLY ROUNDED AND NOT ROUNDED OR OTHERWISE POOR BUTTS

Character of Butts	No. of Ears	Average Yield
Well rounded	346	50.66
Partially rounded	423	50.96
Not rounded or otherwise poor	168	51.04

* Data for the first four years taken from Nebraska Agricultural Experiment Station Bulletin No. 112, by Montgomery.

In conclusion the author says, "The data available indicate that certain ear characters have been given more consideration than their worth as related to yield warrants, while other characters have been emphasized that may actually tend to decrease the yields. Many more data relative to the relation of ear characters to yield are needed, especially regarding those characters whose correlation with yielding capacity might vary according to conditions of soil and climate. It is a well-known fact that under Kansas conditions comparatively smooth types of corn produce better under adverse conditions than the roughly indented types. It is also well known that deep kerneled varieties do not produce as well on thin upland soils as the more shallow grained varieties. In western Kansas, where moisture is usually the limiting factor in growth, comparatively smooth, shallow kerneled varieties of corn produce best. Evidently certain ear characters that are associated with high yields under favorable conditions for corn may or may not be correlated with maximum production under comparatively poor conditions for this crop."

Results from Experiments at the Ohio Experiment Station

At the Ohio Agricultural Experiment Station similar critical investigations have been carried on in relation to the use of the standard score card for seed selection. A summary of data reported in Ohio Experiment Station Bulletin 282, is presented in Tables VI and VII.

TABLE VI.—THE RELATION OF PROMINENT EAR CHARACTERS TO YIELD

	No. Years Average	Yield in Bushels Per Acre
Long vs. short ears		
Long	10	69.55
Short	10	68.16
Cylindrical vs. tapering ears		
Cylindrical	9	66.64
Tapering	9	68.29
Bare vs. filled-tipped ears		
Bare	8	62.42
Filled	8	62.76
Rough vs. smooth dented ears		
Rough	7	63.56
Smooth	7	65.32
High vs. low per cent gain		
High	6	64.64
Low	6	65.06

TABLE VII.—COMPARISON OF YIELD WHEN THE SEED USED WAS TAKEN FROM DIFFERENT PARTS OF THE EAR

Seed from	Yield per Acre		Per cent		
	Grain, Bu.	Stover, Lbs.	Barrenness	Full-sized Ears	Nubbins
Butts	58.86	2,848	10.3	66	34
Middles	59.27	2,925	10.4	64	36
Tips	58.70	2,974	10.6	65	35

The data presented in the above tables indicate no significant correlation between seed ear character and yield.

The Ohio Experiment Station also reports in Experiment Station Bulletin 282 the results from a study of the relation of the number of rows per ear to the yield and character of the progeny. Five consecutive crops were grown and after the first year the selection was continuous. The corn used in this test was 14, 16, 18-rowed Clarage corn. The results are summarized in Table VIII.

TABLE VIII.—THE RELATION OF NUMBER OF ROWS PER EAR TO YIELD AND CHARACTER OF PROGENY

Year	Bushels Corn Per Acre								
	Wooster (shelled corn)			Germantown (ear corn)			Carpenter (ear corn)		
	14	16	18	14	16	18	14	16	18
1910	40.93	41.45	40.07	60.39	62.48	62.20	43.41	70.48	69.77
1911	73.44	73.63	71.25	61.34	56.25	50.64	31.16	30.16	24.31
1912	61.07	60.37	61.63	53.10	49.56	47.65	64.00	60.19	55.82
1913	68.83	66.25	69.42	53.75	53.61	54.75	....	....	....
1914*	59.13	56.03	57.39	59.22	57.79	55.91	....	....	....
Five-year av.	60.86	59.55	59.95	57.56	55.94	54.22	46.19	53.61	49.97

* Ear corn reduced to 15 per cent moisture

Relative to the 14, 16, 18-rowed comparison, the author comments as follows:

"The seed being Wooster grown, originally, as well as during the test, has doubtless been better adapted to Wooster conditions and the results secured at Wooster are probably the more reliable."

Experiments at University Farm, Minnesota

At the Minnesota Experiment Station critical tests were carried out over a period of years at various places within the state in order to determine whether a correlation exists between the ear type and the yield. Table IX (compiled from tables in Minnesota Experiment Station Bulletin 174) shows the results of the investigation at the Minnesota Experiment Station. The variety of corn used was Minnesota No. 13.

TABLE IX.—THE RELATION BETWEEN EAR TYPE SELECTION AND YIELD IN CORN

Average	Average No. of Years	Lower Half	Upper Half
Relation of length of ear to yield	6	57.7	58.3
Relation of weight of ear to yield	6	57.5	58.1
Relation of shelling percentage to yield	6	57.6	58.1
Relation of circumference to yield	6	57.8	57.6
Relation of butts to yield	8	57.5	57.4
Relation of tips to yield	8	57.4	57.6
Relation of kernel uniformity to yield	8	57.2	57.5
Relation of maturity to yield	5	56.3	56.3
Relation of total score to yield	8	57.2	57.9

In the general discussion of results, the authors make the following statement:

"By close and long-continued selection a similarity of type may be obtained. Such similarity is due to the fact that the selection tends toward the production of a variety in which the inheritance for the selected characters approaches the conditon in self-fertilized plants. That is to say, for these characters the male and female reproductive cells tend to become of like nature."

Experiments at Cornell

Love and Wentz have investigated the correlation between ear character and yield in corn (Journal of the American Society of Agronomy, Vol. 9, pp. 315-322). As a result of their investigations, the following conclusions are drawn:

1. "The characters of length, ratio of tip circumference to butt circumference, average circumference of cobb, weight, average weight of kernels, number of rows of kernels, and average length and width of kernels on the seed ears do not show correlations significant enough to be of value in judging seed corn.

2. "The data indicate a slight negative correlation between percentage of grain in the seed ear and yield, meaning that possibly ears containing a low percentage of grain yield higher than ears with a high percentage of grain.

3. "The average circumference of the seed ear is the only character that shows any significant relation to yield.

4. "The judge at a corn show or the farmer in selecting his seed corn cannot pick the high-yielding seed ears when judging from the outward characters of the ears. It is evident that the points emphasized on a score card are of no value for seed ear purposes and are entirely for show purposes."

The Old vs the New Conception of the Relation of Ear Characters to Corn Judging

Richey, Agronomist in Charge of Corn Investigations, Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C., in a paper read at the joint meeting of geneticists interested in agriculture and Section O of the American Association for the Advancement of Science held at Washington, D. C., December 29, 1924, called attention to the former concept with regard to the value of corn judging by quoting the following from a book published in 1903:* "The object of corn judging is to compare samples of corn by a uniform standard in order to determine the best sample for seed, and by best seed corn is meant that which will yield the most corn of the highest quality either for feeding

* Manual of Corn Judging.

or for market, and is consequently the most profitable to grow. The method consists in comparing the samples of corn with the standard scale of points which is supposed to contain all of the qualifications of the best seed corn, viz.:

"First, those points that insure high quality for consumption, such as soundness, maturity, etc.

"Second, such as insure good yield, as size, uniformity, shape of ears, shape of kernels, well filled butts and tips, per cent of corn, etc.

"Third, such as insure a perfect stand, as the per cent and vigor of germination.

"Fourth, if the sample be a purebred variety, such as trueness to color and type and the characteristics of that variety.

"Fifth, the value of the sample for feeding or manufacturing purposes, such as the comparative per cent of oil, protein, and starch in its composition."

In contrast with this point of view, the following statements are quoted from Mr. Richey's paper: "The conclusion reached as a result of these investigations has been practically unanimous that the slight differences in physical characteristics found among reasonably good seed ears are of no value in determining their relative productiveness.

"The relations indicated by the experimental data appear to warrant the recommendation to select longer, heavier ears, with proportionately heavy cobs, and with relatively few rows of wide, thick kernels as a means of obtaining a supply of seed corn for general planting. With the possible exception of number of kernel rows, these relations are of size rather than form. There is nothing in the experimental evidence to indicate that productiveness is correlated closely enough with the physical characteristics of good seed ears to permit scoring samples for productiveness on the basis of their appearance. Consequently, the superiority of an exhibit in a show should be taken as evidence of the ability of the exhibitor to produce and select show corn rather than as evidence of the value of the winning sample itself for breeding purposes.

"Summarizing, it seems reasonable to conclude (1) that selecting longer, heavier ears, with proportionately heavy cobs and relatively few rows of wide, thick kernels is warranted as a means of obtaining a supply of good seed for general planting; (2) that attempting to judge the relative productiveness of samples of reasonably good ears on the basis of their appearance is not warranted; (3) that assuming that a winning sample is genetically more productive than a losing sample frequently is misleading and may be harmful; and, therefore, (4) that winning in a corn show should be taken for what it is, namely, evidence of ability to grow good corn and patience to select a good sample."

BIBLIOGRAPHY

1. Cunningham, C. C. The Relation of Ear Characters of Corn to Yield. Journ. Amer. Soc. Agron., 8:188-196. 1916.
2. Etheridge, W. C. Characters Connected With the Yield of the Corn Plant. Missouri Agr. Expt. Sta. Res. Bul. 46. 1921.
3. Garrison, H. S., and Richey, F. D. Effects of Continuous Selection for Ear Type in Corn. U. S. D. A. Bul. 1341. 1925.
4. Kiesselbach, T. A. Corn Investigations. Nebr. Agr. Expt. Sta. Tech. Bul. 20. 1922.
5. Olson, P. J., Bull, C. P., and Hayes, H. K. Ear Type Selection and Yield in Corn. Minn. Agr. Expt. Sta. Bul. 174. 1918. (Out of print.)
6. Love, H. H., and Wentz, J. B. Correlations between Ear Characters and Yield in Corn. Journ. Amer. Soc. Agron., 9:315-322. 1917.
7. Montgomery, E. G. Experiments With Corn. Nebr. Agr. Expt. Sta. Bul. 112. 1909.
8. Richey, F. D. Corn Judging and the Productiveness of Corn. Jour. Amer. Soc. Agron., 17:313-318. 1925.
9. Smith, L. H., and Brunson, A. M. An Experiment in Selecting Corn for Yield by the Method of the Ear-Row Breeding Plot. Ill. Agr. Expt. Sta. Bul. 271:567-583. 1925.
10. Williams, C. G., and Welton, F. A. Corn Experiments. Ohio Agr. Expt. Sta. Bul. 282. 1915.

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