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Agricultural Experiment Station

BULLETIN No. 271

AN EXPERIMENT IN SELECTING CORN FOR YIELD BY THE METHOD OF THE EAR-ROW BREEDING PLOT

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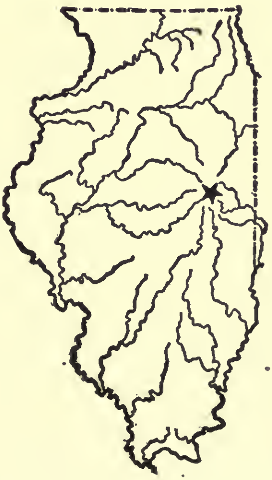

URBANA, ILLINOIS, NOVEMBER, 1925

SUMMARY

The possibility of improving the yield of corn by continuous ear-row selection has been rather generally assumed, and no little effort has been expended in attempting to produce higher yielding strains thru one or another of the various possible modifications of this method of breeding.

The remarkable results in altering, thru ear-row breeding, certain special characters such as protein and oil content of the grain and height of ear on the stalk, led to the assumption that yield might be influenced by a similar process of selection. In view of a doubt as to whether breeding for these special characters and breeding for yield represent truly analagous cases, it seemed desirable to secure some actual experimental evidence. To this end a test was made covering ten years of selection for yield by the method of the ear-row breeding plot.

The results of this investigation led to the conclusion that the simpler method of mass selection, that is, picking seed ears from standing stalks in the field, ordinarily will be just as effective in improving the yield as the more complicated method of continuous ear-row breeding.

The experiment involved the use of an unnamed variety of no particular breeding but adapted to the region. A high-yield and a low-yield breeding plot were founded upon the basis of the relative productiveness of the seed ears as determined by a preliminary ear-row test. Continued selection in these two opposite directions resulted in a marked separation of the two strains with respect to yield. The High Yield strain, however, did not significantly surpass in yield a control strain propagated from the original stock by careful field selection without pedigree breeding.

It appears, therefore, that the difference in productiveness between the High Yield and Low Yield strains was brought about mainly thru a decrease in the Low Yield strain.

AN EXPERIMENT IN SELECTING CORN FOR YIELD BY THE METHOD OF THE EAR-ROW BREEDING PLOT

By Louie H. Smith and Arthur M. Brunson[a]

THE PROBLEM

Many years ago this Experiment Station demonstrated in a striking way the effect, on various special characters in corn, of ear-to-row, or "ear-row," selection. By this method the chemical composition of the grain has been so modified that strains of high and of low protein content, as well as of high and of low oil content, have been produced from a single original variety.[8] Likewise, habits of growth have been influenced to produce strains bearing ears high on the stalk and low on the stalk, according to the direction of the selection, and in similar manner a strain bearing erect ears and another bearing declining ears have been produced by selection in opposite directions.[9]

Following these demonstrations the question arose whether the productive capacity of the corn plant might not likewise be modified by a similar process of continuous selection. A number of seed corn growers, assuming that this would be the case, undertook to improve their varieties by systematic ear-row selection. After working along this line for a few years, some of these breeders became doubtful whether they were making any progress. Unfortunately, they had failed for the most part to plan a check by which a comparison of the selected strains could be made with the original unselected stock.

In view of the dearth of experimental evidence at the time the present investigation was undertaken, as to the efficiency of the ear-row system as a means of improving the yield of corn, it seemed desirable to test the matter by a carefully checked experiment. This bulletin presents the data obtained in an experiment at this Station extending over a period of ten years and includes a brief review of work done at other stations.

INVESTIGATIONS AT OTHER EXPERIMENT STATIONS

Published results of investigations dealing with this particular phase of corn breeding are rather meager, but a summary of the experience of different investigators would seem to show that the ear-row system of selection which has been so effective in influencing special characters in

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corn does not apply with the same success to that exceedingly intricate complex of characters that determines yielding capacity.

Montgomery,[5] working at the Nebraska Experiment Station, reported after the first few years of an ear-row breeding-plot experiment an apparent gain by the use of seed selected in this way over seed representing the original stock. According to a later account of this same experiment by Kiesselbach,[3] however, it appears that the gain thus obtained in the earlier years of the work was subsequently lost.

Noll[6] described some experiments at the Pennsylvania Station in which he compared yields of seed produced by ear-row breeding with ordinary field-grown seed of the same variety. The results on the whole indicated no consistent gains by the use of breeding-plot methods.

Hume,[2] of the South Dakota Station, presented data based upon relative yields of rows within the breeding plot, which apparently indicated to him that some improvement attributable to the ear-row selection had been effected; but when seed from these same breeding plots was brought into a variety test series, the comparisons failed to show any convincing evidence of such improvement.

More favorable results from a somewhat similar method of breeding are shown by Williams and Welton,[12] of the Ohio Station. Of twenty strains produced under a breeding-plot system, eighteen yielded more than the parent stock, the increases ranging from about 1½ bushels to 11 bushels an acre.

Hayes and Alexander,[1] of the Minnesota Station, have recently published an account of some experiments on the relative efficiency of different methods of seed-corn selection. In these experiments Montgomery's method of preliminary ear-row testing and Williams' method are compared with simple mass selection from the field. The authors express the following conclusion: "There seems to be little or no value, from the farmer's standpoint, of using the ear-to-row plan. Under any circumstances its continued use appears undesirable."

After a careful summary of the various published investigations, Richey,[7] of the U. S. Department of Agriculture, came to the following conclusion: "It seems probable that the yield of an entirely unselected or unadapted variety could be improved by a few years of 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."

PLAN OF THE PRESENT INVESTIGATION

In brief, the plan adopted in the present investigation included the following points: (1) the use of a well-adapted local strain which, in its immediate history at least, had not been subjected to systematic selection; (2) the use of a foundation stock extensive enough to insure a reasonably adequate sample of the various types represented in that strain; (3) provision for the continuation of a composite sample of all foundation ears by mass selection in an isolated field, in order to have a basis for comparison; (4) the determination of the relative potential productive capacity by means of a preliminary ear-row test of all foundation ears; (5) the employment of an isolated "High Yield" ear-row breeding plot originated from the remnant seed of the forty rows showing highest production in the preliminary ear-row test; (6) the employment of a corresponding "Low Yield" ear-row breeding plot started from the remnant seed of the forty rows showing lowest production in the preliminary ear-row test; (7) a comparison of annual yields of replicated plots planted from seed composites taken from their respective breeding plots, in this way measuring the effectiveness of the selection.

THE FOUNDATION STOCK

For the purpose of this experiment several bushels of ear corn of an unnamed yellow variety were obtained from a near-by farm. During the known history of the corn it had had no particular breeding other than crib selection of viable seed ears, and had been subjected to no close selection for type. Nine hundred ninety ears were finally taken from the lot to represent the original stock.

THE NON-PEDIGREE STRAIN

In order to measure progress in improving corn it is necessary that the selected strain be compared from year to year with the original stock. For the purpose of perpetuating the foundation strain, a composite lot of seed representing all the original 990 ears was taken. This strain was grown each year in an isolated field of several acres and propagated by simple mass selection. Each fall enough good seed ears were selected from the standing corn to plant the field the following year. This strain was designated as the Non-pedigree strain, as distinguished from the High Yield and Low Yield strains to be produced under pedigree[a] selection.

THE HIGH YIELD AND LOW YIELD STRAINS

The Preliminary Ear-row Test

Seed from each of the original 990 ears was planted in an individual ear-row in 1911 to determine its relative yielding capacity as a basis for the selection of remnant seed with which to start the High Yield and the Low Yield breeding plots. These rows were 33 hills long and were

[a]Strictly speaking, the High Yield and Low Yield strains should perhaps be referred to as representing partial pedigree selection, since the individual pollen parentage was not controlled.

planted two stalks to a hill. Every tenth row was planted from a composite lot of seed to serve as a check row. The field in which this test was planted proved to be lacking in uniformity of productiveness, as evidenced by the extremely wide fluctuations in yield. The range in the yield of the check rows was from 6.5 to 29.2 pounds a row. However,

TABLE 1.—YIELDS OF SELECTED ROWS IN THE PRELIMINARY EAR-ROW TEST OF 990 EARS OF FOUNDATION STOCK, AND THE YIELDS OF THEIR CORRESPONDING CHECK ROWS

Parent ears selected for *high* yield		Average of two nearest check rows	Parent ears selected for *low* yield		Average of two nearest check rows
Ear row No.	Weight of ear corn	Weight of ear corn	Ear row No.	Weight of ear corn	Weight of ear corn
	lbs.	*lbs.*		*lbs.*	*lbs.*
36	18.6	17.1	19	7.5	13.1
51	20.0	12.1	34	5.1	17.1
68	23.7	13.3	46	10.4	13.7
88	21.0	15.9	67	11.6	13.3
115	20.3	13.1	97	7.6	14.8
128	22.7	16.8	108	10.4	11.9
159	30.8	16.8	141	9.5	14.0
179	26.5	16.8	154	10.8	16.8
183	29.5	19.2	166	11.5	16.5
194	22.1	20.5	195	14.4	20.5
203	27.5	18.4	202	16.6	18.4
223	20.3	14.2	222	9.7	14.2
256	23.5	15.0	255	7.3	15.0
272	20.5	11.8	271	9.7	11.8
299	19.6	15.9	294	9.1	15.9
306	20.2	12.6	338	5.2	11.1
337	16.1	11.1	367	7.7	13.3
363	18.4	13.3	383	5.4	8.7
399	16.1	9.0	453	9.2	17.1
408	24.4	11.4	471	13.5	19.6
523	24.3	18.7	534	10.8	16.8
543	23.3	13.0	549	7.4	13.0
616	27.1	19.2	576	7.5	13.6
649	31.0	21.7	604	12.4	17.2
705	21.5	14.5	651	12.4	19.2
751	14.3	8.6	717	4.3	12.9
774	16.5	10.1	752	4.7	8.6
807	20.3	11.6	816	7.7	12.9
854	25.4	18.5	825	7.8	14.0
876	35.6	19.8	858	9.4	18.5
899	29.6	12.2	861	16.6	18.0
908	26.6	15.6	904	8.6	15.6
931	33.0	25.9	921	15.2	21.0
974	18.5	11.9	955	19.7	15.8
993	30.4	22.1	975	10.3	11.9
1006	32.6	24.1	984	10.7	18.6
1027	34.7	27.5	1007	18.5	24.1
1058	26.3	18.1	1047	10.7	16.3
1065	30.8	20.3	1059	14.5	18.1
1087	29.6	21.3	1088	17.9	21.3
Average	24.3	16.2	Average	10.5	15.6

forty rows were selected that were most productive as judged by the nearest check rows, and in similar manner 40 rows that proved to be low yielding were selected. The remnant seed from the ears used in planting these rows was taken as the foundation stock for the High Yield and Low Yield strains respectively.

The yields of these 80 selected rows in 1911, together with the averages of the corresponding check rows, are shown in Table 1. Altho the average of the check rows was almost the same for the two selections—about 16 pounds—the averages of the ear-rows selected for High Yield and for Low Yield differed widely, being 24.3 and 10.5 pounds respectively.

The Breeding Plots

The High Yield and Low Yield breeding plots consisted of 40 individual ear-rows each. The rows were at least 80 hills long, the hills being 39.6 inches apart. The seed was planted three grains in a hill and the stand thinned to two stalks a hill at about the time of the first cultivation. Every fifth row was planted from a composite lot of seed to serve as a check, and in order to prevent contamination in the breeding all plants in these check rows were emasculated by detasseling. In the breeding rows, all the plants in alternate halves of alternate rows were also detasseled, thereby excluding all self-fertilization and practically all sister-brother combinations between plants in the same row.

Shortly before harvest time each year, a search was made in the breeding plots for the most desirable plants from which to obtain seed for the following year. The most vigorous plants, with erect, sturdy stalks and well-developed ears and as free as possible from disease, were tagged in the detasseled portion of every breeding row. At harvest, the crop from each row was weighed separately. In the High Yield plot the tagged ears from the ten highest-producing rows were saved and from the Low Yield plot those from the ten lowest-yielding rows were retained. A germination test and subsequent inspection finally determined the four best ears from each of the ten selected rows in each plot, which constituted the forty ears with which to carry on the plot the following year. An attempt was made to tag only the best plants impartially in both the High Yield and the Low Yield breeding plots, in order that selection would be based entirely upon the yielding capacity of the row, the two plots having equal opportunity from the standpoint of the vigor of the parent plants.

Pedigree records were kept in such manner as to permit tracing the maternal ancestry of every seed ear planted thruout the ten generations of the experiment.

SPECIAL HIGH YIELD STRAIN

This strain originated from the High Yield plot described above, after the work had been under way for five years. It represents an attempt to overcome in some degree the obstacle to controlled breeding presented by the open-pollinating habit of the corn plant. Altho seed selected each year for high yield is confined to the highest-yielding rows, this seed may receive the inheritance of very inferior stock thru fertilization by pollen from lower-yielding, unselected rows.

With the Special High Yield strain, greater control was exercised over the pollen parent. The plan is based on the use of remnants of tested seed ears and follows essentially the system devised by Williams[11] of the Ohio Experiment Station. An ear-row test plot and a mating plot were planted each year. The ear-row test plot contained 80 rows planted from 80 individual ears produced in the mating plot of the preceding year and contained also 20 check rows interspersed at five-row intervals. Remnants of the nine most productive seed ears as determined by this test were carried into the mating plot the year following. This mating plot was made up of 12 rows, 8 of which were planted from individual seed ears and were detasseled. The other 4 rows were planted from a single ear and were allowed to produce pollen for the entire plot. In harvesting the mating plot, 80 ears were chosen from the detasseled rows to be tested in the ear-row plot of the following year.

In order to prevent the alternation of two separate strains in this system, the ear from which the four pollen-producing rows were to be planted was reserved for use in the mating plot the second year after its selection. In getting the system started it was necessary to modify it slightly by planting the pollen-producing rows with seed from the same ear two years in succession.

RESULTS: YIELDS OF THE VARIOUS STRAINS

Since the breeding plots for the High Yield and Low Yield strains, as well as for the Non-pedigree strain, were isolated in order to prevent contamination from other pollen, it was impossible to make any accurate

TABLE 2.—AVERAGE ANNUAL YIELDS OF THE VARIOUS STRAINS IN THE YIELD TEST PLOT
Bushels per acre

Year	High Yield strain	Low Yield strain	Non-pedigree strain	Special High Yield strain	Reid Yellow Dent
1913.......	41.3	38.0	36.7	....	37.5
1914.......	58.9	55.1	60.3	....	54.3
1915.......	58.3	52.7	56.0	....	54.6
1916.......	29.9	20.3	28.6	....	27.5
1917.......	70.9	64.3	71.5	....	61.3
1918.......	69.8	58.3	73.3	72.5	65.9
1919.......	77.9	70.0	73.2	75.2	61.7
1920.......	76.9	60.9	74.9	79.1	78.2
1921.......	68.8	45.7	61.2	63.4	61.1
1922.......	70.1	52.6	73.6	72.7	68.4

comparison of the relative productiveness of the strains from the yields obtained in those plots. Composite lots of seed from each strain were therefore planted each year in a yield test plot, where their productiveness could be compared under as similar conditions as possible. In the earlier years of the work these plots were duplicated, and in later years the replications were increased to four. In addition to the High Yield, Low Yield, Non-pedigree, and Special High Yield strains, the Station Strain of Reid Yellow Dent, as representative of a standard, high-yielding variety, was also included for the sake of comparison. A summary of the yields of these various strains is given in Table 2.

In attempting to measure the progress that may have resulted from these lines of selection, two methods of analysis are employed: (1) the annual yields of the various strains are divided into two five-year periods for comparison; and (2) a graphic and algebraic representation is made by means of fitted straight lines.

ANALYSIS BY FIVE-YEAR PERIODS

Dividing the ten years thru which the test continued into two periods of five years each, a measure of any progressive change in yield is obtained in which the annual fluctuations are largely ironed out. A summary of these comparisons is presented in Table 3.

TABLE 3.—COMPARISONS OF YIELDS OF DIFFERENT STRAINS, BY FIVE-YEAR PERIODS

Strains compared	Period	Difference in bushels per acre	Odds that difference is significant
High Yield over Low Yield	First 5 years	5.80	> 9999:1
	Second 5 years	15.17	> 9999:1
High Yield over Non-pedigree	First 5 years	1.27	3.1:1
	Second 5 years	1.42	3.4:1
Non-pedigree over Low Yield	First 5 years	4.53	34.6:1
	Second 5 years	13.75	> 9999:1
High Yield over Special High Yield	1918–1922	.09	1.1:1
High Yield over Reid Yellow Dent	First 5 years	4.58	216:1
	Second 5 years	6.85	37:1
Non-pedigree over Reid Yellow Dent	First 5 years	3.31	18:1
	Second 5 years	5.43	18:1

NOTE—The statistical measure used in the above table is that proposed by "Student" and further explained as to its adaptation to agronomic work by Love and Brunson.[4] The detailed data upon which this table is based are given in Tables A to F of the Appendix.

Comparing the High Yield with the Low Yield strain, it will be observed that the average annual difference increases from 5.80 bushels an acre in the first five-year period to 15.17 bushels in the second five-year period. Both these differences are highly significant. The increasing divergence of nearly 10 bushels an acre between the means of these two periods shows the possibility of effectively separating superior and inferior strains of corn from an ordinary variety by this means of selection.

In each of the same two periods the Non-pedigree strain produced almost as much as the High Yield. Indeed the small differences cannot be considered statistically significant in either of the five-year periods, as shown by the very small odds. The gain of the High Yield over the Non-pedigree strain is negligible; in other words, there was practically no change in the relative productiveness of the strains. Under the conditions of this experiment at least, the simpler method of mass selection carefully carried out would appear to be as effective in maintaining an ordinary variety of corn at a high level of production as is the more complicated and more expensive method of the pedigree ear-row plot.

The increases of the Non-pedigree over the Low Yield strain for the two periods are very similar to the corresponding differences of the High Yield over the Low Yield strain noted above. The close correspondence of the Non-pedigree strain to the High Yield strain would inevitably lead to this result.

Since the Special High Yield strain was not started until the fifth year of the experiment, we can compare it only during the last period. During that time the average yields of the High Yield strain and the Special High Yield strain were practically identical. Thus even the more complicated system of the Special High Yield plot resulted in no advantage.

Both the High Yield and Non-pedigree strains rather consistently outyielded the Experiment Station's strain of Reid Yellow Dent, and with both strains the increase was greater during the second period than during the first five years. The increase in the yield of the High Yield strain over Reid Yellow Dent is statistically significant, as significance is ordinarily measured, and that of the Non-pedigree strain over Reid Yellow Dent is possibly significant. If we may consider the productiveness of the Reid Yellow Dent to have remained constant thruout the experiment, the slight gains of the High Yield and Non-pedigree strains on this basis are of considerable interest.

Analysis by Fitted Straight Lines

The second method of studying the results of the experiment involves the fitting of straight lines to the annual yields by the method of least squares, a device frequently employed in statistical analyses where it is desired to show trends. The equations representing the lines are calculated in the form $y = mx + n$, where y equals the value of any ordinate (yield); x equals the value of any abscissa (crop year); n, the y-intercept; and m, the slope of the line. By using the annual yields displayed in Table 2, the following equations were calculated.

EQUATIONS FOR STRAIGHT LINES

Ten-Year Results	
High Yield	$y = 46.8873 + 3.4206\,x$
Low Yield	$y = 44.9800 + 1.5133\,x$
Non-pedigree	$y = 45.4254 + 3.4455\,x$
Reid Yellow Dent	$y = 42.0254 + 3.3388\,x$
Five-Year Results	
High Yield	$y = 74.4000 - 0.8500\,x$
Special High Yield	$y = 74.8600 - 1.1400\,x$

The annual yields, together with their fitted straight lines, are shown graphically in Figs. 1 and 2. It may be observed that the straight lines representing the High Yield and the Low Yield strains show a pronounced divergence. On the other hand, the lines for the High Yield

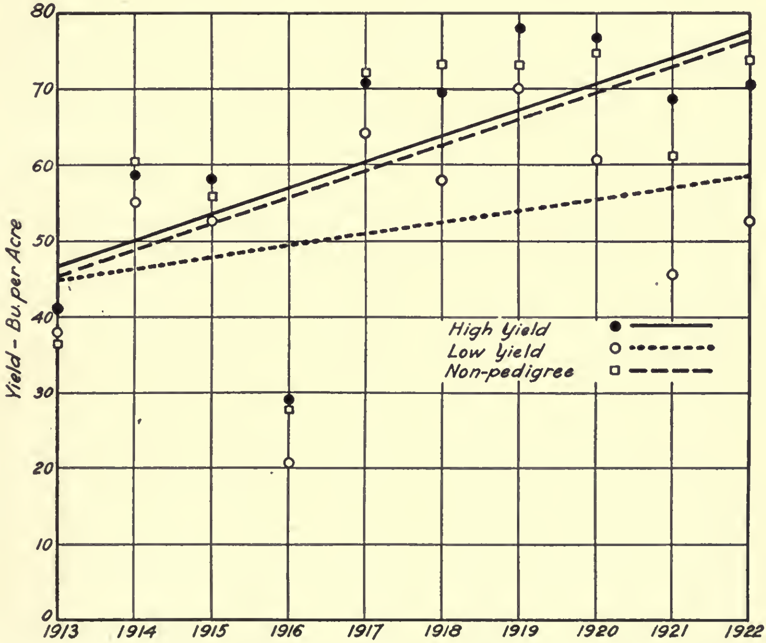

FIG. 1.—FITTED STRAIGHT LINES FOR HIGH YIELD, LOW YIELD, AND NON-PEDIGREE CORN SELECTIONS

strain and the Non-pedigree strain are practically parallel, with the former showing the higher yields thruout. The lack of divergence between these lines suggests that perhaps the High Yield strain gained a slight superiority as a result of the first selection by the preliminary ear-row test, and maintained this advantage thereafter. In Fig. 2 the straight lines representing the High Yield strain and the Special High

Yield strain are nearly identical, indicating little difference in their relative performance.

DIRECTION OF STRAIGHT LINES

Strain	*Relative slope*	*Mean annual divergence, bushels per acre*
High Yield	3.4206	1.9073
Low Yield	1.5133	
High Yield	3.4206	0.0249
Non-pedigree	3.4455	
High Yield	3.4206	0.0818
Reid Yellow Dent	3.3388	
Non-pedigree	3.4455	0.1067
Reid Yellow Dent	3.3388	
High Yield (5 years only)	—0.8500	0.2900
Special High Yield (5 years only)	—1.1400	

Expressing these results numerically rather than graphically, and comparing the relative slopes in terms of mean annual divergence, we find a divergence between the High and Low Yield strains which reduced to the average annual basis amounts to 1.91 bushels an acre. In contrast to this, with the slopes of the High Yield and the Non-pedigree lines almost identical, the mean annual divergence is only .02 bushels an acre. Comparing the High Yield with Reid Yellow Dent, an average yearly gain of .08 bushels an acre is observed. A mean annual divergence of nearly .11 bushels an acre is noted in a comparison of the slopes of the Non-pedigree and Reid Yellow Dent strains. The relative slopes of the High Yield and the Special High Yield strains indicate that the Special strain, in comparison with the High Yield strain, was losing ground at the rate of .29 bushels an acre yearly.

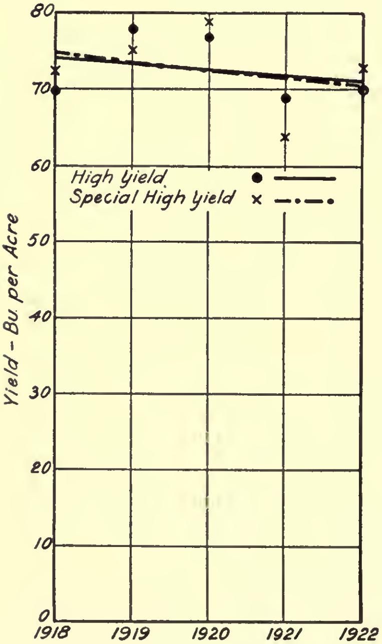

FIG. 2.—ANNUAL YIELDS AND FITTED STRAIGHT LINES FOR HIGH YIELD, LOW YIELD, AND NON-PEDIGREE CORN SELECTIONS

In general, the method of studying the data by fitted straight lines bears out in a striking way the conclusions reached in the preceding method of analysis, where the results of first and second five-year periods are compared.

DISCUSSION

The Non-pedigree strain was planned originally to represent the productiveness of the foundation stock and so furnish a basis for judging the performance of the pedigreed strains. For this purpose, the yielding capacity of the Non-pedigree strain should have remained constant for the duration of the experiment. It is observed, however, that there is a slight upward trend of the Non-pedigree strain when compared with Reid Yellow Dent. The superiority of the Non-pedigree strain over Reid Yellow Dent increased from 3.31 bushels an acre during the first five-year period to 5.43 bushels during the second five-year period. Similarly, the comparative slopes of the fitted straight lines show an increasing divergence of the Non-pedigree strain and Reid Yellow Dent amounting to an average annual increase of about .11 bushel an acre. Altho the number of comparisons is too small to make this slight improvement very significant, it would seem that the productive capacity of the Non-pedigree strain probably was slightly raised by good practices of mass selection.

In the ear-row selections a very pronounced divergence between the High Yield and the Low Yield strains occurred. Altho the High Yield strain thruout the experiment yielded slightly more than the Non-pedigree strain, the performances of the two strains were remarkably parallel. This forces the conclusion that the divergence between the High Yield and the Low Yield strains was due mainly to a decrease in the yielding capacity of the latter. Apparently ear-row breeding produced in the Low Yield strain an effect comparable to the changes produced in the physical and chemical properties of the corn plant by this method of breeding, but in the High Yield selection it failed to cause any significant change. The modified method of the Special High Yield plot was equally ineffective in the five years of its trial.

The reason for this failure to increase productiveness is not altogether clear. In part, it may be related to soil variability and the consequent difficulty of accurately determining the rows of highest yielding capacity, but this difficulty should apply equally in the Low Yield selection, where distinct progress was made in decreasing the yield. Again, the fact that a given factorial complex that makes for a high yield one season may not fit the conditions of the following season should also apply to the Low Yield selection, altho perhaps in a less degree. Probably one of the serious limitations in breeding for high production by ear-to-row selection lies in the effects of the unavoidable close breeding in a small plot. The great mass of available evidence concerning inbreeding in corn points consistently toward lowered yields whenever corn undergoes inbreeding. Altho precautions against inbreeding were taken, such as systematically distributing over the plot seed ears from a parent row, and detasseling all plants from which the seed ears were to be selected, it was inevitable that much close breeding should have taken place where four rows in any year traced back to a single row of the previous year.

The slight superiority of the High Yield strain over the Non-pedigree strain appears to have been present from the first and in all probability was the result of the initial selection of the forty remnant ears from the foundation stock based on their performance in the preliminary ear-row test. No further increase in productiveness over that of careful mass selection was obtained during ten years of ear-to-row breeding.

CONCLUSIONS

The outcome of this investigation leads to two conclusions concerning practical methods of corn breeding:

1. Continuous selection by means of the ear-row breeding plot cannot be recommended as a means of increasing the yield of a well-adapted variety of corn.

2. By continuous mass selection the yield of a well-adapted variety of corn can be maintained and perhaps somewhat increased.

The practical recommendation to the corn grower who desires to maintain the productiveness of his crop on a high plane, or possibly to increase his yields, is to use mass selection as the most effective simple method of selecting corn for yield. For a more complete discussion of such method the reader is referred to Circular 284[13] of this Station, in which the details of the method are described.

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APPENDIX

The tables in this Appendix show the annual yields of the plots in the variety tests, which were planted with a composite of seed produced in the breeding plots the previous year.

For the earlier years of the work (1913-16), when the plots were only duplicated, each yield shown in these tables represents one plot. In the later years (1917-21) each strain was represented by four plots and each yield is the average of two plots from two different series. For 1922 each yield represents but a single plot.

TABLE A.—HIGH YIELD VERSUS LOW YIELD
(Bushels per acre)

First five years				Second five years			
Year	High Yield	Low Yield	Gain H.Y. over L.Y.	Year	High Yield	Low Yield	Gain H.Y. over L.Y.
1913..........	43.7	42.7	1.0	1918.......	72.2	59.2	13.0
	39.0	33.3	5.7		67.3	57.5	9.8
1914..........	69.1	65.6	3.5	1919.......	80.8	72.0	8.8
	48.8	44.6	4.2		75.1	68.1	7.0
1915..........	61.5	56.0	5.5	1920.......	78.9	62.1	16.8
	55.1	49.4	5.7		74.8	59.7	15.1
1916..........	25.6	17.0	8.6	1921.......	73.7	50.6	23.1
	34.1	23.5	10.6		63.8	40.8	23.0
1917..........	72.5	67.9	4.6	1922.......	69.6	55.2	14.4
	69.3	60.7	8.6		70.7	50.0	20.7
Mean........	51.87	46.07	5.80	Mean......	72.69	57.52	15.17
σ............			2.67	σ..........			5.47
z............			2.17	z..........			2.77
Odds.........			>9999:1	Odds.......			>9999:1

TABLE B.—HIGH YIELD VERSUS NON-PEDIGREE
(Bushels per acre)

First five years				Second five years			
Year	High Yield	Non-pedigree	Gain H.Y. over N.P.	Year	High Yield	Non-pedigree	Gain H.Y. over N.P.
1913..........	43.7	36.3	7.4	1918.......	72.2	69.6	2.6
	39.0	37.1	1.9		67.3	77.0	−9.7
1914..........	69.1	61.2	7.9	1919.......	80.8	77.4	3.4
	48.8	59.3	−10.5		75.1	69.1	6.0
1915..........	61.5	55.9	5.6	1920.......	78.9	78.2	.7
	55.1	56.0	−.9		74.8	71.7	3.1
1916..........	25.6	27.3	−1.7	1921.......	73.7	67.0	6.7
	34.1	29.9	4.2		63.8	55.5	8.3
1917..........	72.5	75.1	−2.6	1922.......	69.6	75.4	−5.8
	69.3	67.9	1.4		70.7	71.8	−1.1
Mean........	51.87	50.60	1.27	Mean......	72.69	71.27	1.42
σ............			5.26	σ..........			5.36
z............			.24	z..........			.27
Odds.........			3.1 : 1	Odds.......			3.4 : 1

TABLE C.—NON-PEDIGREE VERSUS LOW YIELD
(Bushels per acre)

First five years				Second five years			
Year	Non-pedigree	Low yield	Gain N.P. over L.Y.	Year	Non-pedigree	Low yield	Gain N.P. over L.Y.
1913.........	36.3 37.1	42.7 33.3	−6.4 3.8	1918.......	69.6 77.0	59.2 57.5	10.4 19.5
1914.........	61.2 59.3	65.6 44.6	−4.4 14.7	1919.......	77.4 69.1	72.0 68.1	5.4 1.0
1915.........	55.9 56.0	56.0 49.4	−.1 6.6	1920.......	78.2 71.7	62.1 59.7	16.1 12.0
1916.........	27.3 29.9	17.0 23.5	10.3 6.4	1921.......	67.0 55.5	50.6 40.8	16.4 14.7
1917.........	75.1 67.9	67.9 60.7	7.2 7.2	1922.......	75.4 71.8	55.2 50.0	20.2 21.8
Mean........	50.60	46.07	4.53	Mean......	71.27	57.52	13.75
σ...........			6.16	σ..........			6.32
z			.73	z..........			2.18
Odds........			34.6 : 1	Odds.......			>9999 : 1

TABLE D.—HIGH YIELD VERSUS SPECIAL HIGH YIELD
(Bushels per acre)

Second five years			
Year	High Yield	Special High Yield	Gain H.Y. over S.H.Y.
1918.......	72.2 67.3	68.9 76.2	3.3 −8.9
1919.......	80.8 75.1	76.8 73.6	4.0 1.5
1920.......	78.9 74.8	82.2 76.0	−3.3 −1.2
1921.......	73.7 63.8	66.9 59.9	6.8 3.9
1922.......	69.6 70.7	74.2 71.3	−4.6 −.6
Mean.......	72.69	72.60	.09
σ..........			4.51
z..........			.02
Odds.......			1.1 : 1

TABLE E.—HIGH YIELD VERSUS REID YELLOW DENT
(Bushels per acre)

First five years				Second five years			
Year	High Yield	Reid Yellow Dent	Gain H.Y. over R.Y.D.	Year	High Yield	Reid Yellow Dent	Gain H.Y. over R.Y.D.
1913.........	43.7 39.0	42.7 32.3	1.0 6.7	1918.......	72.2 67.3	64.5 67.3	7.7 0.0
1914.........	69.1 48.8	58.7 49.9	10.4 −1.1	1919.......	80.8 75.1	61.7 57.3	19.1 17.8
1915.........	61.5 55.1	53.2 56.0	8.3 −0.9	1920.......	78.9 74.8	81.3 78.8	−2.4 −4.0
1916.........	25.6 34.1	23.4 31.5	2.2 2.6	1921.......	73.7 63.8	52.7 62.3	21.0 1.5
1917.........	72.5 69.3	65.7 59.5	6.8 9.8	1922.......	69.6 70.7	67.9 64.6	1.7 6.1
Mean........	51.87	47.29	4.58	Mean......	72.69	65.84	6.85
σ...........			4.11	σ..........			8.81
z...........			1.11	z..........			.78
Odds........			216 : 1	Odds.......			37 : 1

TABLE F.—NON-PEDIGREE VERSUS REID YELLOW DENT
(Bushels per acre)

First five years				Second five years			
Year	Non-pedigree	Reid Yellow Dent	Gain N.P. over R.Y.D.	Year	Non-pedigree	Reid Yellow Dent	Gain N.P. over R.Y.D.
1913.........	36.3 37.1	42.7 32.3	−6.4 4.8	1918.......	69.6 77.0	64.5 67.3	5.1 9.7
1914.........	61.2 59.3	58.7 49.9	2.5 9.4	1919.......	77.4 69.1	61.7 57.3	15.7 11.8
1915.........	55.9 56.0	53.2 56.0	2.7 0.0	1920.......	78.2 71.7	81.3 78.8	−3.1 −7.1
1916.........	27.3 29.9	23.4 31.5	3.9 −1.6	1921.......	67.0 55.5	52.7 62.3	14.3 −6.8
1917.........	75.1 67.9	65.7 59.5	9.4 8.4	1922.......	75.4 71.8	67.9 64.6	7.5 7.2
Mean........	50.60	47.29	3.31	Mean......	71.27	65.84	5.43
σ...........			4.83	σ..........			7.94
z...........			.70	z..........			.68
Odds........			29 : 1	Odds.......			29 :1

AUTHOR INDEX

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BULLETIN. URBANA
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