# BREEDING OF STRAINS OF A-TESTER YELLOW DENT CORN

THESIS FOR DEGREE OF PH. D.

KUO-MING LIU

1927

THESIS

Plant-breeding

Farm Crops

# BREEDING OF STRAINS OF A-TESTER YELLOW DENT CORN

Thesis

Respectfully submitted in partial fulfillment
for the Degree of Doctor of Philosophy

at

Michigan State College
of
Agriculture and Applied Science

-0-

Kuo-Ming Liu

1927

THESIS

## -ACKNOWLEDGMENT-

The writer wishes to acknowledge his indebtedness to Professor E. E. Down and Mr. H. M. Brown for their generosity in transferring him the material of the experiment which had been already under way, and their valuable suggestions and thorough criticisms of the following thesis. He is indebted to Mr. F. H. Clark for very helpful suggestions on the manuscript. He is also indebted to Mrs. Marian Brown for corrections of English in the manuscript. Appreciation is due Professor J. F. Cox, Dr. E. A. Bessey, and Dr. R. P. Hibbard for the final review of the thesis.

TABLE OF CONTENTS

## INTRODUCTION

The purpose of this work was to develop pure strains of a new corn called "A-tester Yellow Dent" to be used in the production of a possible commercial variety of such corn for the Michigan farmer. Such strains have already been derived by this experiment from crosses made between some of the strains which were used here for the corn breeding work and the A-tester corn of Professor R. A. Emerson of Cornell University. The latter is an inbred white flint corn having the genetic constitution aaCCRRyy, while the former are yellow dent corns whose compositions were found to be either AACCrrYY, or AACcrrYY, or AAccrrYY.

Here A is the anthocyanin factor, dominant to its recessive allelomorph(a), and aids in the development of color in the aleurone layer of the seed when the other factors C and R are present. The C factor dominant over its partner (c) is said to be a chromogen, a basic substance which, when acted on by the enzyme R in presence of A, is oxidized to a red color and to a purple color if another dominant factor, Pr, is present. The seeds, whose aleurone layer is either red or purple, will be termed "colored" in this thesis. If either A, C, or R is lacking, the aleurone layer is colorless, and hence these seeds will be designated as "colorless". Y and y are a factor pair which controls the yellow and white endosperm color, the former being dominant.

These strains of A-tester Yellow Dent corn have the composition

aaCCRR inherited from the A-tester and the yellow dent character (YY) from the mother strains. By having such constitution (aaCCRRYY), they can not escape from observation whenever they are contaminated with any common corn which contains the A factor. If they are pollinated accidentally, by pollen from any common corn in a neighboring field, the hybrid seeds will become colored due to the presence of A, C, and R factors where A comes from the pollen parent whether it has yellow or white endosperm. The hybrid seeds can be eliminated simply by discarding the colored seeds. The colorless ones can then be saved since they are always pure.

As it is now, if a pure yellow variety is contaminated by being pollinated with a white type, the grower can not know the same year that this has actually happened in his corn, as all hybrid seeds are yellow. He will not realize this situation until the next year's crop develops, when he sees a number of white grains appearing in his yellow corn, due to natural chance recombination. Under these circumstances, he will have a very hard time to eradicate all the white seeds because the yellow endosperm character is dominant over or covers up the white one and thus the white seeds will reappear each year whenever the yy condition is effected. His pure variety of yellow corn will deteriorate as seed stock.

Moreover, a contamination like this is a menace to his business, if the farmer is a seed-corn grower, since it will make him lose the confidence of his customers and hence, his market.

Also the contaminated ears, in most cases, could not get the first place or grade in the market and in shows. From this point of view, these newly developed strains, if they produce a promising variety, may benefit the farmer a great deal and solve this difficult problem of contamination.

## MATERIALS AND METHODS USED

The work was begun as a problem of the Experiment Station here by the late Professor F. A. Spragg in the year 1923 and was carried on by his associates in 1924 and until all materials were transferred to the writer in the fall of 1925. It is with gratitude that the writer acknowledges his indebtedness to Professor Spragg who was the originator and who laid down the foundation for this work.

Strains used in this investigation as the maternal material are listed in Table I-a. Three strains of M. A. C. (Ac 254), one strain of Michigan White Cap X Bailey (Ac 256), four strains of Duncan (Ac 234), and five strains of Bailey (Ac 128) are yellow dents with red cobs. There are two strains of M. A. C. and one strain of Nelson X Bailey (Ac 255) which are dented, red cobbed, but with red pericarps. One strain of Duncan (Ac 235),and seven strains of M.A.C. (Ac 254) which came from a cross of White Cobbed Golden Glow X White Cobbed Duncan, are yellow dented but white cobbed. All these strains were inbred or selfed for one or more years before used for this work as is shown in Table I-a.

The A-tester corn, which served as the paternal material, was obtained from Professor Emerson in 1922. It is shown in Table I-b. It is an inbred white flint corn with white cob and has been used by Professor Emerson and his students for testing the aleurone color factors. Its genetic constitution is definitely known as aaCCRR.[1] At the same time, the so-called C-tester and R-tester were also received. These testers have been named for the recessive factor present; consequently, the C-tester would be AAccRR, and the R-tester, AACCrr. Both are white dented and white cobbed.

The plant color of this A-tester and of this C-tester was green throughout the plant body. In other words, there was not even a trace of anthocyanic pigment in any part of these plants. It was proved that the A-tester carried the allelomorphic factor $R^gR^g$ as well as aa which causes no pigmentation (pages 67-99 ). The C-tester was found also to carry $R^gR^g$ and hence it was non-pigmented. Some of the R-tester plants showed some color in stalks, silks, glumes, and anthers, and so they carried $r^rr^r$ which causes such pigment. A few R-tester plants were found to be $r^gr^g$. However, only the $R^g$ factor of the A-tester is concerned in our work later on.

All self- or cross-pollination was carefully controlled. Bags of 12-pound size, square bottom, 40-pound weight No. 1 Kraft

---

1. The A-, C-, and R-tester had white endosperms and hence were yy in constitution. Hereafter this endosperm factor will be disregarded unless especially mentioned.

TABLE I-a. Showing the names, accession numbers, selection numbers, plat numbers, kernel color, cob color, years selfed and years intercrossed of the strains used in this investigation.

| Source or Name of variety | Accession Number | 1922 selection No. or Plat No. | 1923 plat No. | Color of kernel | cob | Years selfed | Years intercrossed |
|---|---|---|---|---|---|---|---|
| White Cobbed Duncan | 235 | 02600 | 30100 | yellow | white | 1920 | — |
| White Cobbed M. A. C. — White Cobbed Duncan / White Cobbed G. Glow | 235/239 254 | 02600/12901 | 30200 | " | " | 1921 | 1922 |
| White Cobbed M. A. C. | " 254 | 02600/12904 | 30300 | " | " | " | " |
| " " " " | " | 25202 | 30400 | " | " | " | " |
| " " " " | " | 25203 | 30500 | " | " | " | " |
| " " " " | " | 25303 | 30600 | " | " | " | " |
| " " " " | " | 25306 | 30700 | " | " | " | " |
| " " " " | " | 25312 | 30800 | " | " | " | " |
| Red Cobbed " " | " | 25205 | 30900 | " | red | " | " |
| " " " " | " | 25206 | 31000 | red | " | " | " |
| " " " " | " | 25207 | 31100 | yellow | " | " | " |
| " " " " | " | 25302 | 31200 | " | " | " | " |
| " " " " | " | 25313 | 31300 | red | " | " | " |
| Nelson X Bailey | 128/233 255 | 23000 | 31400 | " | " | 1917-1919/1920 | 1921 |
| Michigan White capped X Bailey | 128/137 256 | 23100 | 31500 | yellow | " | 1917-1919/1917-1920 | " |
| Red Cobbed Duncan | 234 | 23400 | 31600 | " | " | 1920-1922 | |
| " " " | " | 23701 | 31700 | " | " | " | |
| " " " | " | 23705 | 31800 | " | " | " | |
| " " " | " | 23802 | 31900 | " | " | " | |

TABLE I-a continued.

| Source or Name of variety | Accession Number | 1922 selection No. or Plat No. | 1923 plat No. | Color of kernel | cob | Years selfed | Years intercrossed |
|---|---|---|---|---|---|---|---|
| Bailey | 128 | 24101 | 32000 | yellow | red | 1917-1919 1922 | - |
| " | " | 24202 | 32100 | " | " | 1917-1920 1922 | 1921 |
| " | " | 24204 | 32200 | " | " | 1917-1919 1922 | |
| " | " | 24301 | 32300 | " | " | 1917-1922 | |
| " | " | 24302 | 32400 | " | " | 1917-1922 | |

TABLE I-b. Showing names, accession numbers, plat numbers, kernel color and cob color of Emerson's aleurone-color testers.

| Name of variety | Accession Number | 1923 Plat No. | Color of Kernel | Cob |
|---|---|---|---|---|
| A-tester | 247 | 32500 | white | white |
| C-tester | 248 | 32600 | " | " |
| R-tester | 249 | 32700 | " | " |

paper were used for covering the tassels while transparent glassine paper bags (6" x $2\frac{1}{2}$") were used to cover the ear before the silks emerged. Two men, working together, did the pollinating at the time of crossing and selfing. One man took off the tassel bag with its fresh supply of pollen grains and shook them onto the silks cautiously, as soon as the other man quickly tore off the top of the ear bag. The latter fastened the tassel bag over the ear with No. 3 gem paper clip, while the former labeled the plant, crossed or selfed, with a paper tag. Only one pollination to an ear was made, in order to diminish the chances of contamination. Notes were taken on plant characters and growth in the field.

After harvest counts of colored and colorless kernels on the selfed ears were made in the laboratory and then these ears were classified into groups, according to their Mendelian ratios. Notes were taken on ear characters, such as: color of kernels, color of cobs, length of ear, length of kernels, indentation, circumference of tip and butt, weight of ear, and number of rows, etc. All these notes were entered into the selection book together with the proper selection number of the ear.

It might be well to say here a few words concerning the recording system which is used by this station, in order to help the reader trace the records in this paper. The system consists of three parts, i.e., the accession book, the plant breeding register, and the selection book.

Each crop has its series of accession numbers. Any material

of one variety or one cross collected from one source has an accession number assigned to it according to the order in which it is obtained. In the accession book, besides the accession number, the name of the variety, from whom received, source, date received, and date of entering the nursery, are also recorded for each material.

Before planting time, each lot of seeds from one variety or from one selected ear is registered in the plant breeding register and given a plat number. The plat number consists of five or more figures. The first or left hand figure indicates the year in which the material is harvested. The last, or right hand, two figures designate the number of individual selections, up to 99 which are made in that plat. The digits between the first one and the last two figures indicate the number of that particular plat. For instance, 25306 in Table I-a is the selection number of the sixth selection of plat 53 of the crop year of 1922. If the number of selections exceeds 99, other plat numbers are assigned to that plat to care for the extra selections. In the breeding register, the plat number, the selection number, if any, and the accession number, are all recorded in order to identify the individual material in the test. In the selection book only the individual selection number and accession number are noted. This system has been followed throughout this experiment.

A word of explanation is necessary regarding the methods used in calculating the biometrical constants given in this paper.

The formula used for probable error of a Mendelian ratio is P. E. $= 0.6745\sqrt{pqn}$, where n is the total number of individuals in the experiment, p is the percent of one member of the ratio, and q is the percent of the other member of that ratio. Thus in a 3:1 ratio, p = 75% (.75) and q = 25% (.25); and in a 9:7 ratio, p = 56.25% (.5625) and q = 43.75% (.4375) and so forth. The probable error determined by this formula was compared with the actual deviation from the theoretical expectancy.

For tests of closeness of fit in cases where the number of classes was more than two, use was made of the method known as $X^2$ suggested by Harris (1912).

For some statistical study in this work the following formulas were used:

| | |
|---|---|
| $M = \frac{\Sigma f V}{n}$ | Here, M = mean; V = a variable; f = class frequency; $\Sigma$ = summation; n = total number of variables. |
| $\sigma = \sqrt{\frac{\Sigma d^2}{n}}$ | $\sigma$ = standard deviation; d = deviation from the mean. |
| $C.V. = \frac{\sigma}{M} \times 100$ | C.V. = coefficient of variability. |
| $E_s = 0.6745\,\sigma$ | $E_s$ = probable error of single determination. |
| $E_m = \frac{0.6745\,\sigma}{\sqrt{n}}$ | $E_m$ = probable error of mean. |
| $E_{A-B} = \sqrt{E_A^2 + E_B^2}$ | $E_{A-B}$ = probable error of difference between variables A and B if no correlation exists between these two variables. |

## EXPERIMENTAL RESULTS FROM THE $F_1$ GENERATION

In the summer of 1923, twenty-four strains of different varieties used as the female parents ($P_1$) were crossed in the field with the A-tester, which served as the pollen parent. Six crosses were made with each strain. The results are listed in Table II. In the same way these strains were crossed with the C-tester and with the R-tester. Unfortunately, the exact results from these two series of crosses were lost.

As indicated in Table II, all these strains X the A-tester, except one strain, plat 31500, which failed in cross-pollination, resulted in a total of 64 hybrid ($F_1$) ears all of whose kernels were colored. The color of these $F_1$ ears was caused by the complementary action of the three dominant aleurone color factors A, C, and R. The factor A in the hybrids must have come from the side of the female parents since the male parent, A-tester, is known to have contributed no A factor but only the C and R factors to its offspring. Therefore, all the female parental strains, used in the test, contained AA in their constitution.

Information[1] obtained indicated that all hybrid ears resulting from crosses between the strains in plats 31400 and 31700 to 32400 with the C-tester (AAccRR) were colorless. Obviously, these strains must have been cc in order to produce the colorless progenies, because A and R without C will not give the colored aleurone

1. Such information was furnished by Mr. H. M. Brown, Research-Assistant in the Farm Crops Department of the Michigan State College.

**TABLE II.** Showing the number of colored hybrid ears ($F_1$) which resulted from crosses of the strains used in this experiment with the A-tester, and their $F_1$ selection numbers.

| Source or Name of Variety | Accession No. | 1923 Plat No. or Female parent | | A-tester or male parent | No. of colored ears produced by crosses | Selection No. of $F_1$ ears |
|---|---|---|---|---|---|---|
| White Cobbed Duncan | 235 | 30100 | X | 247 | 2 | 301150,-151 |
| White Cobbed M.A.C. | 254 | 30200 | X | " | 2 | 30255,-56 |
| " " " | " | 30300 | X | " | 3 | 30331,-32,-33 |
| " " " | " | 30400 | X | " | 2 | 30408,-09 |
| " " " | " | 30500 | X | " | 3 | 30513,-14,-15 |
| " " " | " | 30600 | X | " | 2 | 30604 |
| " " " | " | 30700 | X | " | 2 | 30702,-03 |
| " " " | " | 30800 | X | " | 2 | 30806,-07 |
| " " " | " | 30900 | X | " | 1 | 30904 |
| " " " | " | 31000 | X | " | 3 | 31008,-09,-10 |
| " " " | " | 31100 | X | " | 3 | 31111,-12,-13 |
| " " " | " | 31200 | X | " | 5 | 31203,-04,-05,-06,-07 |
| " " " | " | 31300 | X | " | 4 | 31306,-07,-08,-09 |
| Nelson X Bailey | 255 | 31400 | X | " | 3 | 31430,-31,-32 |
| Mich. Wh. Cap X Bailey | 256 | 31500 | X | " | 0 | - - - |
| Red Cobbed Duncan | 234 | 31600 | X | " | 3 | 31604,-05 |
| " " " | " | 31700 | X | " | 2 | 31703,-04 |
| " " " | " | 31800 | X | " | 2 | 31802,-03 |
| " " " | " | 31900 | X | " | 5 | 31901,-02 |
| Bailey | 128 | 32000 | X | " | 3 | 32001,-02 |
| " | " | 32100 | X | " | 2 | 32101,-02 |
| " | " | 32200 | X | " | 2 | 32201,-02 |
| " | " | 32300 | X | " | 4 | 32301,-02 |
| " | " | 32400 | X | " | 4 | 32407,-08,-09,-10 |
| Total - - - - - - - - - - - - - - - - - | | | | | 64 | |

in the hybrid seeds. Of the hybrid ears resulting from crosses of the strains in plats 30100 to 31300, 31500, and 31600 with the C-tester, some were all colored and some were only partially colored. This indicated that some of these strains were CC and the other Cc.

The information also stated that these 24 strains X the R-tester (AACCrr) resulted in only colorless hybrid ears. Evidently, all these strains lacked the factor R and hence they were rr. The aleurone color can not be produced in this case as only two dominant factors, A and C, were present in the hybrids.

Summing up the above: all these strains used in this investigation are supposed to be of three types - some of them AACCrr, some AACcrr, and some AAccrr. The whole situation can be understood more clearly by the following factorial diagram, which is in accordance with the above observations and verified by the results of the $F_2$ and $F_3$ generations.

Types of these strains used in this investigation.

| Paternal parent | Maternal parent | | |
|---|---|---|---|
| | AACCrr | AACcrr | AAccrr |
| | | Progeny | |
| A-tester - aaCCRR | Colored | Colored | Colored |
| C-tester - AAccRR | Colored | Half colored<br>Half colorless | Colorless |
| R-tester - AACCrr | Colorless | Colorless | Colorless |

## BREEDING BEHAVIOR IN THE $F_2$ GENERATION

Fifty-four $F_1$ ears were selected. Seeds from these ears were planted in 54 plats and self-pollinated in the summer of 1924. It was found that some of these plats gave ears only with 9:7 ratios or 27:37 ratios of colored to colorless seeds while the other plats gave some ears with 9:7 and other ears with 27:37 ratios of colored to colorless seeds. They are dealt with separately in the following sections.

### The 9:7 ratios

Twenty-nine selfed ears from 3 plats were found to have had 9:7 ratios of colored to colorless kernels. The results are given in Table III-a. A total count of segregates on these ears is as follows:

| | -Colored- | -Colorless- | -Total- |
|---|---|---|---|
| Observed | 6780 | 5220 | 12000 |
| Expected | 6750 | 5250 | 12000 |
| Deviation | + 30 | - 30 | 0 |

$$\frac{\text{Dev.}}{\text{P. E.}} = \frac{30.0}{36.6} = 0.8$$

The deviation is only 0.8 times its probable error. Therefore, the observations are very close to expectancy.

The fact can be explained on the theory of complementary factors. It has been pointed out that aleurone color develops only in the presence of all three dominant factors A, C and R. A 9:7 $F_2$

ratio should result when the $F_1$ is heterozygous for two factors. One recessive factor (a) naturally comes from the male parent, A-tester (aaCCRR), and the other (r) from the female parent. The constitution of the mother strains ($P_1$) must have been AACCrr in this case, whence the $F_1$ genotype was AaCCRr. Theoretically, when such an ear is self-pollinated, on the $F_2$ ear 9 kernels, having all the dominant factors, would be colored, and 7 kernels would be colorless, since only one or two or no dominant factors were present.

### The 27:37 ratios

Two hundred and five $F_2$ ears from 28 plats exhibited a 27:37 ratio of colored to colorless seeds. The results are summarized in Table III-b. The total number of seeds on these ears is given below:

| | -Colored- | -Colorless- | -Total- |
|---|---|---|---|
| Observed | 33823 | 46510 | 80333 |
| Expected | 33890.5 | 46442.5 | 80333 |
| Deviation | -67.5 | + 67.5 | 0 |

$$\frac{\text{Dev.}}{\text{P. E.}} = \frac{67.5}{94.4} = 0.7$$

The deviation is only 0.7 times its probable error. Obviously, observations accord with expectations very well. Explained on the theory of three complementary factors, the $F_1$ genotype should be heterozygous for the three aleurone factors, i.e., AaCcRr. Here the recessive factor (a) obviously comes from the A-tester (aaCCRR), and (c) and (r) from the mother strains ($P_1$) which must be AAccrr in this

TABLE III-a. Showing the lots which produced only $F_2$ ears with 9:7 ratios of colored to colorless kernels. These ears resulted from the $F_1$ genotype AaCCRr (AACCrr X aaCCRR).

| Name of Variety | Accession No. | $F_1$ 1923 Selection No. | $F_2$ 1924 Plat No. | Number of 9:7 ears |
|---|---|---|---|---|
| M.A.C. Yellow Dent | 254 | 30331 | 41100 | 20 |
| " " " | " | 30513 | 41600 | 5 |
| " " " | " | 31203 | 43100 | 4 |
| Total | | | | 29 |

TABLE III-b. Indicating the plats which produced only $F_2$ ears with 27:37 ratios of colored to colorless kernels. These ears resulted from the $F_1$ genotype AaCcRr (AAccrr X aaCCRR).

| Name of Variety | Accession No. | $F_1$ 1923 Selection No. | $F_2$ 1924 Plat No. | Number of 27:37 ears |
|---|---|---|---|---|
| White Cobbed Duncan | 235 | 301150 | 40700 | 11 |
| M.A.C. Yellow Dent | 254 | 30255 | 40900 | 2 |
| " " " | " | 30703 | 42100 | 3 |
| " " " | " | 31111 | 42800 | 5 |
| " " " | " | 31113 | 43000 | 4 |
| " " " | " | 31207 | 43500 | 7 |
| " " " | " | 31306 | 43600 | 3 |
| " " " | " | 31307 | 43700 | 3 |
| " " " | " | 31309 | 43900 | 21 |
| Nelson X Bailey | 255 | 31430 | 44000 | 6 |
| " " " | " | 31431 | 44100 | 7 |
| " " " | " | 31432 | 44200 | 8 |

TABLE III-b (continued).

| Name of Variety | Accession No. | $F_1$ 1923 Selection No. | $F_2$ 1925 Plat No. | Number of 27:37 Ears |
|---|---|---|---|---|
| Red Cobbed Duncan | 234 | 31605 | 44400 | 3 |
| " " " | " | 31703 | 44500 | 8 |
| " " " | " | 31704 | 44600 | 14 |
| " " " | " | 31802 | 44700 | 19 |
| " " " | " | 31803 | 44800 | 14 |
| " " " | " | 31901 | 44900 | 6 |
| " " " | " | 31902 | 45000 | 5 |
| Bailey | 128 | 32001 | 45100 | 2 |
| " | " | 32002 | 45200 | 4 |
| " | " | 32101 | 45300 | 12 |
| " | " | 32201 | 45500 | 17 |
| " | " | 32202 | 45600 | 9 |
| " | " | 32301 | 45700 | 2 |
| " | " | 32302 | 45800 | 2 |
| " | " | 32407 | 45900 | 2 |
| " | " | 32408 | 46000 | 6 |
| Total | | | | 205 |

case. When such an $F_1$ genotype is self-pollinated, on an $F_2$ ear 27 kernels, having all three dominant factors, would be colored, and 37, having at least one homozygous recessive pair of aleurone factors, would be colorless.

The 9:7 and 27:37 ratios

Twenty-one plats, each from a single $F_1$ ear, produced ears with 9:7 ratios and ears with 27:37 ratios of colored to colorless seeds. Out of 200 such $F_2$ ears, 101 were found to have 9:7 ratios, 99 to have 27:37 ratios. The results are summarized in Table III-c. Counts for these two sorts of ears gave the following numbers of kernels:

| | -From 101 9:7 $F_2$ ears- | | | -From 99 27:37 $F_2$ ears- | | |
|---|---|---|---|---|---|---|
| | -Colored- | -Colorless- | -Total- | -Colored- | -Colorless- | -Total- |
| Observed | 20834. | 15958. | 36792 | 18215. | 24588. | 42802 |
| Expected | 20695.5 | 16096.5 | 36792 | 18057.5 | 24745.5 | 42802 |
| Deviation | +138.5 | -138.5 | 0 | +157.5 | -157.5 | 0 |

$\frac{\text{Dev.}}{\text{P.E.}} = \frac{138.5}{64.2} = 2.2$ $\qquad\qquad \frac{157.5}{68.95} = 2.3$

The deviation for the first lot is 2.2 times its probable error and thus indicates a 9:7 Mendelian ratio. The deviation for the second lot is only 2.3 times it probable error, obviously indicating a 27:37 ratio.

Glancing at Table III-c, it is interesting to note that 9:7 ears and 27:37 ears, which occurred in each plat, were in equal numbers. A calculation on this basis for the total number of ears in the 21 plats shows a deviation of 1, which is only 0.2 times its probable

TABLE III-c. Showing the plats which produced both 9:7 and 27:37 $F_2$ ears. They resulted from the $F_1$ genotypes AaCCRr and AaCcRr which occurred on the same ear (AACcrr X aaCCRR).

| Name of Variety | Access-ion No. | $F_1$ 1923 Selec-tion No. | $F_2$ 1923 plat No. | Actual No. of ears in 9:7 | 27:37 | Theoretical No. of ears (1:1) in 9:7 | 27:37 | Dev. | P.E. | Dev./P.E. |
|---|---|---|---|---|---|---|---|---|---|---|
| Wh. Cobbed Duncan | 235 | 301151 | 40800 | 4 | 3 | 3.5 | 3.5 | 0.5 | 0.9 | 0.6 |
| M. A. C. | 254 | 30256 | 41000 | 4 | 9 | 6.5 | 6.5 | 2.5 | 1.2 | 2.1 |
| " " | " | 30332 | 41200 | 12 | 4 | 8.0 | 8.0 | 4.0 | 1.4 | 2.9 |
| " " | " | 30333 | 41300 | 3 | 11 | 7.0 | 7.0 | 4.0 | 1.3 | 3.1 |
| " " | " | 30408 | 41400 | 9 | 7 | 8.0 | 8.0 | 1.0 | 1.4 | 0.7 |
| " " | " | 30409 | 41500 | 4 | 7 | 5.5 | 5.5 | 1.5 | 1.1 | 1.4 |
| " " | " | 30514 | 41700 | 5 | 6 | 5.5 | 5.5 | 0.5 | 1.1 | 0.5 |
| " " | " | 30515 | 41800 | 7 | 9 | 8.0 | 8.0 | 1.0 | 1.4 | 0.7 |
| " " | " | 30604 | 41900 | 1 | 4 | 2.5 | 2.5 | 1.5 | 0.7 | 2.0 |
| " " | " | 30702 | 42000 | 2 | 1 | 1.5 | 1.5 | 0.5 | 0.6 | 0.9 |
| " " | " | 30806 | 42200 | 4 | 3 | 3.5 | 3.5 | 0.5 | 0.9 | 0.5 |
| " " | " | 30904 | 42400 | 1 | 5 | 3.0 | 3.0 | 2.0 | 0.8 | 2.5 |
| " " | " | 31008 | 42500 | 8 | 13 | 10.5 | 10.5 | 2.5 | 1.5 | 1.7 |
| " " | " | 31009 | 42600 | 4 | 4 | 4.0 | 4.0 | 0.0 | 0.9 | 0.0 |
| " " | " | 31011 | 42700 | 7 | 7 | 7.0 | 7.0 | 0.0 | 1.2 | 0.0 |
| " " | " | 31112 | 42900 | 4 | 1 | 2.5 | 2.5 | 1.5 | 0.7 | 2.0 |
| " " | " | 31204 | 43200 | 3 | 2 | 2.5 | 2.5 | 0.5 | 0.7 | 0.7 |
| " " | " | 31205 | 43300 | 2 | 4 | 3.0 | 3.0 | 1.0 | 0.8 | 0.1 |
| " " | " | 31206 | 43400 | 5 | 1 | 3.0 | 3.0 | 2.0 | 0.8 | 2.5 |
| " " | " | 31308 | 43800 | 5 | 2 | 3.5 | 3.5 | 1.5 | 0.9 | 1.5 |
| Red Cob. Duncan | 234 | 31604 | 44300 | 8 | 6 | 7.0 | 7.0 | 1.0 | 1.3 | 0.7 |
| Total - - - - - - - - - - - - - | | | | 101 | 99 | 100.0 | 100.0 | 1.0 | 4.7 | 0.2 |

error. This leads to the conclusion that the $F_1$ genotypes from which these $F_2$ ears resulted must have been of two sorts, AaCCRr, and AaCcRr, but all look alike, i.e. all are colored. Therefore, their parental ($P_1$ or mother strain) constitution must have been AACcrr. When crossed with the A-tester (aaCCRR), two types of gametes, ACr and Acr in equal numbers from this female parent were fertilzed by the gametes, aCR, from the A-tester. When self-pollinated, the genotype AaCCRr produced 9:7 $F_2$ ears, while the genotype AaCcRr produced 27:37 $F_2$ ears, in proportion of 1:1.

Summing up the above: the hypothesis fits all observations in this generation very well, and also verifies the results of the $F_1$ generation. It is further verified by the $F_3$ generation.

THE CONSTITUTION OF THE STRAINS USED IN THIS INVESTIGATION

Emerson (1918) has pointed out that all corn varieties which he tested were rr. In other words, they lacked the R factor. Likewise all varieties were found to be AA except two, one grown locally in Southern Missouri and the other in Ohio. There is apparently greater diversity with respect to the C factor. Some of the varieties are apparently CC, thus being R-testers, while some are Cc and others cc, and yet others a mixture of these types.

It has been found that all strains which have been tested in this experimental work were AA and rr but were inconsistent with regard to the C factor, conclusions which coincide with Emerson's findings. The results are arranged in Table IV, which is in

pedigree form. By it the female parents and their progenies in the $F_1$ and $F_2$ generations can be traced in either direction. The genetic constitution of these maternal $P_1$ strains was determined by the breeding behaviors of progenies of the $F_1$ and $F_2$ generations. Glancing at Table IV, one will see that strains of White Cobbed Duncan (Ac 235) and Red Cobbed Duncan (Ac 234) had the constitution of AACcrr or AAccrr. Strains of M. A. C. (Ac 254) had AACCrr, AACcrr or AAccrr. This diversity of the Cc factor pair may be due to the fact that some of the strains had been either crossed or intercrossed and self-pollinated previous to this investigation. For such information the reader is referred to Table I-a. The strains with Cc in composition would keep on segregating in a simple Mendelian fashion (3C:1c), whenever they were self-fertilized. Probably this is what has actually happened in nature, and has kept nearly all common corn varieties so diverse with regard to the C factor. For some unknown reason such heterozygous condition has been rarely found for the A and r factors.

Bailey (Ac 128) and Nelson X Bailey (Ac 255) have the constitution AAccrr.

## BREEDING BEHAVIOR IN THE $F_3$ GENERATION

For the 1925 ($F_3$) planting eighty-one $F_2$ ears were selected; of these 29 had 9:7 ratios and 52 had 27:37 ratios. Only colored

TABLE IV. Genetic constitution of the maternal $P_1$ strains used in this investigation.

| Name of Variety | Accession No. | $P_1$ 1922 selection No. | $F_1$ 1923 selection No. | $F_2$ 1924 plat No. | Genetic constitution |
|---|---|---|---|---|---|
| Wh. Cob. Duncan | 235 | 02600 | 30150 | 40700 | AAccrr |
| | | | 30151 | 40800 | AACcrr |
| Wh. Cob. Duncan / Wh. Cob. G. Glow M.A.C. | 254 | 02600 / 12901 | 30255 | 40900 | AAccrr |
| | | | 30256 | 41000 | AACcrr |
| | | 02600 / 12904 | 30331 | 41100 | AACCrr |
| | | | 30332 | 41200 | AACcrr |
| | | | 30333 | 41300 | " |
| | | 25202 | 30408 | 41400 | " |
| | | | 30409 | 41500 | " |
| | | 25203 | 30513 | 41600 | AACCrr |
| | | | 30514 | 41700 | AACcrr |
| | | | 30515 | 41800 | " |
| | | 25303 | 30604 | 41900 | " |
| | | 25306 | 30702 | 42000 | " |
| | | | 30703 | 42100 | AAccrr |
| | | 25312 | 30806 | 42200 | AACcrr |
| | | 25205 | 30904 | 42400 | " |
| | | 25206 | 31008 | 42500 | AACcrr |
| | | | 31009 | 42600 | " |
| | | | 31011 | 42700 | " |
| | | 25207 | 31111 | 42800 | AAccrr |
| | | | 31112 | 42900 | AACCrr |

TABLE IV. (continued)

| Name of Variety | Access-ion No. | $P_1$ 1922 selection No. | $F_1$ 1923 selection No. | $F_2$ 1924 Plat No. | Genetic constitution |
|---|---|---|---|---|---|
| M. A. C. (continued) | 254 | | 31113 | 43000 | AAccrr |
| | | 25302 | 31203 | 43100 | AACCrr |
| | | | 31204 | 43200 | AACcrr |
| | | | 31205 | 43300 | " |
| | | | 31206 | 43400 | " |
| | | | 31207 | 43500 | AAccrr |
| | | 25313 | 31306 | 43600 | " |
| | | | 31307 | 43700 | " |
| | | | 31308 | 43800 | AACcrr |
| | | | 31309 | 43900 | " |
| Nelson X Bailey | 255 | 23000 | 31430 | 44000 | AAccrr |
| | | | 31431 | 44100 | " |
| | | | 31432 | 44200 | " |
| | | 23400 | 31604 | 44300 | AACcrr |
| | | | 31605 | 44400 | " |
| Red Cob. Duncan | 234 | 23701 | 31703 | 44500 | AAccrr |
| | | | 31704 | 44600 | " |
| | | 23705 | 31802 | 44700 | " |
| | | | 31803 | 44800 | " |
| | | 23802 | 31901 | 44900 | " |
| | | | 31902 | 45000 | " |
| Bailey | 128 | 24101 | 32001 | 45100 | " |
| | | | 32002 | 45200 | " |
| | | 24202 | 32101 | 45300 | " |
| | | 24204 | 32201 | 45500 | " |
| | | | 32202 | 45600 | " |
| | | 24301 | 32301 | 45700 | " |
| | | | 32302 | 45800 | " |
| | | 24302 | 32407 | 45900 | " |
| | | | 32408 | 46000 | " |

kernels from the two groups were planted and selfed in the field, while the colorless ones from such ears were discarded. The reason for planting the colored individuals and discarding the colorless ones is that the strains of the A-tester yellow dent corn can be derived more easily from the former than from the latter in terms of possibility and economy of work. Theoretically only 1 out of 7 or 37 colorless kernels on a 9:7 or 27:37 ear, respectively, is the A-tester type, while out of 9 or 27 colored kernels from the 9:7 or 27:37 ear, 4 or 6 will, when self-pollinated, produce 3:1 ears of which one-half or one-third of the colorless kernels will be the A-tester types looked for. (See factorial diagrams on pages 23 and 26.) Therefore, using the colored individuals of $F_2$ ears will save the plant breeder more time and will give him more chance or possibility of developing strains of the A-tester yellow dent corn than if he uses the colorless ones.

Segregations for aleurone color of all individual $F_3$ ears were counted. All these ears have been grouped into two groups, i.e. those resulting from the 9:7 $F_2$ ears and those resulting from the 27:37 $F_2$ ears. Each group has shown similar consistent results.

Results of progenies from the 9:7 $F_2$ group

Three kinds of Mendelian ratios for $F_3$ ears have been found in any plat of this group. In each plat, some ears had 1:0, some had 3:1, and others had 9:7 ratios of colored to colorless seeds. A summary of data for this group is set forth in Table V-a.

Theoretically, colored seeds of any 9:7 $F_2$ ear, if from a cross of AACCrr X aaCCRR, should act in the following manner when they are selfed in the $F_3$ generation.

| -$F_2$ genotypes- | -Breeding behavior in $F_3$- | -Phenotypic Proportion of $F_3$ ears- |
|---|---|---|
| 1 AACCRR | 1:0 (only colored) breeds true | 1 |
| 2 AaCCRR | 3 colored: 1 colorless (aaCCRR) (A-tester type) | 4 |
| 2 AACCRr | 3 colored: 1 colorless (AACCrr) (R-tester type) | |
| 4 AaCCRr | 9 colored: 7 colorless | 4 |

Such was proved to be the case by the actual observations. As seen from Table V-a, the numbers of ears in each plat with these three different Mendelian ratios were in the proportion of 1:4:4. Values of $X^2$ for most plats were less than 1, hence the value for closeness of fit (P) is very high. Evidently observations are very close to expectation. The total numbers of actual and expected ears of these classes from 29 plats are given below:

| Ratio | 1:0 | 3:1 | 9:7 |
|---|---|---|---|
| Observed total | 53.0 | 233.0 | 230.0 |
| Expected total | 57.3 | 229.3 | 229.3 |
| Deviation | -4.3 | + 3.7 | - 0.7 |

$X^2$ for total = 0.3880  P = very close fit.

There were two kinds of 3:1 ears: one resulted from the $F_2$ genotype AaCCRR, and the other resulted from the $F_2$ genotype AACCRr. The first kind of 3:1 ears is the one which has been looked for by this experiment, because its colorless seeds are the A-tester type

TABLE V-a. Number of $F_3$ ears, resulting from colored individuals of 9:7 $F_2$ ears, showing 1:0, 3:1 and 9:7 ratios.

| $F_2$ 1924 Selection No. | $F_3$ 1925 Plat No. | Actual No. of ears with ratios of 1:0 | 3:1 | 9:7 | Theoretical No.(1:4:4) of ears with ratios of 1:0 | 3:1 | 9:7 | $X^2$ | Closeness of fit (P) |
|---|---|---|---|---|---|---|---|---|---|
| 44304 | 51600 | 0 | 3 | 6 | 1.0 | 4.0 | 4.0 | 2.2500 | 0.3318 |
| 40607 | 53400 | 2 | 8 | 9 | 2.1 | 8.4 | 8.4 | 0.0658 | Very good |
| 41102 | 53900 | 3 | 17 | 12 | 3.6 | 14.2 | 14.2 | 0.9766 | " " |
| 41109 | 54000 | 3 | 7 | 8 | 2.0 | 8.0 | 8.0 | 0.6250 | " " |
| 41113 | 54100 | 2 | 18 | 13 | 3.7 | 14.7 | 14.7 | 2.4620 | 0.3011 |
| 41114 | 54200 | 2 | 5 | 7 | 1.6 | 6.2 | 6.2 | 0.4642 | Very good |
| 41118 | 54300 | 3 | 10 | 7 | 2.2 | 8.8 | 8.8 | 0.8125 | " " |
| 41119 | 54400 | 2 | 6 | 7 | 1.7 | 6.7 | 6.7 | 0.1502 | " " |
| 41201 | 54500 | 2 | 13 | 6 | 2.3 | 9.3 | 9.3 | 3.1070 | 0.2137 |
| 41211 | 54600 | 3 | 11 | 10 | 2.7 | 10.7 | 10.7 | 0.0937 | Very good |
| 41212 | 54700 | 2 | 7 | 9 | 2.0 | 8.0 | 8.0 | 0.2500 | " " |
| 41216 | 54900 | 4 | 11 | 9 | 2.7 | 10.7 | 10.7 | 0.9375 | " " |
| 41311 | 55000 | 3 | 7 | 11 | 2.3 | 9.3 | 9.3 | 1.0714 | 0.5895 |
| 41409 | 55400 | 3 | 10 | 8 | 2.3 | 9.3 | 9.3 | 0.4286 | Very good |
| 41413 | 55500 | 1 | 13 | 10 | 2.7 | 10.7 | 10.7 | 1.5938 | 0.4648 |
| 41503 | 55600 | 1 | 11 | 9 | 2.3 | 9.3 | 9.3 | 1.0712 | 0.5896 |
| 41512 | 55900 | 1 | 11 | 10 | 2.4 | 9.8 | 9.8 | 0.8739 | Very good |
| 41602 | 56000 | 3 | 7 | 6 | 1.8 | 7.1 | 7.1 | 1.0156 | 0.6028 |
| 41604 | 56100 | 1 | 6 | 6 | 1.4 | 5.8 | 5.8 | 0.1453 | Very good |
| 41605 | 56200 | 1 | 7 | 6 | 1.6 | 6.2 | 6.2 | 0.3752 | " " |

TABLE V-a (continued)

| $F_2$ 1924 Selection No. | $F_3$ 1925 Plat No. | Actual No. of ears with ratios of 1:0 | 3:1 | 9:7 | Theoretical No. (1:4:4) of ears with ratios of 1:0 | 3:1 | 9:7 | $X^2$ | Closeness of fit (P) |
|---|---|---|---|---|---|---|---|---|---|
| 41701 | 56300 | 1 | 6 | 10 | 1.9 | 7.6 | 7.6 | 1.5293 | 0.4802 |
| 41708 | 56500 | 1 | 6 | 6 | 1.4 | 5.8 | 5.8 | 0.1453 | Very good |
| 41802 | 56600 | 3 | 6 | 9 | 2.0 | 8.0 | 8.0 | 1.1250 | 0.5767 |
| 41810 | 56700 | 1 | 3 | 10 | 1.6 | 6.2 | 6.2 | 4.1605 | 0.1268 |
| 41904 | 57000 | 2 | 6 | 5 | 1.4 | 5.8 | 5.8 | 0.3227 | Very good |
| 42203 | 57300 | 1 | 6 | 4 | 1.2 | 4.9 | 4.9 | 0.4544 | " " |
| 42208 | 57400 | 1 | 4 | 5 | 1.1 | 4.4 | 4.4 | 0.1249 | " " |
| 42505 | 57700 | 2 | 4 | 7 | 1.4 | 5.8 | 5.8 | 1.0192 | 0.6020 |
| 42708 | 58100 | 2 | 5 | 9 | 1.8 | 7.1 | 7.1 | 1.1561 | 0.5693 |
| Total | 29 plats | 53 | 233 | 230 | 57.3 | 229.3 | 229.3 | 0.3880 | Very good |

which has the constitution of aaCCRR and from which the strains of the A-tester yellow dent will be derived. Colorless seeds of the other kind of 3:1 ears are the R-tester type (AACCrr). Since these two kinds of 3:1 ears all look alike, they must be separated from each other by a method which will be dealt with later on.

Results of progenies from the 27:37 $F_2$ group

Plants grown from colored seeds of any 27:37 $F_2$ ear bred differently in $F_3$, as was expected. In nearly every plat were found $F_3$ ears with 1:0, 3:1, 9:7, and 27:37 ratios of colored to colorless seeds, but 1:0 ears did not appear in some plats, since they occur theoretically only once in 27 cases. The results are listed in Table V-b. On the theory of complementary factors, the 27 $F_2$ colored individuals, when selfed, will produce the following types and in the following proportion in $F_3$.

| -$F_2$ genotypes- | -Breeding behavior in $F_3$- | -Proportion of $F_3$ phenotypes- |
|---|---|---|
| 1AACCRR | 1:0 (only colored) breeds true | 1 |
| 2AaCCRR | 3 colored: 1 colorless (aaCCRR) (A-tester type) | |
| 2AACcRR | 3 colored: 1 colorless (AAccRR) (C-tester type) | 6 |
| 2AACCRr | 3 colored: 1 colorless (AACCrr) (R-tester type) | |
| 4AaCCRr | 9 colored:7 colorless | |
| 4AaCcRR | 9 colored:7 colorless | 12 |
| 4AACcRr | 9 colored:7colorless | |
| 8AaCcRr | 27 colored:37 colorless | 8 |

TABLE V-b. Number of $F_3$ ears, resulting from colored individuals of 27:37 $F_2$ ears, showing 1:0, 3:1, 9:7 and 27:37 ratios.

| $F_2$ 1924 Selection No. | $F_3$ 1925 Plat No. | Actual No. of ears with ratios of 1:0 | 3:1 | 9:7 | 27:37 | Theoretical No. (1:6:12:8) of ears with ratios of 1:0 | 3:1 | 9:7 | 27:37 | $x^2$ | Closeness of fit (P) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 45502 | 51200 | 0 | 5 | 8 | 7 | 0.7 | 4.4 | 8.9 | 5.9 | 0.9173 | Very good |
| 45509 | 51300 | 0 | 5 | 9 | 5 | 0.7 | 4.2 | 8.4 | 5.6 | 0.9512 | " " |
| 45702 | 51400 | 1 | 7 | 9 | 6 | 0.9 | 5.1 | 10.2 | 6.8 | 0.9695 | " " |
| 46006 | 51500 | 2 | 3 | 10 | 7 | 0.8 | 4.9 | 9.8 | 6.5 | 2.5146 | 0.6654 |
| 44306 | 51700 | 1 | 8 | 10 | 5 | 0.9 | 5.3 | 10.7 | 7.1 | 2.0193 | 0.5689 |
| 44311 | 51800 | 1 | 3 | 9 | 7 | 0.7 | 4.4 | 8.9 | 5.9 | 0.7562 | Very good |
| 44503 | 51900 | 3 | 4 | 12 | 7 | 1.0 | 5.8 | 11.6 | 7.7 | 4.9379 | 0.1731 |
| 44609 | 52000 | 0 | 5 | 10 | 10 | 0.9 | 5.6 | 11.1 | 7.4 | 2.0001 | 0.5724 |
| 44614 | 52100 | 0 | 3 | 7 | 5 | 0.6 | 3.3 | 6.7 | 4.4 | 0.6751 | Very good |
| 44711 | 52200 | 0 | 8 | 13 | 9 | 1.1 | 6.7 | 13.4 | 8.9 | 1.3873 | 0.7126 |
| 44807 | 52300 | 0 | 6 | 11 | 6 | 0.9 | 5.1 | 10.2 | 6.8 | 1.1631 | 0.7639 |
| 44905 | 52400 | 0 | 3 | 3 | 3 | 0.3 | 2.0 | 4.0 | 2.7 | 1.1233 | 0.7730 |
| 40701 | 52500 | 1 | 8 | 14 | 9 | 1.2 | 7.1 | 14.2 | 9.5 | 0.1680 | Very good |
| 40702 | 52600 | 1 | 2 | 14 | 10 | 1.0 | 6.0 | 12.0 | 8.0 | 3.4999 | 0.3262 |
| 40703 | 52700 | 0 | 3 | 7 | 5 | 0.6 | 3.3 | 6.7 | 4.4 | 0.6751 | Very good |
| 40705 | 52800 | 2 | 1 | 5 | 5 | 0.5 | 2.9 | 5.8 | 3.9 | 6.4720 | 0.0932 |
| 40708 | 52900 | 0 | 3 | 11 | 6 | 0.7 | 4.4 | 8.9 | 5.9 | 1.7125 | 0.6582 |
| 40709 | 53000 | 0 | 7 | 8 | 6 | 0.8 | 4.7 | 9.3 | 6.2 | 2.2715 | 0.5233 |
| 40710 | 53100 | 0 | 2 | 9 | 4 | 0.6 | 3.3 | 6.7 | 4.4 | 1.9501 | 0.5839 |
| 40802 | 53200 | 1 | 6 | 6 | 4 | 0.6 | 3.8 | 7.6 | 5.0 | 2.4708 | 0.4917 |
| 40803 | 53300 | 1 | 5 | 10 | 8 | 0.9 | 5.3 | 10.7 | 7.1 | 0.2847 | Very good |
| 40901 | 53500 | 0 | 2 | 6 | 5 | 0.5 | 2.9 | 5.8 | 3.9 | 1.1057 | 0.7771 |

TABLE V-b (continued)

| $F_2$ 1924 Selection No. | $F_3$ 1925 plat No. | Actual No. of ears with ratios of 1:0 | 3:1 | 9:7 | 27:37 | Theoretical No. (1:6:12:8) of ears with ratios of 1:0 | 3:1 | 9:7 | 27:37 | $X^2$ | Closeness of Fit (P) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40902 | 53600 | 0 | 1 | 7 | 6 | 0.5 | 3.1 | 6.2 | 4.1 | 2.8699 | 0.4152 |
| 41001 | 53700 | 1 | 1 | 8 | 1 | 0.4 | 2.4 | 4.9 | 3.3 | 5.2613 | 0.1562 |
| 41002 | 53800 | 1 | 3 | 8 | 5 | 0.6 | 3.8 | 7.6 | 5.0 | 0.9766 | Very good |
| 41213 | 54800 | 1 | 5 | 9 | 3 | 0.7 | 4.0 | 8.0 | 5.3 | 1.5624 | 0.6724 |
| 41312 | 55100 | 1 | 3 | 9 | 5 | 0.7 | 4.0 | 8.0 | 5.3 | 0.5625 | Very good |
| 41313 | 55200 | 1 | 4 | 11 | 5 | 0.8 | 4.7 | 9.3 | 6.2 | 0.6964 | " " |
| 41401 | 55300 | 1 | 6 | 8 | 5 | 0.7 | 4.4 | 8.9 | 5.9 | 0.8679 | " " |
| 41504 | 55700 | 1 | 5 | 10 | 6 | 0.8 | 4.9 | 9.8 | 6.5 | 0.1138 | " " |
| 41507 | 55800 | 1 | 5 | 7 | 6 | 0.7 | 4.2 | 8.4 | 5.6 | 0.5396 | " " |
| 41706 | 56400 | 0 | 4 | 3 | 3 | 0.4 | 2.2 | 4.4 | 3.0 | 1.8129 | 0.6154 |
| 41816 | 56800 | 0 | 4 | 7 | 4 | 0.5 | 3.3 | 6.7 | 4.4 | 0.7498 | Very good |
| 41902 | 56900 | 1 | 4 | 9 | 5 | 0.7 | 4.2 | 8.4 | 5.6 | 0.2435 | " " |
| 41905 | 57100 | 2 | 4 | 6 | 4 | 0.6 | 3.6 | 7.1 | 4.7 | 3.7151 | 0.2986 |
| 42002 | 57200 | 1 | 2 | 6 | 5 | 0.6 | 3.1 | 6.2 | 4.1 | 1.0268 | 0.7952 |
| 42401 | 57500 | 0 | 2 | 10 | 3 | 0.6 | 3.3 | 6.7 | 4.4 | 3.2248 | 0.3624 |
| 42501 | 57600 | 1 | 3 | 8 | 6 | 0.7 | 4.0 | 8.0 | 5.3 | 0.5000 | Very good |
| 42516 | 57800 | 1 | 3 | 9 | 5 | 0.7 | 4.0 | 8.0 | 5.3 | 0.5625 | " " |
| 42602 | 57900 | 0 | 1 | 8 | 1 | 0.4 | 2.2 | 4.4 | 2.9 | 5.1883 | 0.1605 |
| 42701 | 58000 | 1 | 4 | 5 | 5 | 0.6 | 3.5 | 6.7 | 4.4 | 0.9749 | Very good |
| 42802 | 58200 | 0 | 4 | 9 | 6 | 0.7 | 4.2 | 8.4 | 5.6 | 0.7764 | Very good |
| 42906 | 58300 | 1 | 3 | 11 | 3 | 0.7 | 4.0 | 8.0 | 5.3 | 2.5623 | 0.4708 |

TABLE V-b (continued)

| $F_2$ 1924 Selection No. | $F_3$ 1925 plat No. | Actual No. of ears with ratios of 1:3 | 3:1 | 9:7 | 27:37 | Theoretical No. (1:6:12:8) of ears with ratios of 1:0 | 3:1 | 9:7 | 27:37 | $x^2$ | Closeness of fit (P) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 43004 | 58400 | 1 | 9 | 8 | 3 | 0.8 | 4.7 | 9.3 | 6.2 | 5.9461 | 0.1150 |
| 43603 | 58500 | 0 | 4 | 3 | 2 | 0.3 | 2.0 | 3.9 | 2.7 | 2.8335 | 0.4218 |
| 43803 | 58600 | 1 | 10 | 15 | 4 | 1.1 | 6.7 | 13.3 | 8.9 | 4.5769 | 0.2098 |
| 43916 | 58700 | 0 | 4 | 11 | 6 | 0.8 | 4.7 | 9.3 | 6.2 | 1.1785 | 0.7572 |
| 44001 | 58800 | 0 | 4 | 14 | 7 | 0.9 | 5.6 | 11.1 | 7.4 | 1.7550 | 0.6286 |
| 44004 | 58900 | 1 | 5 | 9 | 8 | 0.9 | 5.1 | 10.2 | 6.8 | 0.3571 | Very good |
| 44101 | 59000 | 0 | 4 | 7 | 6 | 0.6 | 3.8 | 7.6 | 5.0 | 1.2348 | 0.7476 |
| 44104 | 59100 | 1 | 5 | 5 | 4 | 0.6 | 3.3 | 6.7 | 4.4 | 1.6494 | 0.6528 |
| 44207 | 59200 | 1 | 6 | 8 | 5 | 0.7 | 4.4 | 8.9 | 5.9 | 0.7871 | Very good |
| Total | 52 plats | 35 | 221 | 448 | 276 | 36.3 | 217.8 | 435.6 | 290.4 | 1.1607 | 0.7645 |

As seen in Table V-b, of a total of 980 ears from 52 plats, 53 were 1:0 ratio, 221 were 3:1 ratio, 448 were 9:7 ratio, and 276 were 27:37 ratio for colored to colorless seeds. Their expected numbers on a basis of 1:6:12:8 ratio were 36.3:217.8:435.6:290.4. The value of $X^2$ is 1.1607 and hence the value of closeness of fit (P) is 0.7645. This indicates that these observations are very close to expectancy.

Here the 3:1 ears were of three sorts genotypically. Colorless individuals (kernels) of the 3:1 ears derived from the $F_2$ genotype AaCCRR were the A-tester types which were sought for by the present experiment. Likewise, the colorless kernels from the 3:1 ears of the $F_2$ genotype AACcRR would produce a C-tester type, AAccRR, and the colorless kernels of the 3:1 ears of the $F_2$ genotype AACCRr would produce an R-tester type, AACCrr. How to sort the A-tester type out of the other two types will be described later on.

Segregation of yellow and white endosperm characters

As pointed out previously, all the mother strains had the yellow endosperm character and were crossed with Emerson's A-tester which had the white endosperm character. On the basis of a single pair of factors, the former should be YY and the latter yy regardless of the aleurone factors. All the $F_1$ kernels should be yellow due to the factor Y being dominant over its allelomorph y, and they should segregate in the manner of 2 yellow to 1 white in $F_2$ when self-pollinated. It should be recalled that the yellow endosperm was wholly covered up in the $F_1$ and partly so in the $F_2$ by the colored

aleurones. No data were taken for these two generations.

Three groups of ears segregating for the yellow and white endosperms were observed in the colorless aleurone individuals of the 3:1 $F_3$ classes. These groups were those which bred true for either yellow or white endosperm and those which did not breed true for the yellow endosperm but segregated in a 3:1 ratio. The results are arranged in Table VI.

Forty $F_3$ ears with a total of 3370 yellow kernels were found to be in the group (a in Table VI) which bred true for the yellow endosperm character, since the progenies of these ears resulted in a total of 233 ears with only the yellow endosperm in the $F_4$ generation.

Thirty-five $F_3$ ears with a total of 2866 white seeds were noted and found to be in the group (c in Table VI) which bred true for the white endosperm but were not carried on to the $F_4$.

Eighty-two $F_3$ ears were found to be in the group (b in Table VI) which did not breed true for either of these characters. They gave a total of 4870 yellow seeds to 1567 white seeds, where 4827.75: 1069.25 were expected. A deviation of 42.25 was obtained, which is 1.8 times its probable error. Evidently it is a 3:1 ratio of yellows to whites on these ears. The yellow individuals were carried on to the $F_4$ generation and resulted in 141 yellow seeded ears (1:0) and 298 yellow and white seeded ears in nearly a proportion of 1:2. Calculating on this basis the expected numbers for these two classes of ears are 146.3 : 292.7. The deviation is 5.3 which is only 0.8 times its probable error. Thus, observations are very close to expectancy.

**TABLE VI.** Segregation of yellow and white endosperm in the colorless aleurone individuals of the 3:1 $F_3$ class and their behavior in $F_4$.

(a) Group which bred true for the yellow endosperm.

| 1925 ($F_3$) Selection No. | Number of Kernels with endosperm | | 1926 ($F_4$) Plat No. | Number of ears | | |
|---|---|---|---|---|---|---|
| | -Yellow- | -White- | | Yellow seeded | Yellow and white seeded | White seeded |
| 51707 | 90 | 0 | 650300 | 3 | 0 | 0 |
| 52603 | 72 | 0 | 650600 | 1 | 0 | 0 |
| 52803 | 30 | 0 | 650900 | 1 | 0 | 0 |
| 53006 | 75 | 0 | 651200 | 8 | 0 | 0 |
| 53302 | 105 | 0 | 651600 | 6 | 0 | 0 |
| 53303 | 40 | 0 | 651700 | 1 | 0 | 0 |
| 53801 | 83 | 0 | 652300 | 11 | 0 | 0 |
| 53915 | 92 | 0 | 652700 | 11 | 0 | 0 |
| 54006 | 86 | 0 | 653000 | 14 | 0 | 0 |
| 54116 | 72 | 0 | 653500 | 5 | 0 | 0 |
| 54208 | 14 | 0 | 653900 | 0 | 0 | 0 |
| 54304 | 90 | 0 | 654000 | 15 | 0 | 0 |
| 54404 | 80 | 0 | 654300 | 5 | 0 | 0 |
| 54509 | 68 | 0 | 654600 | 0 | 0 | 0 |
| 54605 | 101 | 0 | 654800 | 5 | 0 | 0 |
| 54608 | 106 | 0 | 654900 | 5 | 0 | 0 |
| 54708 | 92 | 0 | 655000 | 9 | 0 | 0 |
| 54906 | 134 | 0 | 655200 | 11 | 0 | 0 |
| 55102 | 98 | 0 | 655900 | 1 | 0 | 0 |
| 55202 | 90 | 0 | 656100 | 8 | 0 | 0 |
| 55303 | 70 | 0 | 656500 | 9 | 0 | 0 |

TABLE VI, (a) (continued)

| 1925 ($F_3$) Selection No. | Number of kernels with endosperm -Yellow- | -White- | 1926 ($F_4$) Plat No. | Number of ears Yellow seeded | Yellow and white seeded | White Seeded |
|---|---|---|---|---|---|---|
| 55307 | 146 | 0 | 656600 | 16 | 0 | 0 |
| 55510 | 75 | 0 | 657100 | 3 | 0 | 0 |
| 55804 | 84 | 0 | 657700 | 7 | 0 | 0 |
| 55903 | 89 | 0 | 657800 | 3 | 0 | 0 |
| 55909 | 40 | 0 | 658000 | 4 | 0 | 0 |
| 56007 | 110 | 0 | 658100 | 7 | 0 | 0 |
| 56303 | 39 | 0 | 658300 | 4 | 0 | 0 |
| 56403 | 109 | 0 | 658500 | 1 | 0 | 0 |
| 57501 | 105 | 0 | 659500 | 3 | 0 | 0 |
| 57603 | 76 | 0 | 659700 | 2 | 0 | 0 |
| 57901 | 121 | 0 | 660000 | 3 | 0 | 0 |
| 58303 | 95 | 0 | 660700 | 5 | 0 | 0 |
| 58501 | 62 | 0 | 661100 | 9 | 0 | 0 |
| 58502 | 123 | 0 | 661200 | 15 | 0 | 0 |
| 58602 | 117 | 0 | 661300 | 6 | 0 | 0 |
| 58603 | 95 | 0 | 661400 | 3 | 0 | 0 |
| 58606 | 58 | 0 | 661500 | 4 | 0 | 0 |
| 58607 | 70 | 0 | 661600 | 2 | 0 | 0 |
| 58702 | 62 | 0 | 661800 | 7 | 0 | 0 |
| Total 40 ears | 3370 | 0 | | 233 | 0 | 0 |

TABLE VI (continued)

(b) Group segregating for the yellow and white endosperms.

| 1925 ($F_3$) Selection No. | Number of kernels with endosperm | | 1926 ($F_4$) Plat No. | Number of ears | | |
|---|---|---|---|---|---|---|
| | -Yellow- | -White- | | Yellow seeded | Yellow and White seeded | White seeded |
| 51204 | 63 | 21 | 650000 | 2 | 6 | 0 |
| 51503 | 81 | 30 | 650100 | 1 | 3 | 0 |
| 51704 | 72 | 20 | 650200 | 0 | 1 | 0 |
| 52301 | 55 | 25 | 650400 | 0 | 3 | 0 |
| 52504 | 65 | 21 | 650500 | 0 | 3 | 0 |
| 52702 | 50 | 21 | 650700 | 1 | 4 | 0 |
| 52703 | 18 | 6 | 650800 | 0 | 1 | 0 |
| 52902 | 42 | 21 | 651000 | 0 | 1 | 0 |
| 53002 | 65 | 21 | 651100 | 1 | 2 | 0 |
| 53202 | 77 | 25 | 651300 | 3 | 5 | 0 |
| 53205 | 47 | 14 | 651400 | 2 | 4 | 0 |
| 53207 | 15 | 4 | 651500 | failed | | |
| 53304 | 52 | 22 | 651800 | 2 | 6 | 0 |
| 53404 | 51 | 19 | 651900 | 3 | 0 | 0 |
| 53405 | 78 | 22 | 652000 | 1 | 2 | 0 |
| 53502 | 29 | 12 | 652100 | 0 | 4 | 0 |
| 53601 | 66 | 25 | 652200 | 0 | 2 | 0 |
| 53908 | 91 | 28 | 652400 | 5 | 10 | 0 |
| 53910 | 94 | 34 | 652500 | 6 | 11 | 0 |
| 53911 | 90 | 28 | 652600 | 0 | 5 | 0 |
| 53917 | 89 | 28 | 652800 | 1 | 4 | 0 |
| 53918 | 83 | 22 | 652900 | 4 | 5 | 0 |

TABLE VI, (b) (continued)

| 1925 ($F_3$) Selection No. | Number of kernels with endosperm | | 1926 ($F_4$) Plat No. | Number of ears | | |
|---|---|---|---|---|---|---|
| | -Yellow- | -White- | | Yellow seeded | Yellow and white seeded | White seeded |
| 54009 | 62 | 16 | 653100 | 2 | 3 | 0 |
| 54103 | 42 | 14 | 653200 | self-pollination failed | | |
| 54107 | 100 | 27 | 653300 | 2 | 6 | 0 |
| 54112 | 20 | 7 | 653400 | 1 | 2 | 0 |
| 54118 | 52 | 15 | 653600 | 1 | 2 | 0 |
| 54205 | 63 | 20 | 653700 | failed | | |
| 54207 | 11 | 5 | 653800 | 0 | 1 | 0 |
| 54308 | 36 | 14 | 654100 | 2 | 4 | 0 |
| 54310 | 38 | 14 | 654200 | 3 | 1 | 0 |
| 54405 | 65 | 17 | 654400 | 3 | 4 | 0 |
| 54408 | 82 | 24 | 654500 | 8 | 3 | 0 |
| 54604 | 59 | 19 | 654700 | 3 | 4 | 0 |
| 54905 | 63 | 23 | 655100 | 0 | 2 | 0 |
| 54908 | 43 | 17 | 655300 | 3 | 4 | 0 |
| 55004 | 55 | 20 | 655400 | 2 | 4 | 0 |
| 55005 | 58 | 20 | 655500 | 2 | 3 | 0 |
| 55007 | 62 | 20 | 655600 | 2 | 4 | 0 |
| 55008 | 61 | 17 | 655700 | 0 | 0 | 0 |
| 55010 | 57 | 21 | 655800 | 0 | 0 | 0 |
| 55103 | 92 | 31 | 656000 | 4 | 9 | 0 |
| 55203 | 37 | 13 | 656200 | 0 | 2 | 0 |
| 55204 | 42 | 14 | 656300 | 1 | 5 | 0 |

TABLE VI, (b) (continued)

| 1925 ($F_3$) Selection No. | Number of kernels with endosperm -Yellow- | -White- | 1926 ($F_4$) Plat No. | Number of ears Yellow seeded | Yellow and white seeded | White seeded |
|---|---|---|---|---|---|---|
| 55205 | 98 | 30 | 656400 | 5 | 11 | 0 |
| 55411 | 62 | 18 | 656700 | 2 | 3 | 0 |
| 55502 | 50 | 22 | 656800 | 1 | 3 | 0 |
| 55508 | 65 | 28 | 656900 | 2 | 4 | 0 |
| 55509 | 71 | 22 | 657000 | 3 | 10 | 0 |
| 55511 | 62 | 14 | 657200 | 2 | 4 | 0 |
| 55603 | 52 | 18 | 657300 | 1 | 5 | 0 |
| 55703 | 86 | 28 | 657400 | 0 | 4 | 0 |
| 55802 | 78 | 21 | 657500 | 2 | 8 | 0 |
| 55803 | 90 | 26 | 657600 | 2 | 6 | 0 |
| 55904 | 83 | 24 | 657900 | 2 | 3 | 0 |
| 56202 | 60 | 18 | 658200 | 3 | 4 | 0 |
| 56401 | 88 | 25 | 658400 | 2 | 1 | 0 |
| 56503 | 66 | 13 | 658600 | 2 | 6 | 0 |
| 56801 | 88 | 22 | 658700 | 0 | 3 | 0 |
| 56802 | 59 | 24 | 658800 | 1 | 3 | 0 |
| 56804 | 34 | 10 | 658900 | 0 | 2 | 0 |
| 56902 | 49 | 11 | 659000 | 3 | 9 | 0 |
| 56903 | 46 | 12 | 659100 | 3 | 7 | 0 |
| 57003 | 50 | 14 | 659200 | 1 | 3 | 0 |
| 57104 | hard to classify | | 659300 | 1 | 2 | 0 |
| 57203 | 35 | 16 | 659400 | 2 | 0 | 0 |

TABLE VI, (b) (continued)

| 1925 ($F_3$) Selection No. | Number of kernels with endosperm -Yellow- | -White- | 1926 ($F_4$) plat No. | Number of ears Yellow seeded | Yellow and white seeded | White seeded |
|---|---|---|---|---|---|---|
| 57602 | 55 | 24 | 659600 | 1 | 2 | 0 |
| 57703 | 68 | 20 | 659800 | 3 | 3 | 0 |
| 57802 | 62 | 22 | 659900 | 2 | 2 | 0 |
| 58004 | 44 | 15 | 660100 | 2 | 4 | 0 |
| 58103 | 70 | 24 | 660200 | 2 | 5 | 0 |
| 58107 | 64 | 19 | 660300 | 3 | 4 | 0 |
| 58108 | 89 | 26 | 660400 | 5 | 8 | 0 |
| 58202 | 36 | 13 | 660500 | 2 | 4 | 0 |
| 58204 | 36 | 19 | 660600 | 0 | 2 | 0 |
| 58402 | 77 | 25 | 660800 | 2 | 5 | 0 |
| 58403 | 50 | 15 | 660900 | 0 | 0 | 0 |
| 58404 | 83 | 15 | 661000 | 1 | 2 | 0 |
| 58701 | 39 | 8 | 661700 | 2 | 3 | 0 |
| 58704 | 90 | 25 | 661900 | 2 | 4 | 0 |
| 59205 | 62 | 24 | 662000 | 1 | 1 | 0 |
| 59206 | hard to classify | | 662100 | 2 | 3 | 0 |
| Total for 82 ears -- | 4870 | 1567 | Total for 82 plats-- | 141 | 298 | 0 |
| Expected total -- | 4827.75 | 1609.25 | Expected total -- | 146.3 | 292.7 | |
| Deviation total -- | + 42.25 | -42.25 | Deviation total -- | - 5.3 | + 5.3 | |

$\frac{\text{Dev.}}{\text{P.E.}} = \frac{42.25}{23.4} = 1.8$ $\frac{\text{Dev.}}{\text{P.E.}} = \frac{5.3}{6.7} = 0.8$

TABLE VI (continued)

(c) Group which bred true for the white endosperm but not carried on to $F_4$.

| 1925 ($F_3$) Selection No. | Number of kernels with endosperm | | 1925 ($F_3$) Selection No. | Number of kernels with endosperm | |
|---|---|---|---|---|---|
| | -Yellow- | -White- | | -Yellow- | -White- |
| 52701 | 0 | 138 | 56204 | 0 | 66 |
| 53306 | 0 | 85 | 56307 | 0 | 95 |
| 53804 | 0 | 83 | 56402 | 0 | 118 |
| 54007 | 0 | 120 | 56506 | 0 | 51 |
| 54008 | 0 | 62 | 56608 | 0 | 89 |
| 54108 | 0 | 58 | 56703 | 0 | 91 |
| 54110 | 0 | 73 | 56905 | 0 | 68 |
| 54117 | 0 | 92 | 57402 | 0 | 103 |
| 54306 | 0 | 92 | 58002 | 0 | 69 |
| 54505 | 0 | 123 | 58201 | 0 | 102 |
| 54512 | 0 | 68 | 58405 | 0 | 78 |
| 54610 | 0 | 31 | 58406 | 0 | 56 |
| 54704 | 0 | 122 | 58407 | 0 | 94 |
| 54803 | 0 | 50 | 58503 | 0 | 114 |
| 54805 | 0 | 50 | Total 35 ears | 0 | 2866 |
| 55009 | 0 | 41 | | | |
| 55407 | 0 | 88 | | | |
| 55602 | 0 | 99 | | | |
| 56006 | 0 | 76 | | | |
| 56106 | 0 | 71 | | | |
| 56203 | 0 | 50 | | | |

## TESTING THE $F_3$ FOR STRAINS OF A-TESTER YELLOW DENT CORN

Two methods have been followed in sorting out the A-tester type from the other two types, C-tester and R-tester. One method was to detect the anthocyanic pigment of seedlings grown from the colorless seeds of 3:1 $F_3$ ears. The other method was to cross these three tester types with Emerson's A, C, and R aleurone color testers.

### Results of the seedling test

It was thought that the A factor was entirely responsible for the production of anthocyanic pigment in the mature corn plant and likewise in the seedlings. Consequently, the types C-tester and R-tester could be eliminated at the seedling stage, since they had the A factor which would cause those seedlings to be colored, whereas the A-tester type could be picked out because its seedlings would be non-colored on account of lacking the A factor. This idea was proved to be invalid, to some extent, by the results of the other method, i.e. crossing these tester types with Emerson's aleurone testers in the field (see Tables IX-a and IX-b). Those results have revealed that both the A-tester type and the C-tester type resulted from colorless seeds of 3:1 $F_3$ ears of the 27:37 $F_2$ group, whose seedlings were considered to be non-colored by the seedling test (Table IX-b), and that the seedling test could not be used to rogue out the C-tester type from the A-tester type.

By a later experiment (pages 67-99 ), it has been found that

the multiple allelomorphic factor $r^r$ of the R series was present in the R-tester type, hence the type was $AACCr^rr^r$; $r^r$ causes the seedlings to be colored in presence of the A factor. Also, $R^gR^g$ recessive to $r^rr^r$ for plant color, has been found present in the A-tester type, hence the type was $aaCCR^gR^g$ and in the C-tester type making it $AAccR^gR^g$. In the presence of the factor A, $R^gR^g$ would cause these seedlings to be non-colored. This is the reason why the C-tester type could not be rogued out by the seedling test, but it could be distinguished by crossing it with Emerson's testers.

In the winter of 1925, colorless seeds from 394 3:1 $F_3$ ears were planted in sand trays in the laboratory for seedling tests. Of the 394 ears, 208 were progenies of the 9:7 $F_2$ ears and 186 were progenies of the 27:37 $F_2$ ears. About three weeks after planting, the seedlings were pulled out and their color was recorded. From the 9:7 $F_2$ lot, of 208 ears, 99 showed colored seedlings and 109 gave non-colored seedlings. The results are shown in Table VII-a. As pointed out previously, there were two kinds of 3:1 $F_3$ ears, genotypically, i.e. one contained the A-tester type and the other contained the R-tester type. Theoretically, these two types should have been in equal numbers and approximately such was the case. Thus the 109 ears must have been of the A-tester type and the 99 ears of the R-tester type. They were practically in equal proportion. The expected numbers were 104:104. This exhibits a deviation of 5, which is only 1.0 times its probable error. Observations were very close to expectation. That this conclusion was correct was

**TABLE VII-a.** Showing that colorless seeds of 99 3:1 $F_3$ ears of the 9:7 $F_2$ group gave only colored seedlings, which would be of the R-tester (ACr) type; and that colorless seeds of 109 3:1 $F_3$ ears of the same $F_2$ group gave only non-colored seedlings which would be of the A-tester (aCR) type.

| 1925 ($F_3$) Plat No. | Number of 3:1 $F_3$ ears giving: colored seedlings (ACr) | Number of 3:1 $F_3$ ears giving: non-colored seedlings (aCR) | 1925 ($F_3$) Plat No. | Number of 3:1 $F_3$ ears giving: colored seedlings (ACr) | Number of 3:1 $F_3$ ears giving: non-colored seedlings (aCR) |
|---|---|---|---|---|---|
| 51600 | 3 | 0 | 56200 | 1 | 4 |
| 53400 | 1 | 2 | 56300 | 3 | 3 |
| 53900 | 11 | 6 | 56500 | 2 | 3 |
| 54000 | 2 | 5 | 56600 | 4 | 2 |
| 54100 | 8 | 8 | 56700 | 1 | 1 |
| 54200 | 6 | 0 | 57000 | 1 | 3 |
| 54300 | 4 | 6 | 57100 | 1 | 2 |
| 54400 | 2 | 4 | 57200 | 1 | 1 |
| 54500 | 7 | 6 | 57300 | 1 | 4 |
| 54600 | 2 | 3 | 57400 | 1 | 2 |
| 54700 | 3 | 3 | 57700 | 2 | 2 |
| 54900 | 5 | 4 | 58100 | 2 | 4 |
| 55000 | 3 | 4 | 58300 | 2 | 1 |
| 55400 | 4 | 5 | Actual total - | 99 | 109 |
| 55500 | 3 | 8 | | | |
| 55600 | 1 | 3 | Expected total - | 104 | 104 |
| 55900 | 4 | 5 | Deviation- | -5 | +5 |
| 56000 | 4 | 3 | | | |
| 56100 | 4 | 2 | | | |

$$\frac{\text{Dev.}}{\text{P.E.}} = \frac{5.0}{4.8} = 1.04$$

proved by the results from the field crosses between these two tester types and Emerson's testers. As shown in Tables VIII-a, VIII-c and IX-a, the colorless kernels of 3:1 $F_3$ ears, whose seedlings were shown to be non-colored by the seedling test, produced only the A-tester type, and those whose seedlings were shown to be colored by the same test produced only the R-tester type.

From the 27:37 $F_2$ lot, of 186 $F_3$ ears, 63 gave colored seedlings and 123 gave non-colored ones. The results are shown in Table VII-b. As said before, the 3:1 ears were of three sorts in this group, namely, the A-tester type ($aaCCR^gR^g$), the C-tester type ($AAccR^gR^g$) and the R-tester type ($AACCr^rr^r$). Obviously, these 63 ears must have been the R-tester type, while the 123 ears must have been the A-tester type plus the C-tester type. Calculation on 1:2 basis showed that the expected numbers for the R-tester type and for the A-tester type plus the C-tester type were 62:124. The deviation is 1.0, which is only 0.2 times its probable error. Observation accords with expectancy exceedingly well. This conclusion was also verified by the results from the actual field crosses between these tester types and Emerson's testers, as is shown in Tables VIII-a, VIII-b, VIII-c and IX-b, because both the A-tester type and the C-tester type resulted from the colorless seeds of 3:1 $F_3$ ears whose seedlings were shown to be non-colored by the seedling test, and the R-tester type resulted from the colorless seeds of 3:1 $F_3$ ears whose seedlings were shown to be colored by the same test.

TABLE VII-b. Colorless seeds of 63 3:1 $F_3$ ears of the 27:37 $F_2$ group produced only colored seedlings, which would be of the R-tester type (ACr); and those of 123 3:1 $F_3$ ears of the same $F_2$ group produced only non-colored seedlings, which would be of the A-tester type plus the C-tester type.

| 1925 ($F_3$) Plat No. | Number of 3:1 $F_3$ ears giving colored seedlings (ACr) | non-colored seedlings (aCR + AcR) | 1925 ($F_3$) Plat No. | Number of 3:1 $F_3$ ears giving colored seedlings (ACr) | non-colored seedlings (aCR + AcR) |
|---|---|---|---|---|---|
| 51200 | 1 | 4 | 53200 | 2 | 4 |
| 51300 | 3 | 2 | 53300 | 1 | 4 |
| 51400 | 3 | 4 | 53500 | 1 | 1 |
| 51500 | 1 | 2 | 53600 | 0 | 1 |
| 51700 | 2 | 5 | 53700 | 0 | 0 |
| 51800 | 1 | 2 | 53800 | 0 | 3 |
| 51900 | 3 | 0 | 54800 | 1 | 3 |
| 52000 | 1 | 2 | 55100 | 2 | 1 |
| 52100 | 0 | 1 | 55200 | 1 | 3 |
| 52200 | 1 | 4 | 55300 | 1 | 5 |
| 52300 | 2 | 1 | 55700 | 1 | 3 |
| 52400 | 1 | 1 | 55800 | 1 | 3 |
| 52500 | 6 | 2 | 56400 | 0 | 3 |
| 52600 | 0 | 2 | 56800 | 1 | 3 |
| 52700 | 0 | 3 | 56900 | 1 | 3 |
| 52800 | 0 | 1 | 57100 | 1 | 2 |
| 52900 | 2 | 1 | 57500 | 0 | 1 |
| 53000 | 2 | 4 | 57600 | 0 | 2 |
| 53100 | 1 | 0 | 57800 | 1 | 1 |

TABLE VII-b (continued)

| 1925 ($F_3$) Plat No. | Number of 3:1 $F_3$ ears giving colored seedlings (ACr) | Number of 3:1 $F_3$ ears giving non-colored seedlings (aCR + AcR) |
|---|---|---|
| 57900 | 0 | 1 |
| 58000 | 2 | 2 |
| 58200 | 1 | 3 |
| 58300 | 2 | 1 |
| 58400 | 2 | 6 |
| 58500 | 2 | 2 |
| 58600 | 2 | 6 |
| 58700 | 1 | 3 |
| 58800 | 2 | 2 |
| 58900 | 1 | 3 |
| 59000 | 1 | 2 |
| 59100 | 0 | 2 |
| 59200 | 2 | 3 |
| Actual total - | 63 | 123 |
| Expected total (1:2)- | 62 | 124 |
| Deviation | +1 | -1 |

$$\frac{\text{Dev.}}{\text{P.E.}} = \frac{1.0}{4.2} = 0.2$$

Results of crosses between $F_3$ A-, C-, and R-tester types and Emerson's A-, C-, and R-testers.

Out of 394 3:1 $F_3$ ears in the seedling test, 190 were selected for the 1926 planting. From such ears only seeds with yellow endosperm were planted in the field. Of the 190 ears, 110 whose cobs were white and whose seedlings were non-colored were planted in 110 plats on one side of the field; while 13 red-cobbed ears with colored seedlings were planted in 13 plats, 25 red-cobbed ears with non-colored seedlings were planted in 25 plats, and 42 white-cobbed ears with colored seedlings were planted in 42 plats on the other side of the field. The purpose of this planting was two-fold: (1) to identify the A-tester type by crossing with Emerson's testers, and (2) to determine any relation between the color of seedlings and these three tester types, especially the A-tester type. The center rows in the field were planted with Emerson's A-, C-, and R-testers. In each of the 190 plats, 4 or more plants were crossed with the A-tester, 4 with the C-tester and 4 with the R-tester. Several of the remaining plants in the plat were selfed. The principle for these crosses is shown in the following diagram:

Emerson's Aleurone color testers

| Tester types from 3:1 $F_3$ ears | A-tester aCR | C-tester AcR | R-tester ACr |
|---|---|---|---|
| aCR | Colorless | Colored | Colored |
| AcR | Colored | Colorless | Colored |
| ACr | Colored | Colored | Colorless |

In this way, the A-, C-, and R-tester types from the yellow seeds of these 3:1 $F_3$ ears could be determined and distinguished.

There were 92 plats in which the plants or ears proved to be the A-tester types because in these plats 171 hybrid ears were colorless when crossed with the Emerson A-tester, 214 were colored when crossed with the C-tester, and 178 were colored when crossed with the R-tester. The results are arranged in Table VIII-a and illustrated in Plate I. Some of the selfed ears in these plats are the strains of A-tester Yellow Dent sought for in this problem. A detail for selection of these strains will be given under another heading.

Table VIII-b shows that plants or ears of 31 plats proved to be the C-tester types since they gave 55 colored hybrid ears when crossed with A-testers, 49 colorless ears when crossed with C-testers, and 48 partially colored and all colored ears when crossed with R-testers. The types are illustrated in Plate II. The latter hybrid ears should be all colored according to theory, as indicated in the diagram. The partially colored ears were probably caused by some of the R-testers, being heterozygous for the C factor.

Fifty-five plats were found to have plants of the R-tester type as shown by the fact that the plants gave 86 colored ears when crossed with A-testers, 71 colored ears when crossed with C-testers and 73 colorless ears when crossed with R-testers. The data are indicated in Table VIII-c and types illustrated in Plate III.

There were 12 plats in which both croses and selfings failed. They are noted in parenthesis ( ) in Tables IX-a and IX-b. Some of

TABLE VIII-a. Showing results of crossing the A-tester types (aCR) with Emerson's A-, C-, R-testers.

| Name of Variety | Accession No. | $F_1$ 1923 selection No. | $F_2$ 1924 selection No. | $F_3$ 1925 selection No. | 1926 Plat No. | Color of $F_3$ seedlings | No. of ears colorless when crossed with A-tester | No. of ears colored when crossed with C-, | R-tester |
|---|---|---|---|---|---|---|---|---|---|
| Red Cobbed Duncan | 234 | 31802 | 44807 | 52301 | 650400 | w | 1 | 2 | 2 |
| White Cobbed Duncan | 235 | 301150 | 40701 | 52504 | 650500 | w | failed 0 | 4 | failed 0 |
| | | | 40703 | 52702 | 650700 | w | 2 | 2 | 2 |
| | | | 40709 | 53006 | 651200 | w | 3 | 3 | 3 |
| | | 301151 | 40802 | 53202 | 651300 | w | 3 | 4 | 3 |
| | | | | 53205 | 651400 | w | 1 | 2 | 2 |
| | | | 40803 | 53302 | 651600 | w | 3 | 1 | 3 |
| | | | 40807 | 53404 | 651900 | w | 2 | 2 | 1 |
| | | | | 53405 | 652000 | w | 1 | 1 | 2 |
| White Cobbed M.A.C. | 254 | 30331 | 41102 | 53908 | 652400 | w | 3 | 4 | 3 |
| | | | | 53910 | 652500 | w | 2 | 4 | 3 |
| | | | | 53911 | 652600 | w | 2 | 2 | 1 |
| | | | | 53915 | 652700 | w | 3 | 4 | 2 |
| | | | | 53918 | 652900 | w | 1 | 1 | 2 |
| | | | 41109 | 54006 | 653000 | w | 4 | 4 | 3 |
| | | | | 54009 | 653100 | w | 1 | 3 | 1 |
| | | | 41113 | 54103 | 653300 | w | 4 | 5 | 2 |
| | | | | 54112 | 653400 | w | 2 | 2 | 1 |

w = non-colored (green)

TABLE VIII-a. (continued)

| Name of Variety | Accession No. | $F_1$ 1923 selection No. | $F_2$ 1924 selection No. | $F_3$ 1925 selection No. | 1926 Plat no. | Color of $F_3$ seedlings | No. of colorless ears when crossed with A-tester | No. of colored ears when crossed with C-, | R-tester |
|---|---|---|---|---|---|---|---|---|---|
| White Cobbed M.A.C. | 254 | | | 54116 | 653500 | w | 2 | 3 | 2 |
| | | | | 54118 | 653600 | w | 3 | 1 | 3 |
| | | | 41118 | 54304 | 654000 | w | 3 | 4 | 2 |
| | | | | 54308 | 654100 | w | 3 | 3 | 2 |
| | | | | 54310 | 654200 | w | 2 | 0 | 2 |
| | | | 41119 | 54404 | 654300 | w | 2 | 2 | 3 |
| | | | | 54405 | 654400 | w | 2 | 3 | 3 |
| | | | | 54408 | 654500 | w | 1 | 2 | 3 |
| | | 30332 | 41211 | 54605 | 654800 | w | 2 | 2 | 1 |
| | | | | 54608 | 654900 | w | 2 | 0 | 0 |
| | | | 41212 | 54708 | 655000 | w | 3 | 2 | 1 |
| | | | 41216 | 54905 | 655100 | w | 3 | 2 | 1 |
| | | | | 54906 | 655200 | w | 3 | 2 | 3 |
| | | | | 54908 | 655300 | w | 1 | 2 | 2 |
| | | 30333 | 41311 | 55005 | 655500 | w | 2 | 0 | 1 |
| | | | | 55007 | 655600 | w | 0 | 3 | 3 |
| | | | 41312 | 55103 | 656000 | w | 2 | 3 | 3 |
| | | | | 55105 | 656400 | w | 3 | 3 | 3 |
| | | 30408 | 41401 | 55303 | 656500 | w | 2 | 4 | 3 |
| | | | | 55307 | 656600 | w | 3 | 3 | 3 |
| | | | 41409 | 55411 | 656700 | w | 2 | 2 | 2 |

TABLE VIII-a (continued)

| Name of Variety | Accession No. | $F_1$ 1923 selection No. | $F_2$ 1924 selection No. | $F_3$ 1925 selection No. | 1926 Plat No. | Color of $F_3$ seedlings | No. of colorless ears when crossed with A-tester | No. of colored ears when crossed with C-, | R-tester |
|---|---|---|---|---|---|---|---|---|---|
| White Cobbed M.A.C. | 254 | | 41413 | 55502 | 656800 | w | 1 | 2 | 1 |
| | | | | 55508 | 656900 | w | 1 | 3 | 1 |
| | | | | 55509 | 657000 | w | 3 | 2 | 2 |
| | | | | 55510 | 657100 | w | 2 | 2 | 1 |
| | | | | 55511 | 657200 | w | 2 | 4 | 3 |
| | | 30409 | 41503 | 55603 | 657300 | w | 1 | 2 | 2 |
| | | | 41504 | 55703 | 657400 | w | 2 | 4 | 1 |
| | | | 41507 | 55802 | 657500 | w | 1 | 2 | 2 |
| | | | | 55803 | 657600 | w | 3 | 4 | 2 |
| | | | 41512 | 55903 | 657800 | w | 2 | 3 | 2 |
| | | | | 55904 | 657900 | w | 2 | 2 | 3 |
| | | | | 55909 | 658000 | w | 2 | 2 | 1 |
| | | 30513 | 41602 | 56007 | 658100 | w | 2 | 3 | 3 |
| | | | 41605 | 56202 | 658200 | w | 2 | 2 | 3 |
| | | 30514 | 41701 | 56303 | 658300 | w | 2 | 1 | 0 |
| | | | 41708 | 56503 | 658600 | w | 3 | 2 | 3 |
| | | 30515 | 41816 | 56801 | 658700 | w | 2 | 2 | 2 |
| | | | | 56802 | 658800 | w | 1 | 3 | 3 |
| | | 30604 | 41902 | 56902 | 659000 | w | 1 | 1 | 4 |
| | | | | 56903 | 659100 | w | 1 | 3 | 2 |
| | | | 41904 | 57003 | 659200 | w | 2 | 3 | 2 |

TABLE VIII-a (continued)

| Name of Variety | Access-ion No. | $F_1$ 1923 selection No. | $F_2$ 1924 selection No. | $F_3$ 1925 selection No. | 1926 Plat No. | Color of $F_3$ seedlings | No. of colorless ears when crossed with A-tester | No. of colored ears when crossed with C-, | R-tester |
|---|---|---|---|---|---|---|---|---|---|
| White Cobbed MAC | 254 | | 41905 | 57104 | 659300 | w | 0 | 2 | 1 |
| | | 30904 | 42401 | 57501 | 659500 | w | 2 | 0 | 2 |
| | | 31008 | 42501 | 57602 | 659600 | w | 2 | 3 | 1 |
| | | | 42505 | 57703 | 659800 | w | 2 | 4 | 1 |
| | | | 42516 | 57802 | 659900 | w | 1 | 2 | 3 |
| | | 31009 | 42602 | 57901 | 660000 | w | 0 | 2 | 3 |
| | | 31011 | 42701 | 58004 | 660100 | w | 3 | 3 | 3 |
| | | | 42706 | 58103 | 660200 | w | 2 | 2 | 4 |
| | | | | 58107 | 660300 | w | 2 | 3 | 2 |
| | | | | 58108 | 660400 | w | 3 | 3 | 2 |
| | | 31111 | 42802 | 58202 | 660500 | w | 1 | 3 | 0 |
| | | 31112 | 42906 | 58303 | 660700 | w | 2 | 2 | 1 |
| | | 31113 | 43004 | 58403 | 660900 | w | 1 | 1 | 2 |
| | | | | 58404 | 661000 | w | 1 | 1 | 1 |
| | | 31306 | 43603 | 58501 | 661100 | w | 2 | 6 | 2 |
| | | | | 58502 | 661200 | w | 1 | 2 | 2 |
| | | 31308 | 43803 | 58602 | 661300 | w | 1 | 3 | 3 |
| | | | | 58603 | 661400 | w | 2 | 2 | 3 |
| | | | | 58606 | 661500 | w | 2 | 4 | 3 |
| | | | | 58607 | 661600 | w | 2 | 2 | 0 |
| | | 31309 | 43916 | 58702 | 661800 | w | 0 | 3 | 3 |

TABLE VIII-a (continued)

| Name of Variety | Access-ion No. | $F_1$ 1923 selec-tion No. | $F_2$ 1924 selec-tion No. | $F_3$ 1925 selec-tion No. | 1926 Plat No. | Color of $F_3$ seed-lings | No. of color-less ears when crossed with A-tester | No. of colored ears when crossed with C-, | R-tester |
|---|---|---|---|---|---|---|---|---|---|
| Nelson X Bailey | 255 | 31432 | 44207 | 59205 | 662000 | w | 2 | 1 | 2 |
| | | | | 59206 | 662100 | w | 3 | 3 | 2 |
| Bailey | 128 | 32201 | 45502 | 51201 | 663500 | w | 1 | 1 | 1 |
| | | 32301 | 45702 | 51402 | 663900 | w | 1 | 1 | 1 |
| | | | | 51403 | 664000 | w | 1 | 2 | 1 |
| | | 32407 | 46006 | 51502 | 664300 | w | 0 | 1 | 1 |
| White Cobbed Duncan | 235 | 30806 | 42203 | 57303 | 665500 | w | 2 | 0 | 0 |
| | | | | 57305 | 665600 | w | 2 | 0 | 0 |
| | | | 42208 | 57403 | 665700 | w | 2 | 1 | 0 |
| Red Cobbed Duncan | 234 | 31803 | 44807 | 52302 | 666400 | w | 1 | 2 | 1 |
| White Cobbed M.A.C. | 254 | 30331 | 41118 | 54312 | 667900 | w | 2 | 1 | 2 |
| TOTAL . . . . . . . . . . . . . . | | | | | 92 plats . . | | 171 | 214 | 178 |

PLATE I


Individuals in plat 652400 proved to be the A-tester type (aCR) of corn since they produced three colorless ears (top of the picture) when crossed with Emerson's A-tester, three colored ears (on left side at bottom) when crossed with C-tester and two colored ears (on right side at bottom) when crossed with R-tester.

TABLE VIII-b. Showing results of crossing the C-tester types (AcR) with Emerson's A-, C-, and R- testers.

| Name of Variety | Accession No. | $F_1$ 1923 selection No. | $F_2$ 1924 selection No. | $F_3$ 1925 selection No. | 1926 Plat No. | Color of $F_3$ seedlings | Number of ears colored when crossed with A-tester | colorless when crossed with C-tester | colored when crossed with R-tester |
|---|---|---|---|---|---|---|---|---|---|
| Bailey | 128 | 32201 | 45502 | 51204 | 650000 | w | 2 | 3 | 3* |
| White Cob. Duncan | 235 | 301150 | 40703 | 52703 | 650800 | w | 1 | 1 | 0 |
| | | | 40702 | 52603 | 650600 | w | 2 | 1 | 1* |
| | | | 40705 | 52803 | 650900 | w | 2 | 2 | 3* |
| | | | 40709 | 53002 | 651100 | w | 2 | 5 | 3* |
| | | 301151 | 40803 | 53303 | 651700 | w | 2 | 2 | 1 + 1* |
| | | | | 53304 | 651800 | w | 2 | 2 | 3* |
| White Cob. M.A.C. | 254 | 30255 | 40901 | 53502 | 652100 | w | 1 | 1 | 2* |
| | | | 40902 | 53601 | 652200 | w | 3 | 2 | 2* |
| | | 30256 | 41002 | 53803 | 652300 | w | 4 | 5 | 1 + 2* |
| | | 30333 | 41313 | 55202 | 656100 | w | 5 | 2 | 1* |
| | | 30409 | 41507 | 55804 | 657700 | w | 1 | 4 | 2* |
| | | 30514 | 41706 | 56401 | 658400 | w | 2 | 2 | 3* |
| | | | | 56403 | 658500 | w | 3 | 0 | 3* |
| | | 30515 | 41816 | 56804 | 658900 | w | 2 | 2 | 1* |
| | | 31008 | 42501 | 57603 | 659700 | w | 0 | 2 | 1* |
| | | 31111 | 42802 | 58204 | 660600 | w | 0 | 1 | 0 |
| | | 31309 | 43916 | 58701 | 661700 | w | 2 | 1 | 2 |
| | | | | 58704 | 661900 | W | 3 | 3 | 1* |
| Bailey | 128 | 32201 | 45502 | 51202 | 663600 | w | 1 | 0 | 0 |
| | | | | 51205 | 663700 | w | 2 | 1 | 2* |
| | | | 45509 | 51319 | 663800 | w | 1 | 1 | 1 |
| | | 32301 | 45702 | 51405 | 664100 | w | 1 | 2 | 1 |
| | | | | 51406 | 664200 | w | 1 | 1 | 0 |

TABLE VIII-b (continued)

| Name of Variety | Access-ion No. | $F_1$ 1923 selec-tion No. | $F_2$ 1924 selec-tion No. | $F_2$ 1925 selec-tion No. | 1926 Plat No. | Color of $F_3$ seed-lings | Number of ears colored when crossed with A-tester | colorless when crossed with C-tester | colored when crossed with R-tester |
|---|---|---|---|---|---|---|---|---|---|
| Red Cob. Duncan | 234 | 31604 | 44306 | 51701 | 664400 | w | 2 | 0 | 2* |
| | | | | 51801 | 664500 | w | 0 | 0 | 1 |
| | | | 44311 | 51802 | 664600 | w | 1 | 0 | 0 |
| | | 31704 | 44609 | 52003 | 664800 | w | 1 | 0 | 1* |
| | | 31802 | 44711 | 52201 | 665100 | w | 1 | 1 | 0 |
| | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | | 31430 | 44104 | 59102 | 665900 | w | 2 | 1 | 3* |
| | | 31432 | 44207 | 59204 | 666000 | w | 3 | 1 | 1* |
| TOTAL. . . . . . . . . . . . | | | | | 31 plats . . . | | 55 | 49 | 48 |

* Ears were partly colored.

PLATE II

The picture shows that individuals in plat 652300 proved to be the C-tester type (AcR), since they gave three colorless ears (center of the picture) when crossed with Emerson's C-tester (AcR), three colored ears (on left-hand side) when crossed with A-tester and two partly colored ears (on right-hand side) when crossed with R-tester. The partial coloring was probably due to heterozygous (Cc) in R-tester.

TABLE VIII-c. Results of crossing the R-tester types (ACr) with Emerson's A-, C-, and R-testers.

| Name of Variety | Maternal Accession No. | $F_1$ 1923 selection No. | $F_2$ 1924 selection No. | $F_3$ 1925 selection No. | 1926 Plat No. | Color of $F_3$ seedlings | Number of ears colored when crossed with A- tester | Number of ears colored when crossed with C- tester | Number of ears colorless when crossed with R-tester |
|---|---|---|---|---|---|---|---|---|---|
| Bailey | 128 | 32408 | 46006 | 51503 | 650100 | R | 1 | 2 | 1 |
| Red Cobbed Duncan | 234 | 31604 | 44306 | 51704 | 650200 | R | 3 | 1 | 0 |
| | | | | 51707 | 650300 | R | 3 | 3 | 2 |
| White Cob. Duncan | 235 | 301150 | 40708 | 52902 | 651000 | R | 1 | 1 | 1 |
| White Cob. M.A.C. | 254 | 30331 | 41102 | 53917 | 652800 | R | 2 | 2 | 4 |
| | | | 41113 | 54103 | 653200 | R | 1 | 2 | 1 |
| | | | | 54208 | 653900 | R | 1 | 1 | 0 |
| | | 30332 | 41211 | 54604 | 654700 | R | 2 | 3 | 1 |
| | | 30333 | 41311 | 55004 | 655400 | R | 2 | 2 | 2 |
| | | | | 55008 | 655700 | R | 0 | 1 | 0 |
| | | | | 55010 | 655800 | R | 2 | 1 | 2 |
| | | | 41313 | 55203 | 656200 | R | 3 | 3 | 3 |
| | | | | 55204 | 656300 | R | 2 | 2 | 3 |
| | | 31306 | 43603 | 58402 | 660800 | R | 2 | 3 | 2 |
| Bailey | 128 | 32201 | 45502 | 51203 | 662200 | R | 3 | 2 | 2 |
| | | | 45509 | 51315 | 662300 | R | 2 | 1 | 1 |
| | | | | 51317 | 662400 | R | 1 | 0 | 0 |
| | | 32301 | 45702 | 51404 | 662500 | R | 2 | 1 | 1 |
| | | | | 51413 | 662600 | R | 1 | 3 | 3 |
| Red Cobbed Duncan | 234 | 31604 | 44304 | 51601 | 662700 | R | 2 | 2 | 1 |

R = colored

TABLE VIII-c (continued)

| Name of Variety | Maternal Access-ion No. | $F_1$ 1923 selec-tion No. | $F_2$ 1924 selec-tion No. | $F_3$ 1925 selec-tion No. | 1926 Plat No. | Color of $F_3$ seed-lings | Number of ears colored when crossed with A-, | C-tester | colorless when crossed with R-tester |
|---|---|---|---|---|---|---|---|---|---|
| | | | 44303 | 51602 | 662800 | R | 2 | 1 | 1 |
| | | | | 51603 | 662900 | R | 2 | 1 | 1 |
| | | | 44306 | 51703 | 663000 | R | 2 | 2 | 1 |
| | | 31703 | 44503 | 51904 | 663100 | R | 2 | 1 | 2 |
| | | | | 51905 | 663200 | R | 1 | 0 | 2 |
| | | 31803 | 44807 | 52303 | 663300 | R | 1 | 1 | 1 |
| White Cobbed M.A.C. | 254 | 30806 | 42203 | 57306 | 663400 | R | 2 | 1 | 0 |
| Red Cobbed Duncan | 234 | 31802 | 44711 | 52205 | 665300 | R | 1 | 1 | 2 |
| Bailey | 128 | 32201 | 45502 | 51316 | 666100 | R | 1 | 2 | 1 |
| Red Cobbed Duncan | 234 | 31604 | 44306 | 51702 | 666200 | R | 1 | 1 | 1 |
| | | 31704 | 44609 | 52001 | 666300 | R | 3 | 1 | 0 |
| White Cobbed Duncan | 235 | 301150 | 40701 | 52507 | 666500 | R | 2 | 1 | 2 |
| | | | | 52510 | 666600 | R | 0 | 0 | 2 |
| | | | 40710 | 53101 | 666800 | R | 1 | 0 | 2 |
| | | 301151 | 40803 | 53305 | 667000 | R | 1 | 2 | 2 |
| | | | 40807 | 53403 | 667100 | R | 1 | 0 | 2 |
| White Cobbed M.A.C. | 254 | 30331 | 41102 | 53904 | 667200 | R | 1 | 1 | 0 |
| | | | | 53905 | 667300 | R | 2 | 1 | 2 |
| | | | | 53906 | 667400 | R | 2 | 1 | 2 |
| | | | | 53913 | 667500 | R | 2 | 1 | 2 |
| | | | 41109 | 54005 | 667600 | R | 2 | 1 | 1 |
| | | | 41113 | 54111 | 667700 | R | 1 | 2 | 2 |

TABLE VIII-c (continued)

| Name of Variety | Maternal Access-ion No. | $F_1$ 1923 selec-tion No. | $F_2$ 1924 selec-tion No. | $F_3$ 1925 selec-tion No. | 1926 Plat No. | Color of $F_3$ seed-lings | colored when crossed with A-, | C-tester | colorless when crossed with R-tester |
|---|---|---|---|---|---|---|---|---|---|
| | | | 41114 | 54204 | 667800 | R | 1 | 1 | 2 |
| | | | | 54205 | 653700 | R | 0 | 1 | 0 |
| | | | 41119 | 54406 | 668000 | R | 2 | 2 | 1 |
| | | 30332 | 41201 | 54504 | 668100 | R | 1 | 1 | 1 |
| | | 30333 | 41212 | 54704 | 668200 | R | 1 | 1 | 1 |
| | | | 41312 | 55104 | 668300 | R | 1 | 0 | 0 |
| | | 30408 | 41409 | 55412 | 668400 | R | 0 | 0 | 1 |
| | | 30515 | 41802 | 56604 | 668500 | R | 2 | 1 | 2 |
| | | 30806 | 42203 | 57404 | 665800 | R | 3 | 0 | 0 |
| | | 31111 | 42906 | 58302 | 668600 | R | 2 | 2 | 1 |
| | | 31306 | 43603 | 58504 | 668700 | R | 2 | 2 | 1 |
| Nelson X Bailey | 255 | 31430 | 44004 | 58905 | 668800 | R | 1 | 1 | 1 |
| | | 31432 | 44207 | 59202 | 668900 | R | 1 | 1 | 1 |
| | TOTAL . . . . . . . . . . . . . . . . | | | | 55 plats . | | 86 | 71 | 73 |

PLATE III


Individuals in this plat proved to be the R-tester type (ACr) as they produced two colorless ears (right) when crossed with R-tester, three colored ears (center) when crossed with C-tester and two colored ears (left) when crossed with A-tester.

them were determined as A-, or R-tester types by their seedling color.

Glancing at Tables IX-a and IX-b, one will see that there is perfect correlation between the R-tester type and the color of seedlings. In other words, those whose seedlings were colored were the R-tester types. Likewise, the A-tester types were correlated with non-colored seedlings, but they could not be distinguished by seedling color from the C-tester types whose seedlings were also non-colored, when both types came from the 27:37 $F_2$ group (see Table IX-b). Thus it is seen that these data give a substantial support to the seedling test.

## DESCRIPTION AND SELECTION OF STRAINS OF A-TESTER YELLOW DENT CORN

In 92 plats a total of 371 selfed ears proving to be the A-tester types was obtained in the $F_4$ generation (1926). Among these, some ears were yellow dent and some were yellow flint. In regard to the endosperm color, some ears were homozygous for the yellow endosperm and some were segregating for the yellow and white endosperms (see Table VI). The flint and the white endosperm characters came from Emerson's A-tester, while the dent and the yellow endosperm characters came from the maternal strains used in this experiment.

Out of the 371 ears, 36 with homozygous yellow endosperm in dent form were considered as desirable ears. The pedigrees of these ears are given in Table X. From the 36 ears, 11 were selected as

TABLE IX-a. Showing that the seedling color of colorless individuals of 3:1 $F_3$ ears coming from the 9:7 $F_2$ group were verified by crossing with Emerson's testers. The A-tester type resulted from those individuals having non-colored seedlings and the R-tester type from those having colored seedlings.

| 1925 ($F_3$) selection No. | $F_3$ seedling color | 1926 ($F_4$) Plat No. | Tester type proved to be- | 1925 ($F_3$) selection No. | $F_3$ seedling color | 1926 ($F_4$) Plat No. | Tester type proved to be- |
|---|---|---|---|---|---|---|---|
| 51601 | R | 662700 | ACr | 54112 | W | 653400 | aCR |
| 51602 | R | 662800 | " | 54116 | W | 653500 | " |
| 51603 | R | 662900 | " | 54118 | W | 653600 | " |
| 53403 | R | 667100 | " | 54204 | R | 667800 | ACr |
| 53404 | W | 651900 | aCR | 54205 | R | 653700 | ( " ) |
| 53405 | W | 652000 | " | 54207 | R | 653800 | ( " ) |
| 53904 | R | 667200 | ACr | 54208 | R | 653900 | " |
| 53905 | R | 667300 | " | 54304 | W | 654000 | aCR |
| 53906 | R | 667400 | " | 54308 | W | 654100 | " |
| 53908 | W | 652400 | aCR | 54310 | W | 654200 | " |
| 53910 | W | 652500 | " | 54312 | W | 667900 | " |
| 53911 | W | 652600 | " | 54404 | W | 654300 | " |
| 53913 | R | 667500 | ACr | 54405 | W | 654400 | " |
| 53915 | W | 652700 | aCR | 54406 | R | 668000 | ACr |
| 53917 | R | 652800 | ACr | 54408 | W | 654500 | aCR |
| 53918 | W | 652900 | aCR | 54504 | R | 668100 | ACr |
| 54005 | R | 667600 | ACr | 54509 | W | 654600 | (aCR) |
| 54006 | W | 653000 | aCR | 54604 | R | 654700 | ACr |
| 54009 | W | 653100 | " | 54605 | W | 654800 | aCR |
| 54103 | R | 653200 | ACr | 54608 | W | 654900 | " |
| 54107 | W | 653300 | aCR | 54704 | R | 668200 | ACr |
| 54111 | R | 667700 | ACr | 54708 | " | 655000 | aCR |

R = colored; W = non-colored

TABLE IX-a (continued)

| 1925 ($F_3$) Selection No. | $F_3$ seedling color | 1926 ($F_4$) Plat No. | Tester type proved to be- | 1925 ($F_3$) Selection No. | ($F_3$) Color of Seedling | 1926 ($F_4$) Plat No. | Tester type proved to be- |
|---|---|---|---|---|---|---|---|
| 54905 | W | 655100 | aCR | 56604 | R | 668500 | ACr |
| 54906 | W | 655200 | " | 57003 | W | 659200 | aCR |
| 54908 | W | 655300 | " | 57203 | W | 659400 | ( " ) |
| 55004 | R | 655400 | ACr | 57303 | W | 665500 | " |
| 55005 | W | 655500 | aCR | 57305 | W | 665600 | " |
| 55007 | W | 655600 | " | 57306 | R | 663400 | ACr |
| 55008 | R | 655700 | ACr | 57403 | W | 665700 | aCR |
| 55010 | R | 655800 | " | 57404 | R | 665800 | ACr |
| 55411 | W | 656700 | aCR | 57703 | W | 659800 | aCR |
| 55412 | R | 668400 | ACr | 58103 | W | 660200 | " |
| 55502 | W | 656800 | aCR | 58107 | W | 660300 | " |
| 55508 | W | 656900 | " | 58108 | W | 660400 | " |
| 55509 | W | 657000 | " | | | | |
| 55510 | W | 657100 | " | | | | |
| 55511 | W | 657200 | " | | | | |
| 55603 | W | 657300 | " | | | | |
| 55903 | W | 657800 | " | | | | |
| 55904 | W | 657900 | " | | | | |
| 55909 | W | 658000 | " | | | | |
| 56007 | W | 658100 | " | | | | |
| 56202 | W | 658200 | " | | | | |
| 56303 | W | 658300 | " | | | | |
| 56503 | W | 658600 | " | | | | |

( ) crosses in these plats failed, so types were determined by seedling color.

TABLE IX-b. Showing that the seedling color of the colorless individuals of 3:1 $F_3$ ears coming from the 27:37 $F_2$ group were verified by crossing with Emerson's A-, C-, and R-testers. The R-tester type was correlated with colored seedlings; both A-, and C-tester types resulted from those having non-colored seedlings.

| 1925 ($F_3$) Selection No. | $F_3$ seedling color | 1926 ($F_4$) Plat No. | Tester type proved to be- | 1925 ($F_3$) Selection No. | $F_3$ seedling color | 1926 ($F_4$) Plat No. | Tester type proved to be- |
|---|---|---|---|---|---|---|---|
| 51201 | W | 663500 | aCR | 51707 | R | 650300 | ACr |
| 51202 | W | 663600 | AcR | 51801 | W | 664500 | AcR |
| 51203 | R | 662200 | ACr | 51802 | W | 664600 | " |
| 51204 | W | 650000 | AcR | 51904 | R | 663100 | ACr |
| 51205 | W | 663700 | " | 51905 | R | 663200 | " |
| 51315 | R | 662300 | ACr | 52001 | R | 666300 | " |
| 51316 | R | 666100 | " | 52002 | W | 664700 | (--) |
| 51317 | R | 662400 | " | 52003 | W | 664800 | AcR |
| 51319 | W | 663800 | AcR | 52101 | W | 664900 | (--) |
| 51402 | W | 663900 | aCR | 52201 | W | 665000 | (--) |
| 51403 | W | 664000 | " | 52202 | W | 665100 | AcR |
| 51404 | R | 662500 | ACr | 52204 | W | 665200 | (--) |
| 51405 | W | 664100 | AcR | 52205 | R | 665300 | ACr |
| 51406 | W | 664200 | " | 52301 | W | 650400 | aCR |
| 51413 | R | 662600 | ACr | 52302 | W | 666400 | " |
| 51502 | W | 664300 | aCR | 52303 | R | 663300 | ACr |
| 51503 | R | 650100 | ACr | 52401 | W | 665400 | (---) |
| 51701 | W | 664400 | AcR | 52504 | W | 650500 | aCR |
| 51702 | R | 666200 | ACr | 52507 | R | 666500 | ACr |
| 51703 | R | 663000 | " | 52510 | R | 666600 | " |
| 51704 | R | 650200 | " | 52603 | W | 650600 | AcR |

R = colored; W = non-colored

TABLE IX-b (continued)

| 1925 ($F_3$) Selection No. | $F_3$ seedling color | 1926 ($F_4$) Plat No. | Tester type proved to be- | 1925 ($F_3$) Selection No. | $F_3$ seedling color | 1926 ($F_4$) Plat No. | Tester type proved to be- |
|---|---|---|---|---|---|---|---|
| 52702 | W | 650700 | aCR | 55203 | R | 656200 | ACr |
| 52703 | W | 650800 | AcR | 55204 | R | 656300 | " |
| 52803 | W | 650900 | " | 55205 | W | 656400 | aCR |
| 52902 | R | 651000 | ACr | 55303 | W | 656500 | " |
| 53002 | W | 651100 | AcR | 55307 | W | 656600 | " |
| 53003 | R | 666700 | (ACr) | 55703 | W | 657400 | aCR |
| 53006 | W | 651200 | aCR | 55802 | W | 657500 | " |
| 53101 | R | 666800 | ACr | 55803 | W | 657600 | aCR |
| 53202 | W | 651300 | aCR | 55804 | W | 657700 | AcR |
| 53204 | R | 666900 | (ACr) | 56401 | W | 658400 | [illegible] |
| 53205 | W | 651400 | aCR | 56403 | W | 658500 | " |
| 53207 | W | 651500 | (--) | 56801 | W | 658700 | aCR |
| 53302 | W | 651600 | aCR | 56802 | W | 658800 | " |
| 53303 | W | 651700 | AcR | 56804 | W | 658900 | AcR |
| 53304 | W | 651800 | " | 56902 | W | 659000 | aCR |
| 53305 | R | 667000 | ACr | 56903 | W | 659100 | " |
| 53502 | W | 652100 | AcR | 57104 | W | 659300 | " |
| 53601 | W | 652200 | " | 57501 | W | 659500 | " |
| 53803 | W | 652300 | " | 57602 | W | 659600 | " |
| 55102 | R | 655900 | (ACr) | 57603 | W | 659700 | AcR |
| 55103 | W | 656000 | aCR | 57802 | W | 659900 | aCR |
| 55104 | R | 668300 | ACr | 57901 | W | 660000 | " |
| 55202 | W | 656100 | AcR | 58004 | W | 660100 | " |

TABLE IX-b (continued)

| 1925 ($F_3$) Selection No. | $F_3$ seedling color | 1926 ($F_4$) Plat No. | Tester type proved to be- |
|---|---|---|---|
| 58202 | W | 660500 | aCR |
| 58204 | W | 660600 | AcR |
| 58303 | W | 660700 | aCR |
| 58302 | R | 668600 | ACr |
| 58402 | R | 660800 | " |
| 58403 | W | 660900 | aCR |
| 58404 | W | 661000 | " |
| 58501 | W | 661100 | " |
| 58502 | W | 661200 | aCR |
| 58504 | R | 668700 | ACr |
| 58602 | W | 661300 | aCR |
| 58603 | W | 661400 | " |
| 58606 | W | 661500 | " |
| 58607 | W | 661600 | " |
| 58701 | W | 661700 | AcR |
| 58702 | W | 661800 | aCR |
| 58704 | W | 661900 | AcR |
| 58905 | R | 668800 | ACr |
| 59102 | W | 665900 | AcR |
| 59202 | R | 668900 | ACr |
| 59204 | W | 666000 | AcR |
| 59205 | W | 662000 | aCR |
| 59206 | W | 662100 | " |

(--) crosses in these plats failed.

52002, 52101, 52204, 52401, 53207, 52201 — These individuals could not be classified as the A-, or C-tester type by seedling color.

(ACr)
53003, 53204, 55102 — were of the ACr type as determined by their colored seedlings as crosses failed in the field.

the most desirable types and are shown in Table X with (*) marks and in Plate IV. This table shows that one of the 36 ears is the descendant of White Cobbed Duncan and 35 are descendants of White Cobbed Golden Glow X White Cobbed Duncan,

Ears numbered 656510 and 656511 are the A-tester yellow dent with white caps, and hence are called the "White Capped A-Tester Yellow Dent". They are sisters as both came from a mother ear (No. 55303) of the $F_3$ generation.

As to some ear characters, all of the 36 ears are white cobbed with yellow endosperm in the dent form: the number of kernel rows ranges from 10 to 14; the length of ear ranges from 10 to 19 centimeters; the weight of ear is from 34 to 128 grams; and the indentation of all ears is smooth.

The growth, as observed in the field in 1926, of A-, C-, and R-tester types was fairly good, although they were hit by a sand storm and several frosts during the seedling stage. The soil was very poor because of lack of manure and fertilizers, but plants of the A-tester type in most plats looked more uniform and vigorous than those of their sister types, C-, and R-testers in the same breeding lot (see the Table on page 66). This gives at least an indication that the lack of anthocyanic pigment in the A-tester types has no bad effect upon the plant growth and the yield. It was thought that the A-tester types, lacking the factor for anthocyanin, would grow weaker and not give as good a yield as

TABLE X. Showing parentages and general characters of 36 strains of A-tester Yellow Dent.

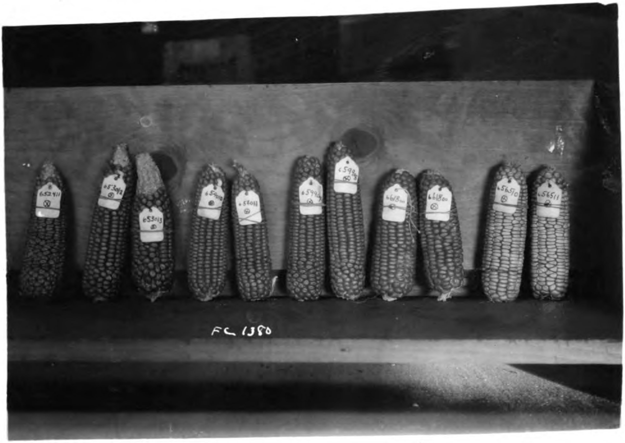
| Name of Variety | Accession No. | $P_1$ 1922 selection | $F_1$ 1923 selection | $F_2$ 1924 selection | $F_3$ 1925 selection | $F_4$ 1926 selection | Cob Color | Length of ear in cms. | No. of rows | Wt. of ear in grams | Color of endosperm | Indentation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wh, Cob. Duncan | 235 | 02600 | 301150 | 40803 | 53302 | 651608 | White | 13 | 12 | 68 | Yellow | Smooth |
| Wh.Cob. G.Glow X Wh.Cob. Duncan | 254 | 02600 / 12904 | 30331 | | 53908 | 652411* | " | 15 | 14 | 97 | deep yellow | " |
| | | | | | | 652412 | " | 14 | 14 | 97 | yellow | " |
| | | | | 41102 | 53910 | 652510 | " | 13 | 14 | 86 | " | " |
| | | | | | 53918 | 652905 | " | 12 | 14 | 69 | " | " |
| | | | | | | 653012* | " | 17 | 12 | 110 | " | " |
| | | | | | | 653013* | " | 15 | 14 | 101 | " | " |
| | | | | 41109 | 54006 | 653014 | " | 15 | 14 | 85 | " | " |
| | | | | | | 653015 | " | 14 | 14 | 86 | " | " |
| | | | | | | 653016 | " | 17 | 12 | 100 | " | " |
| | | | | 41113 | 54103 | 653312 | " | 19 | 14 | 88 | " | " |
| | | | | | | 654010* | " | 14 | 14 | 95 | " | " |
| | | | | | | 654011* | " | 13 | 12 | 77 | " | " |
| | | | | | | 654012 | " | 13 | 12 | 75 | " | " |
| | | | | 41118 | 54304 | 654013 | " | 12 | 12 | 70 | " | " |
| | | | | | | 654014 | " | 12 | 12 | 63 | " | " |
| | | | | | | 654015 | " | 12 | 12 | 60 | " | " |
| ... | ... | 25202 | 30408 | 41211 | 54606 | 654806 | " | 10 | 12 | 64 | " | " |
| | | | | | | 654807 | " | 12 | 14 | 65 | " | " |
| | | | | | 55303 | 656510* | " | 16 | 12 | 106 | Wh.cap. yellow | " |
| | | | | 41401 | | 656511* | " | 13 | 12 | 96 | " | " |

TABLE X (continued)

| Name of Variety | Accession No. | $P_1$ 1922 selection No. | $F_1$ 1923 selection No. | $F_2$ 1924 selection No. | $F_3$ 1925 selection No. | $F_4$ 1926 selection No. | Cob Color | Length of ear in cms. | No. of rows | Wt. of ear in grams | Color of endosperm | Indentation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 55307 | 656610 | White | 15 | 12 | 108 | wh.cap. Yellow | Smooth |
| | | | | 41409 | 55411 | 656707 | " | 10 | 14 | 45 | Yellow | " |
| | | 25206 | 31008 | 42416 | 57802 | 659907* | " | 14 | 12 | 90 | " | " |
| | | | | | | 659908* | " | 16 | 12 | 93 | " | " |
| | | | 31009 | 42602 | 57901 | 660006 | " | -- | -- | -- | " | " |
| | | | | 42701 | 58004 | 660110 | " | -- | -- | -- | " | " |
| | | | 31011 | 42708 | 58103 | 660209 | " | 13 | 12 | 68 | faded yellow | " |
| | | | | | | 660210 | " | 12 | 14 | 74 | yellow & dilute yellow | " |
| | | | | | 58107 | 660308 | " | 17 | 14 | 126 | yellow | " |
| | | | | | | 660309 | " | 11 | 14 | 34 | " | " |
| | | 25207 | 31111 | 42802 | 58202 | 660505 | " | 17 | 10 | 89 | " | " |
| | | 25313 | 31306 | 43603 | 58501 | 551112 | " | 16 | 12 | 91 | " | " |
| | | | | | 58502 | 661205 | " | 12 | 14 | 75 | " | " |
| | | | 31309 | 43916 | 58702 | 661807* | " | 13 | 14 | 109 | deep yellow | " |
| | | | | | | 661808* | " | 12 | 12 | 95 | " | " |

(*) The most desirable strains.

PLATE IV




Strains of A-tester Yellow Dent Corn.

Nos. 656510 and 656511 (on right side of the picture) are the White Capped A-tester Yellow Dent.

the C-tester and R-tester types, which have the A factor. In order to put this discussion on a scientific basis, a statistical study of plant height, ear length, and ear weight for these three tester types, A-, C-, and R-, was made.

Twenty-five plants were measured for height if the plat had 25 or more plants, and all plants were measured if the plat had less than 25 plants. All selfed ears were measured for length of ear, and weight of ear. Biometric constants were calculated.

A comparison of height of plants was made between the A-tester type and the R-tester type. The difference was slightly in favor of the A-tester type, but it was not significant statistically. Comparisons of ear length and ear weight between these two types indicate that the differences are also in favor of the A-tester type, but of not statistical significance. Similarly, these three variables have been compared between the A-tester type and the C-tester type. All differences were in favor of the A-tester type. The data for these comparisons are given below:

| Type | Height of plant | | Length of Ear | | Weight of Ear | |
|---|---|---|---|---|---|---|
| | Mean ± E Feet | C.V. Percent | Mean ± E Cms. | C.V. Percent | Mean ± E Grams | C.V. Percent |
| A-tester | 4.98 ± 0.38 | 11.56 | 13.41 ± 1.13 | 12.83 | 64.09 ± 9.54 | 22.20 |
| R-tester | 4.96 ± 0.37 | 11.33 | 12.83 ± 1.12 | 13.43 | 52.22 ± 9.20 | 28.32 |
| Dif.--- | +0.02 ± 0.53 | +0.23 | +0.58 ± 1.56 | -0.60 | +12.87 ±13.23 | -6.12 |
| A-tester | 4.98 ± 0.38 | 11.56 | 13.41 ± 1.13 | 12.83 | 64.09 ± 9.54 | 22.20 |
| C-tester | 4.98 ± 0.47 | 14.66 | 12.04 ± 1.18 | 14.70 | 51.61 ±10.02 | 29.27 |
| Dif.--- | 0.00 ± 0.64 | -3.10 | +1.37 ± 1.14 | -1.87 | +12.48 ±13.79 | -7.07 |

Summing up the above, it is concluded that the A-tester type of corn is not inferior to the other types, C-, and R-testers, in growth and yield, in terms of plant height, ear length, and ear weight.

## RELATION OF THE FACTORS $R^g$ AND $r^r$ TO THE DEVELOPMENT OF ANTHOCYANIC PIGMENT AS FOUND IN THIS EXPERIMENT

Emerson (1921) has pointed out that the R factor exists as a series of allelomorphs, such as, $R^r$, $R^g$, $r^r$, $r^g$, etc. The factor $r^r$ is recessive for aleurone color and dominant for plant color, while the factor $R^g$ is dominant for aleurone color and recessive for plant color. $R^rR^r$ or $R^rR^g$ or $r^rr^r$ or $r^rr^g$ will cause more or less red pigment to develop in the plant body in the presence of the A factor. Neither $R^gR^g$ nor $r^gr^g$ will cause red pigment to develop in the plant body in presence of A, which is the factor responsible for the production of any anthocyanic pigment in a corn plant.

It has been mentioned in a previous section that the A-, and C-tester types, progenies of the 27:37 $F_2$ group, which could not be separated by the seedling test, might involve the factor $R^gR^g$, and that the R-tester types, which were easily rogued out by seedling tests, must involve the factor $r^rr^r$. It is upon this fact and upon this assumption that the following investigation has been taken up.

### Seedling color in the $P_1$ and $F_1$ generations

Remnants of 16 maternal $P_1$ strains were obtained and planted in sand trays. Twelve of them gave only colored seedlings, and the remaining 4 strains gave mostly colored seedlings with but very few non-colored ones. This indicates that the strains whose seedlings were pigmented must have carried the factor $r^r$ which causes the seedlings to be colored in the presence of the A factor. Their compositions

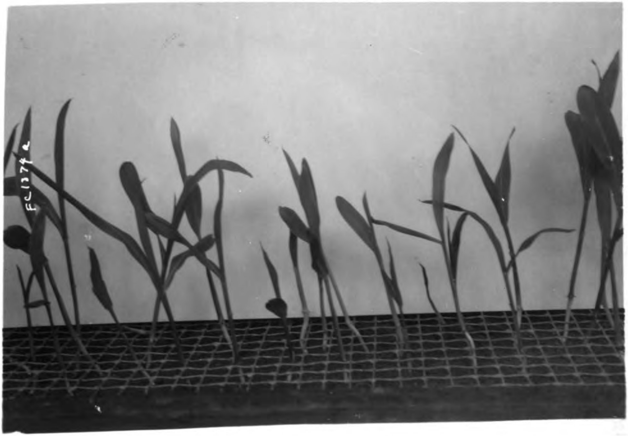
TABLE XI-a. Showing that all maternal $P_1$ strains gave colored seedlings, indicating the presence of $r^r r^r$.

| Name of Variety | Accession No. | 1922 Selection No. or Plat No. | 1923 Plat No. | Number of seedlings: Colored | Number of seedlings: Non-colored |
|---|---|---|---|---|---|
| White Cob. G. Glow X | | 02600 / 12901 | 30200 | 22 | 0 |
| White Cob. Duncan | 254 | 02600 / 12904 | 30300 | 39 | 4 |
| | | 25202 | 30400 | 19 | 0 |
| | | 25203 | 30500 | 22 | 0 |
| | | 25303 | 30600 | 16 | 0 |
| | | 25306 | 30700 | 21 | 0 |
| | | 25312 | 30800 | 22 | 0 |
| | | 25205 | 30900 | 22 | 0 |
| | | 25206 | 31000 | 35 | 0 |
| | | 25207 | 31100 | 34 | 2 |
| | | 25302 | 31200 | 38 | 0 |
| Nelson X Bailey | 255 | 23000 | 31400 | 16 | 0 |
| Red Cobbed Duncan | 234 | 23400 | 31600 | 15 | 5 |
| | | 23701 | 31800 | 25 | 14 |
| | | 23802 | 31900 | 5 | 0 |
| Bailey | 128 | 24301 | 32300 | 20 | 3 |
| TOTAL | | | | 371 | 28 |

TABLE XI-b. The paternal parent, A-tester gave all non-colored seedlings. These were later proved to be $R^g R^g$.

| -Ear No.- | -Colored seedlings- | -Colorless seedlings- |
|---|---|---|
| 1 | 0 | 24 |
| 2 | 0 | 22 |
| 3 | 0 | 24 |
| 4 | 0 | 25 |
| TOTAL | 0 | 95 |

PLATE V




This picture shows that the maternal $P_1$ strains give colored seedlings, indicating the presence of $r^r r^r$.

might be written as AACC $r^r r^r$, AACc$r^r r^r$ and AAcc$r^r r^r$. The results are in Table XI-a and illustrated in Plate V.

Four ears of Emerson's A-tester corn which were selfed in 1926 were planted in sand boxes and produced all non-colored seedlings. The data will be found in Table XI-b. The composition of the Emerson A-tester was either aaCC$R^g R^g$, or aaCC$R^r R^g$, or aaCC$R^r R^r$.

Assuming the first type to be the case, in the $F_1$ generation, the seedlings from any of the following crosses should be colored because $r^r$ is dominant over $R^g$.

| -Maternal strains- | | -Emerson's A-tester- |
|---|---|---|
| AACC$r^r r^r$ | X | aaCC$R^g R^g$ |
| AACc$r^r r^r$ | X | aaCC$R^g R^g$ |
| AAcc$r^r r^r$ | X | AACC$R^g R^g$ |

Unfortunately, there were no remnants of $F_1$ seeds left, so there is no way to get data for this generation. This supposition therefore, remains to be proved by the seedling behavior in the later generations.

### Seedling behavior in the $F_2$ and $F_3$ generations

Remnants of 66 $F_2$ ears used for planting in 1925 were tested. They were colored kernels from both 9:7 ears and 27:37 ears. All were planted in sand boxes in the laboratory. If the hypothesis at hand is right, the $F_2$ colored seeds either from the 9:7 ears or from the 27:37 ears must give colored and non-colored seedlings in the proportion of 2 to 1 according to the following factorial diagrams in which the $F_3$ behaviors are also shown.

Diagram a. Colored seeds of 9:7 $F_2$ ears from
$AACCr^rr^r$ X $aaCCR^gR^g$.

| Genotypic Ratio | $F_2$ genotypes | Proportion of seedling color | $F_3$ behavior |
|---|---|---|---|
| 1 | $AACCR^gR^g$ giving non-colored seedlings | 1 | breeds true for non-colored seedlings |
| 2 | $AaCCR^gR^g$ giving " " | | 1 $AACCR^gR^g$<br>2 $AaCCR^gR^g$<br>1 $aaCCR^gR^g$ all non-colored seedlings |
| 2 | $AACCR^gr^r$ giving colored seedlings | 2 | 1 $AACCR^gR^g$<br>2 $AACCR^gr^r$ colored seeds giving 2:1 of colored and non-colored seedlings<br>1 $AACCr^rr^r$ Colorless seeds giving only colored seedlings |
| 4 | $AaCCR^gr^r$ giving colored seedlings | | 2 colored; 1 non-colored seedlings as in $F_2$ |

Diagram b. Colored seeds of 27:37 $F_2$ ears from
$AAccr^rr^r$ X $aaCCR^gR^g$.

| Genotypic Ratio | $F_2$ genotypes | Proportion of seedling color | $F_3$ seedling behavior |
|---|---|---|---|
| 1 | $AACCR^gR^g$ non-colored seedlings | 1 | Breeds true for non-colored seedlings |
| 2 | $AaCCR^gR^g$ " " " | | 1 $AACCR^gR^g$<br>2 $AaCCR^gR^g$<br>1 $aaCCR^gR^g$ all non-colored seedlings |
| 2 | $AACcR^gR^g$ " " " | | 1 $AACCR^gR^g$<br>2 $AACcR^gR^g$<br>1 $AAccR^gR^g$ all non-colored seedlings |
| 4 | $AaCcR^gR^g$ " " " | | |
| 2 | $AACCR^gr^r$ colored seedlings | 2 | 1 $AACCR^gR^g$ non-colored Seedling<br>2 $AACCR^gr^r$ colored "<br>1 $AACCr^rr^r$ all colored " |
| 4 | $AaCCR^gr^r$ " " | | 2:1 colored and non-colored as in $F_2$ |
| 4 | $AACcR^gr^r$ " " | | 2:1 colored and non-colored as in $F_2$ |
| 8 | $AaCcR^gr^r$ " " | | 2:1 colored and non-colored as in $F_2$ |

TABLE XII. Colored seeds from 9:7 $F_2$ ears and 27:37 $F_2$ ears gave colored and non-colored seedlings in a ratio of 2:1, thus indicating the segregation of the allemorphic pair $R^g r^r$.

| Name of Variety | Accession No. | 1923 ($F_1$) selection No. | 1924 ($F_2$) selection No. | Ratio of ear | Number of seedlings- Colored | Non-colored |
|---|---|---|---|---|---|---|
| White Cob. Duncan | 235 | 301150 | 40701 | 27:37 | 16 | 6 |
| | | | 40702 | " | 6 | 6 |
| | | | 40703 | " | 3 | 1 |
| | | 301150 | 40705 | " | 4 | 3 |
| | | | 40708 | " | 4 | 2 |
| | | | 40710 | " | 13 | 7 |
| | | 301151 | 40802 | " | 6 | 6 |
| | | | 40803 | " | 0 | 3 |
| | | | 40807 | 9:7 | 13 | 11 |
| White Cob. G.Glow X White Cob. Duncan | 254 | 30255 | 40901 | 27:37 | 7 | 3 |
| | | | 40902 | " | 1 | 2 |
| | | 30256 | 41002 | " | 15 | 7 |
| | | 30331 | 41102 | 9:7 | 17 | 6 |
| | | | 41109 | " | 19 | 7 |
| | | | 41113 | " | 13 | 6 |
| | | | 41114 | " | 10 | 8 |
| | | | 41118 | " | 11 | 7 |
| | | | 41119 | " | 12 | 8 |
| | | 30332 | 41201 | " | 7 | 4 |
| | | | 41211 | " | 9 | 4 |

TABLE XII (continued)

| Name of Variety | Accession No. | 1923 ($F_1$) selection No. | 1924 ($F_2$) selection No. | Ratio of ear | Number of seedlings- Colored | Non-colored |
|---|---|---|---|---|---|---|
| | 254 (continued) | 30332 | 41212 | 9:7 | 12 | 4 |
| | | | 41213 | 27:37 | 4 | 1 |
| | | | 41216 | " | 16 | 7 |
| | | 30333 | 41311 | " | 0 | 18 |
| | | | 41312 | " | 14 | 7 |
| | | | 41313 | " | 1 | 0 |
| | | 30408 | 41401 | 9:7 | 2 | 1 |
| | | | 41409 | " | 9 | 5 |
| | | | 41413 | " | 12 | 7 |
| | | 30409 | 41503 | " | 15 | 6 |
| | | | 41504 | 27:37 | 6 | 2 |
| | | | 41507 | " | 5 | 4 |
| | | 30513 | 41602 | 9:7 | 14 | 6 |
| | | | 41604 | " | 13 | 8 |
| | | | 41605 | " | 8 | 5 |
| | | 30514 | 41701 | " | 11 | 6 |
| | | 30515 | 41802 | " | 17 | 6 |
| | | | 41810 | " | 16 | 9 |
| | | | 41816 | 27:37 | 7 | 3 |
| | | 30604 | 41902 | " | 7 | 4 |
| | | | 41905 | 9:7 | 15 | 8 |
| | | 30702 | 42002 | " | 8 | 4 |

TABLE XII (continued)

| Name of Variety | Accession No. | 1923 ($F_1$) selection No. | 1924 ($F_2$) selection No. | Ratio of ear | Number of seedlings Colored | Non-colored |
|---|---|---|---|---|---|---|
| | 254 (continued) | | | | | |
| | | 30806 | 42203 | 9:7 | 9 | 5 |
| | | | 42209 | " | 14 | 7 |
| | | 30904 | 42401 | 27:37 | 11 | 8 |
| | | 31008 | 42505 | 9:7 | 15 | 5 |
| | | | 42516 | 27:37 | 3 | 1 |
| | | 31009 | 42602 | " | 7 | 2 |
| | | 31011 | 42701 | 27:37 | 17 | 6 |
| | | | 42708 | 9:7 | 14 | 7 |
| | | 31111 | 42802 | 27:37 | 11 | 6 |
| | | 31112 | 42906 | " | 2 | 1 |
| | | 31113 | 43004 | " | 8 | 3 |
| | | 31306 | 43603 | " | 9 | 5 |
| | | 31308 | 43803 | 9:7 | 12 | 9 |
| Nelson X Bailey | 255 | 31430 | 44001 | 27:37 | 15 | 6 |
| | | 31431 | 44101 | " | 5 | 2 |
| | | | 44104 | " | 12 | 6 |
| | | 31432 | 44207 | " | 4 | 1 |
| | | 31604 | 44304 | 9:7 | 10 | 12 |
| | | | 44306 | 27:37 | 3 | 0 |
| | | | 44311 | " | 11 | 5 |

TABLE XII (continued)

| Name of Variety | Accession No. | 1923 ($F_1$) selection No. | 1924 ($F_2$) selection No | Ratio of ear | Number of seedlings: Colored | Number of seedlings: Non-colored |
|---|---|---|---|---|---|---|
| | 255 (continued) | 31703 | 44503 | 27:37 | 3 | 2 |
| | | 31704 | 44609 | " | 1 | 2 |
| | | 32201 | 45502 | " | 5 | 2 |
| | | . | . | | | |
| | | 32301 | 45702 | " | 2 | 1 |

66 ears

Actual total . . . 601 . . . . 320

Expected
total (2:1). . 614 . . . . 307

Deviation . . . . -13 . . . . +13

$$\frac{\text{Dev.}}{\text{P.E.}} = \frac{13}{9.6} = 1.4$$

Such was proved to be the case. Colored seeds of these 66 $F_2$ remnant ears gave a total of 601 colored seedlings and 320 non-colored seedlings where 614 colored seedlings and 307 non-colored seedlings were expected. This exhibits a deviation of 13, which is only 1.4 times its probable error, indicating that observations were very close to expectancy. The results are arranged in Table XII.

Unfortunately, many of the $F_3$ ears had been thrown away before this seedling situation was fully realized. Those ears which remained were tested in two groups, i.e. those derived from the colored individuals of the 9:7 $F_2$ ears and those derived from the colored individuals of the 27:37 $F_2$ ears.

$F_3$ seedling behavior in the 9:7 $F_2$ group

In this group 6 $F_3$ homozygous colored ears (1:0) gave only non-colored seedlings. The results are shown in Table XIII-a. Here is a critical test for the hypothesis indicated in diagram a. These colored seeds of 1:0 $F_3$ ears should carry the $R^gR^g$ factor in order to produce non-colored seedlings in presence of **the A factor.** The $R^gR^g$ must have come from Emerson's A-tester ($aaCCR^gR^g$) in order that the 1:0 $F_3$ ears could have the constitution $AACCR^gR^g$ because it has been shown, Table XI-a, that $r^rr^r$ came from the maternal $P_1$ strains. Otherwise, these 1:0 $F_3$'s, indicated in Table XIII-a, would not produce all non-colored seedlings.

One hundred and nine 3:1 $F_3$ ears showed all non-colored seedlings either from the colored seeds or from the colorless seeds. These

ears were proved[1] to be the A-tester types (aCR in Table IX-a) with respect to their colorless seeds. Consequently, they must have contained $R^gR^g$ in order to produce all non-colored seedlings in presence of the A factor. The data are set forth in Table XIII-b.

Table XIII-c shows that another set of 97 3:1 $F_3$ ears gave 1684 colored seedlings and 881 non-colored seedlings from the colored seeds and gave only 2083 colored seedlings from the colorless seeds. Expected numbers of colored and non-colored seedlings for the former are 1710:855 on a basis of 2:1. The deviation is 26, which is 1.6 times its probable error. This explains the fact that all these ears have been proved to be the R-tester type (ACr) with regard to their colorless seeds (see Table IX-a). They came from the $F_2$ genotype $AACCR^gr^r$ (diagram a). Consequently, from such 3:1 $F_3$ ears the seeds with $AACCR^gr^r$ would give colored seedlings and the seeds with $AACCR^gR^g$ would produce non-colored seedlings in the proportion of 2 to 1. The colorless seeds with $AACCr^rr^r$ of the same ear would produce all colored seedlings on account of the presence of $r^r$ in addition to the A factor.

Colored seeds from 43 9:7 $F_3$ ears gave a total of 831 colored seedlings and 458 non-colored seedlings where 859.3:429.7 are expected

---

1 Not all of the 3:1 $F_3$ ears were included in the 1926 planting. The ears which were selected for crossing with Emerson's testers were chosen because of characteristics other than those affected by $R^g$ or $r^r$ and hence the ears reported in Tables IX-a and IX-b may be considered to be random samples of the ears tested in the sand trays, and the results obtained by the field crosses may be considered as typical for the various types of seedlings. The sameholds true for the other results from 3:1 $F_3$ ears mentioned in this section.

TABLE XIII-a. Showing that only non-colored seedlings were produced by the 1:0 $F_3$ ears which were progenies of the 9:7 $F_2$ group.

| 1925 ($F_3$) Selection No. | Number of seedlings Colored | Non-colored |
|---|---|---|
| 53901 | 0 | 18 |
| 53902 | 0 | 16 |
| 54101 | 0 | 14 |
| 55401 | 0 | 8 |
| 56001 | 0 | 24 |
| 56002 | 0 | 20 |
| Total | 0 | 100 |

TABLE XIII-b. Showing that only non-colored seedlings resulted from both colored and colorless kernels of 109 3:1 $F_3$ ears, progenies of the 9:7 $F_2$ group, indicating the presence of $R^gR^g$.

| 1925 ($F_3$) Selection No. | From colored kernels -seedlings- colored | From colored kernels -seedlings- colorless | From colorless kernels -seedlings- colored | From colorless kernels -seedlings- colorless | 1925 ($F_3$) Selection No. | From colored kernels -seedlings- colored | From colored kernels -seedlings- colorless | From colorless-kernels -seedlings- colored | From colorless-kernels -seedlings- colorless |
|---|---|---|---|---|---|---|---|---|---|
| 53404 | 0 | 24 | 0 | 25 | 54304 | 0 | 20 | 0 | 23 |
| 53405 | 0 | 22 | 0 | 23 | 54305 | 0 | 15 | 0 | 19 |
| 53908 | 0 | 20 | 0 | 11 | 54306 | 0 | 20 | 0 | 18 |
| 53910 | 0 | 25 | 0 | 20 | 54308 | 0 | 25 | 0 | 21 |
| 53911 | 0 | 23 | 0 | 18 | 54310 | 0 | 21 | 0 | 20 |
| 53912 | 0 | 24 | 0 | 21 | 54312 | 0 | 23 | 0 | 20 |
| 53915 | 0 | 23 | 0 | 22 | 54403 | 0 | 25 | 0 | 19 |
| 53918 | 0 | 25 | 0 | 23 | 54404 | 0 | 20 | 0 | 23 |
| 54004 | 0 | 24 | 0 | 21 | 54405 | 0 | 19 | 0 | 21 |
| 54006 | 0 | 23 | 0 | 20 | 54[illegible]08 | 0 | 20 | 0 | 24 |
| 54007 | 0 | 21 | 0 | 15 | 54505 | 0 | 19 | 0 | 24 |
| 54008 | 0 | 24 | 0 | 22 | 54509 | 0 | 20 | 0 | 15 |
| 54009 | 0 | 24 | 0 | 21 | 54512 | 0 | 25 | 0 | 23 |
| 54106 | 0 | 25 | 0 | 23 | 54513 | 0 | 24 | 0 | 15 |
| 54107 | 0 | 24 | 0 | 25 | 54514 | 0 | 14 | 0 | 13 |
| 54108 | 0 | 26 | 0 | 24 | 54515 | 0 | 20 | 0 | 24 |
| 54110 | 0 | 21 | 0 | 23 | 54605 | 0 | 21 | 0 | 21 |
| 54112 | 0 | 24 | 0 | 25 | 54607 | 0 | 24 | 0 | 25 |
| 54116 | 0 | 21 | 0 | 20 | 54608 | 0 | 20 | 0 | 15 |
| 54117 | 0 | 21 | 0 | 20 | 54703 | 0 | 25 | 0 | 20 |
| 54118 | 0 | 21 | 0 | 15 | 54705 | 0 | 21 | 0 | 15 |

TABLE XIII-b (continued)

| 1925 ($F_3$) Selection No. | From colored kernels -seedlings- colored | colorless | From colorless kernels -seedlings- colored | colorless | 1925 ($F_3$) Selection No. | From colored kernels -seedlings- colored | colorless | From colorless kernels -seedlings- colored | colorless |
|---|---|---|---|---|---|---|---|---|---|
| 54708 | 0 | 19 | 0 | 24 | 55602 | 0 | 24 | 0 | 24 |
| 54905 | 0 | 25 | 0 | 21 | 55603 | 0 | 25 | 0 | 25 |
| 54906 | 0 | 25 | 0 | 22 | 55605 | 0 | 23 | 0 | 27 |
| 54908 | 0 | 23 | 0 | 21 | 55902 | 0 | 22 | 0 | 21 |
| 54913 | 0 | 25 | 0 | 21 | 55903 | 0 | 25 | 0 | 23 |
| 55005 | 0 | 26 | 0 | 25 | 55904 | 0 | 25 | 0 | 21 |
| 55006 | 0 | 26 | 0 | 20 | 55907 | 0 | 24 | 0 | 19 |
| 55007 | 0 | 25 | 0 | 23 | 55909 | 0 | 25 | 0 | 20 |
| 55009 | 0 | 23 | 0 | 25 | 56006 | 0 | 22 | 0 | 21 |
| 55405 | 0 | 24 | 0 | 20 | 56007 | 0 | 23 | 0 | 23 |
| 55408 | 0 | 5 | 0 | 19 | 56008 | 0 | 21 | 0 | 24 |
| 55409 | 0 | 27 | 0 | 20 | 56106 | 0 | 23 | 0 | 25 |
| 55410 | 0 | 25 | 0 | 20 | 56107 | 0 | 25 | 0 | 21 |
| 55411 | 0 | 21 | 0 | 19 | 56202 | 0 | 24 | 0 | 25 |
| 55502 | 0 | 25 | 0 | 20 | 56203 | 0 | 21 | 0 | 19 |
| 55504 | 0 | 19 | 0 | 15 | 56204 | 0 | 22 | 0 | 20 |
| 55505 | 0 | 25 | 0 | 21 | 56206 | 0 | 23 | 0 | 24 |
| 55508 | 0 | 24 | 0 | 24 | 56302 | 0 | 25 | 0 | 22 |
| 55509 | 0 | 24 | 0 | 20 | 56303 | 0 | 24 | 0 | 23 |
| 55510 | 0 | 25 | 0 | 21 | 56307 | 0 | 27 | 0 | 24 |
| 55511 | 0 | 24 | 0 | 22 | 56502 | 0 | 21 | 0 | 20 |
| 55512 | 0 | 25 | 0 | 23 | 56503 | 0 | 25 | 0 | 20 |

TABLE XIII-b (continued)

| 1925 ($F_3$) Selection No. | From colored kernels -seedlings- colored | | From colorless kernels -seedlings- colored | |
|---|---|---|---|---|
| | colored | colorless | colored | colorless |
| 56506 | 0 | 25 | 0 | 20 |
| 56608 | 0 | 26 | 0 | 25 |
| 56609 | 0 | 25 | 0 | 24 |
| 56703 | 0 | 24 | 0 | 25 |
| 57003 | 0 | 23 | 0 | 24 |
| 57004 | 0 | 25 | 0 | 19 |
| 57006 | 0 | 21 | 0 | 15 |
| 57104 | 0 | 24 | 0 | 18 |
| 57105 | 0 | 25 | 0 | 19 |
| 57203 | 0 | 24 | 0 | 19 |
| 57302 | 0 | 23 | 0 | 20 |
| 57303 | 0 | 24 | 0 | 18 |
| 57304 | 0 | 25 | 0 | 15 |
| 57305 | 0 | 25 | 0 | 16 |
| 57402 | 0 | 25 | 0 | 17 |
| 57403 | 0 | 24 | 0 | 18 |
| 57703 | 0 | 23 | 0 | 20 |
| 57706 | 0 | 25 | 0 | 21 |
| 58103 | 0 | 24 | 0 | 25 |
| 58106 | 0 | 23 | 0 | 21 |
| 58107 | 0 | 22 | 0 | 20 |
| 58108 | 0 | 24 | 0 | 25 |
| 58303 | 0 | 25 | 0 | 24 |
| Total ... | 0 .. | 2504 ..... | 0 .. | 2261 |

TABLE XIII-c. Showing that the colored kernels from 97 3:1 $F_3$ ears of the 9:7 $F_2$ group gave colored and non-colored seedlings in ratio of 2:1 indicating the presence of $R^g r^r$ and $R^g R^g$ respectively while the colorless kernels of the same ears gave only colored seedlings indicating the presence of $r^r r^r$.

| 1925 ($F_3$) Selection No. | From colored kernels | | From colorless kernels | |
|---|---|---|---|---|
| | colored seedlings | colorless seedlings | colored seedlings | colorless seedlings |
| 51601 | 19 | 12 | 5 | 0 |
| 51602 | 16 | 7 | 25 | 0 |
| 51603 | 19 | 9 | 24 | 0 |
| 53403 | 18 | 10 | 23 | 0 |
| 53904 | 14 | 5 | 22 | 0 |
| 53905 | 23 | 5 | 22 | 0 |
| 53906 | 18 | 8 | 22 | 0 |
| 53907 | 17 | 9 | 24 | 0 |
| 53909 | 21 | 10 | 17 | 0 |
| 53913 | 14 | 7 | 25 | 0 |
| 53914 | 16 | 7 | 12 | 0 |
| 53916 | 20 | 7 | 17 | 0 |
| 53917 | 15 | 9 | 10 | 0 |
| 53919 | 15 | 7 | 24 | 0 |
| 54005 | 19 | 10 | 24 | 0 |
| 54010 | 16 | 6 | 12 | 0 |
| 54103 | 18 | 10 | 16 | 0 |
| 54104 | 15 | 8 | 18 | 0 |
| 54105 | 13 | 5 | 18 | 0 |
| 54109 | 20 | 13 | 23 | 0 |
| 54111 | 17 | 12 | 11 | 0 |

TABLE XIII-c (continued)

| 1925 ($F_3$) Selection No. | From colored kernels colored seedlings | colorless seedlings | From colorless kernels colored seedlings | colorless seedlings |
|---|---|---|---|---|
| 54113 | 12 | 7 | 17 | 0 |
| 54114 | 10 | 8 | 20 | 0 |
| 54115 | 25 | 14 | 22 | 0 |
| 54203 | 16 | 12 | 15 | 0 |
| 54204 | 15 | 6 | 24 | 0 |
| 54205 | 21 | 16 | 19 | 0 |
| 54207 | 13 | 8 | 20 | 0 |
| 54208 | 13 | 8 | 19 | 0 |
| 54213 | 11 | 6 | 20 | 0 |
| 54307 | 11 | 6 | 23 | 0 |
| 54309 | 22 | 9 | 20 | 0 |
| 54311 | 14 | 12 | 22 | 0 |
| 54313 | 14 | 8 | 24 | 0 |
| 54406 | 15 | 10 | 22 | 0 |
| 54407 | 16 | 9 | 22 | 0 |
| 54503 | 13 | 9 | 22 | 0 |
| 54506 | 17 | 8 | 23 | 0 |
| 54507 | 19 | 7 | 25 | 0 |
| 54508 | 18 | 7 | 22 | 0 |
| 54510 | 15 | 8 | 25 | 0 |
| 54511 | 18 | 8 | 23 | 0 |
| 54604 | 15 | 7 | 21 | 0 |
| 54606 | 19 | 8 | 23 | 0 |

TABLE XIII-c (continued)

| 1925 ($F_3$) Selection No. | From colored kernels | | From colorless kernels | |
|---|---|---|---|---|
| | colored seedlings | colorless seedlings | colored seedlings | colorless seedlings |
| 54704 | 21 | 9 | 25 | 0 |
| 54706 | 17 | 8 | 23 | 0 |
| 54707 | 18 | 8 | 24 | 0 |
| 54907 | 21 | 9 | 22 | 0 |
| 54909 | 18 | 7 | 23 | 0 |
| 54910 | 19 | 8 | 25 | 0 |
| 54911 | 21 | 8 | 21 | 0 |
| 54912 | 10 | 4 | 22 | 0 |
| 55004 | 17 | 10 | 14 | 0 |
| 55008 | 15 | 9 | 19 | 0 |
| 55010 | 18 | 10 | 17 | 0 |
| 55404 | 18 | 8 | 25 | 0 |
| 55406 | 16 | 10 | 20 | 0 |
| 55407 | 15 | 8 | 27 | 0 |
| 55412 | 19 | 11 | 24 | 0 |
| 55503 | 14 | 6 | 22 | 0 |
| 55506 | 20 | 8 | 21 | 0 |
| 55507 | 20 | 7 | 24 | 0 |
| 55604 | 20 | 11 | 23 | 0 |
| 55905 | 21 | 10 | 24 | 0 |
| 55906 | 20 | 12 | 23 | 0 |
| 55908 | 23 | 10 | 24 | 0 |
| 55910 | 19 | 11 | 24 | 0 |

TABLE XIII-c (continued)

| 1925 ($F_3$) Selection No. | From colored kernels | | From colorless kernels | |
|---|---|---|---|---|
| | colored seedlings | colorless seedlings | colored seedlings | colorless seedlings |
| 56004 | 16 | 8 | 25 | 0 |
| 56005 | 18 | 8 | 24 | 0 |
| 56009 | 11 | 5 | 25 | 0 |
| 56010 | 23 | 9 | 24 | 0 |
| 56102 | 17 | 8 | 21 | 0 |
| 56103 | 13 | 10 | 22 | 0 |
| 56104 | 14 | 9 | 23 | 0 |
| 56105 | 11 | 6 | 21 | 0 |
| 56205 | 13 | 9 | 25 | 0 |
| 56304 | 23 | 9 | 25 | 0 |
| 56305 | 15 | 9 | 26 | 0 |
| 56306 | 14 | 8 | 20 | 0 |
| 56504 | 14 | 9 | 24 | 0 |
| 56505 | 21 | 10 | 22 | 0 |
| 56604 | 14 | 9 | 23 | 0 |
| 56605 | 18 | 10 | 21 | 0 |
| 56606 | 14 | 9 | 21 | 0 |
| 56607 | 17 | 10 | 19 | 0 |
| 56704 | 19 | 9 | 20 | 0 |
| 57005 | 16 | 9 | 21 | 0 |
| 57103 | 20 | 10 | 23 | 0 |
| 57202 | 27 | 10 | 25 | 0 |
| 57306 | 12 | 7 | 21 | 0 |

TABLE XIII-c (continued)

| 1925 ($F_3$) Selection No. | From colored kernels | | From colorless kernels | |
|---|---|---|---|---|
| | colored seedlings | colorless seedlings | colored seedlings | colorless seedlings |
| 57404 | 32 | 17 | 24 | 0 |
| 57704 | 23 | 10 | 24 | 0 |
| 57705 | 20 | 11 | 25 | 0 |
| 58104 | 23 | 12 | 19 | 0 |
| 58105 | 17 | 9 | 21 | 0 |
| 58302 | 23 | 12 | 25 | 0 |
| 58304 | 21 | 11 | 21 | 0 |
| TOTAL (97 ears) | | | | |
| Actual | 1684 | 881 | 2083 | 0 |
| Expected | 1710 | 855 | | |
| Deviation | -26 | +26 | | |

$$\frac{\text{Dev.}}{\text{P.E.}} = \frac{26}{16.1} = 1.6$$

TABLE XIII-d. Showing that colored seeds of 43 9:7 $F_3$ ears of the 9:7 $F_2$ group gave 2:1 ratio of colored to non-colored seedlings.

| 1925 ($F_3$) Selection No. | Number of seedlings Colored | Number of seedlings Non-colored | 1925 ($F_3$) Selection No. | Number of seedlings Colored | Number of seedlings Non-colored |
|---|---|---|---|---|---|
| 51604 | 22 | 6 | 55613 | 24 | 15 |
| 51606 | 26 | 10 | 55614 | 24 | 11 |
| 51608 | 20 | 11 | 55616 | 21 | 15 |
| 53920 | 20 | 11 | 55617 | 17 | 11 |
| 53925 | 24 | 9 | 55618 | 16 | 11 |
| 53926 | 22 | 8 | 56015 | 23 | 11 |
| 53929 | 18 | 12 | 56016 | 14 | 11 |
| 53931 | 11 | 9 | 56311 | 13 | 7 |
| 54013 | 21 | 13 | 56312 | 13 | 9 |
| 54016 | 20 | 11 | 56315 | 16 | 11 |
| 54018 | 17 | 12 | 56512 | 12 | 7 |
| 54126 | 13 | 7 | 56513 | 16 | 9 |
| 54127 | 20 | 9 | 56616 | 20 | 11 |
| 54128 | 24 | 9 | 56710 | 22 | 7 |
| 54129 | 23 | 11 | 57011 | 26 | 12 |
| 54133 | 23 | 14 | 57308 | 15 | 10 |
| 54516 | 23 | 12 | 57309 | 21 | 9 |
| 54518 | 18 | 11 | 57710 | 15 | 9 |
| 54610 | 23 | 11 | 57712 | 14 | 8 |
| 54620 | 17 | 10 | 57713 | 18 | 12 |
| 54624 | 23 | 12 | Actual total | 831 ...... | 458 |
| 54710 | 21 | 12 | Theoretical total | 859.3 .... | 429.7 |
| 54712 | 22 | 12 | Deviation | -28.3 .... | +28.3 |

$$\frac{\text{Dev.}}{\text{P.E.}} = \frac{28.3}{11.3} = 2.4$$

on the basis of 2:1. This shows a deviation of 26.3 which is 2.4 times its probable error. Obviously, observations coincide with expectation fairly well. The results are seen in Table XIII-d.

$F_3$ seedling behavior in the 27:37 $F_2$ group

In this group it should be remembered that the $F_3$ ears are of four kinds of Mendelian ratios. They are 1:0, 3:1, 9:7, and 27:37 ratios.

Five of 1:0 $F_3$ ears were tested for $R^gR^g$ and they all gave non-colored seedlings. This is just what would be expected, from results in the group of 1:0 $F_3$ ears from 9:7 $F_3$ ears, and gives substantial support to the hypothesis formulated in diagrams a and b. The results are listed in Table XIV-a.

Table XIV-b shows that a total of 117 $F_3$ 3:1 ears gave all non-colored seedlings from both the colored and the colorless seeds. Therefore, they all carried $R^gR^g$ (see diagram b) as expected. It should be recalled that some of these ears had colorless seeds which proved to be the A-tester types and that some of them had colorless seeds which proved to be the C-tester types, as was shown in Table IX-b. Here is another critical test in support of the hypothesis. It was the $R^gR^g$ factor which caused the C-tester type to be indistinguishable from the A-tester type in the seedling tests. The C-tester type would be easily rogued out by the seedling test, if either $R^rR^r$ or $R^gR^r$ were present.

Fifty-six 3:1 $F_3$ ears, as shown in Table XIV-c, were known as the R-tester types. The colored seeds gave 1051 colored seedlings

TABLE XIV-a. Showing that only non-colored seedlings resulted from 5 1:0 $F_3$ ears which were progenies of the 27:37 $F_2$ group, conclusively indicating the presence of $R^gR^g$ ($AACCR^gR^g$).

| 1925 ($F_3$) Selection No. | Number of seedlings | |
|---|---|---|
| | Colored | non-colored |
| 51901 | 0 | 18 |
| 51902 | 0 | 19 |
| 53801 | 0 | 16 |
| 57201 | 0 | 16 |
| 59101 | 0 | 19 |
| Total ........ | 0 ........ | 88 |

**TABLE XIV-b.** Showing that 117 $F_3$ ears, progenies of the 27:37 $F_2$ group, gave all non-colored seedlings from both colored and colorless seeds, thereby indicating presence of $R^gR^g$.

| 1925 ($F_3$) Selection No. | From colored kernels -seedlings- colored | From colored kernels -seedlings- colorless | From colorless kernels -seedlings- colored | From colorless kernels -seedlings- colorless | 1925 ($F_3$) Selection No. | From colored kernels -seedlings- colored | From colored kernels -seedlings- colorless | From colorless kernels -seedlings- colored | From colorless kernels -seedlings- colorless |
|---|---|---|---|---|---|---|---|---|---|
| 51201 | 0 | 25 | 0 | 24 | 52201 | 0 | 23 | 0 | 26 |
| 51202 | 0 | 26 | 0 | 25 | 52202 | 0 | 22 | 0 | 24 |
| 51204 | 0 | 25 | 0 | 26 | 52204 | 0 | 23 | 0 | 25 |
| 51205 | 0 | 26 | 0 | 27 | 52205 | 0 | 24 | 0 | 21 |
| 51304 | 0 | 24 | 0 | 19 | 52301 | 0 | 22 | 0 | 23 |
| 51305 | 0 | 25 | 0 | 20 | 52401 | 0 | 25 | 0 | 24 |
| 51402 | 0 | 23 | 0 | 21 | 52504 | 0 | 24 | 0 | 25 |
| 51403 | 0 | 22 | 0 | 19 | 52508 | 0 | 21 | 0 | 21 |
| 51405 | 0 | 25 | 0 | 20 | 52602 | 0 | 25 | 0 | 20 |
| 51406 | 0 | 24 | 0 | 16 | 52603 | 0 | 25 | 0 | 21 |
| 51502 | 0 | 25 | 0 | 15 | 52701 | 0 | 26 | 0 | 24 |
| 51504 | 0 | 26 | 0 | 6 | 52702 | 0 | 24 | 0 | 20 |
| 51701 | 0 | 25 | 0 | 20 | 52703 | 0 | 25 | 0 | 21 |
| 51703 | 0 | 26 | 0 | 21 | 52803 | 0 | 20 | 0 | 19 |
| 51704 | 0 | 24 | 0 | 22 | 52902 | 0 | 25 | 0 | 21 |
| 51705 | 0 | 22 | 0 | 19 | 53002 | 0 | 26 | 0 | 23 |
| 51706 | 0 | 21 | 0 | 18 | 53004 | 0 | 24 | 0 | 24 |
| 51801 | 0 | 20 | 0 | 20 | 53005 | 0 | 25 | 0 | 25 |
| 51802 | 0 | 25 | 0 | 20 | 53006 | 0 | 25 | 0 | 20 |
| 52002 | 0 | 24 | 0 | 21 | 53202 | 0 | 25 | 0 | 20 |
| 52003 | 0 | 24 | 0 | 20 | 53203 | 0 | 21 | 0 | 21 |
| 52101 | 0 | 25 | 0 | 25 | 53205 | 0 | 24 | 0 | 24 |

TABLE XIV-b (continued)

| 1925 ($F_3$) Selection No. | From colored kernels -seedlings- colored | From colored kernels -seedlings- colorless | From colorless kernels -seedlings- colored | From colorless kernels -seedlings- colorless | 1925 ($F_3$) Selection No. | From colored kernels -seedlings- colored | From colored kernels -seedlings- colorless | From colorless kernels -seedlings- colored | From colorless kernels -seedlings- colorless |
|---|---|---|---|---|---|---|---|---|---|
| 53207 | 0 | 23 | 0 | 23 | 55703 | 0 | 21 | 0 | 17 |
| 53302 | 0 | 24 | 0 | 24 | 55704 | 0 | 22 | 0 | 18 |
| 53303 | 0 | 25 | 0 | 25 | 55802 | 0 | 23 | 0 | 11 |
| 53304 | 0 | 24 | 0 | 21 | 55803 | 0 | 24 | 0 | 19 |
| 53306 | 0 | 24 | 0 | 22 | 55804 | 0 | 23 | 0 | 20 |
| 53501 | 0 | 25 | 0 | 19 | 56401 | 0 | 24 | 0 | 24 |
| 53601 | 0 | 22 | 0 | 18 | 56402 | 0 | 24 | 0 | 24 |
| 53803 | 0 | 23 | 0 | 19 | 56403 | 0 | 25 | 0 | 20 |
| 53804 | 0 | 24 | 0 | 20 | 56801 | 0 | 25 | 0 | 21 |
| 53805 | 0 | 25 | 0 | 21 | 56802 | 0 | 25 | 0 | 23 |
| 54801 | 0 | 25 | 0 | 23 | 56804 | 0 | 24 | 0 | 20 |
| 54802 | 0 | 26 | 0 | 24 | 56902 | 0 | 26 | 0 | 23 |
| 54805 | 0 | 27 | 0 | 21 | 56903 | 0 | 23 | 0 | 24 |
| 55103 | 0 | 25 | 0 | 25 | 56905 | 0 | 24 | 0 | 20 |
| 55202 | 0 | 24 | 0 | 21 | 57501 | 0 | 25 | 0 | 21 |
| 55203 | 0 | 22 | 0 | 24 | 57602 | 0 | 21 | 0 | 19 |
| 55205 | 0 | 23 | 0 | 25 | 57603 | 0 | 23 | 0 | 18 |
| 55302 | 0 | 24 | 0 | 20 | 57802 | 0 | 24 | 0 | 15 |
| 55303 | 0 | 25 | 0 | 21 | 57901 | 0 | 21 | 0 | 12 |
| 55304 | 0 | 26 | 0 | 23 | 58002 | 0 | 24 | 0 | 17 |
| 55305 | 0 | 24 | 0 | 20 | 58004 | 0 | 25 | 0 | 18 |
| 55307 | 0 | 24 | 0 | 19 | 58201 | 0 | 25 | 0 | 16 |
| 55702 | 0 | 22 | 0 | 15 | 58202 | 0 | 20 | 0 | 19 |

TABLE XIV-b (continued)

| 1925 ($F_3$) Selection No. | From colored kernels -seedlings- colored | From colored kernels -seedlings- colorless | From colorless kernels -seedlings- colored | From colorless kernels -seedlings- colorless |
|---|---|---|---|---|
| 58204 | 0 | 24 | 0 | 20 |
| 58403 | 0 | 25 | 0 | 19 |
| 58404 | 0 | 25 | 0 | 20 |
| 58405 | 0 | 25 | 0 | 15 |
| 58406 | 0 | 21 | 0 | 16 |
| 58407 | 0 | 24 | 0 | 17 |
| 58409 | 0 | 23 | 0 | 12 |
| 58501 | 0 | 24 | 0 | 18 |
| 58502 | 0 | 25 | 0 | 20 |
| 58602 | 0 | 25 | 0 | 21 |
| 58603 | 0 | 20 | 0 | 23 |
| 58604 | 0 | 22 | 0 | 24 |
| 58701 | 0 | 27 | 0 | 23 |
| 58702 | 0 | 25 | 0 | 24 |
| 58704 | 0 | 25 | 0 | 25 |
| 58802 | 0 | 21 | 0 | 19 |
| 58803 | 0 | 24 | 0 | 20 |
| 58902 | 0 | 25 | 0 | 21 |
| 58903 | 0 | 24 | 0 | 23 |
| 58904 | 0 | 21 | 0 | 24 |
| 59002 | 0 | 21 | 0 | 21 |
| 59003 | 0 | 23 | 0 | 23 |
| 59102 | 0 | 25 | 0 | 19 |
| 59103 | 0 | 21 | 0 | 17 |
| 59204 | 0 | 25 | 0 | 18 |
| 59205 | 0 | 24 | 0 | 21 |
| 59206 | 0 | 25 | 0 | 23 |
| Total... | 0 ... | 2792.... | 0 .. | 2404 |

TABLE XIV-c. Showing that 56 3:1 $F_3$ ears of the 27:37 $F_2$ group gave colored and colorless seedlings in a ratio of 2:1 from colored seeds thereby indicating presence of $R^gr^r$ and $R^gR^g$ respectively and only colored seedlings from colorless seeds thereby indicating $r^rr^r$.

| 1925 ($F_3$) Selection No. | From colored seeds | | From colorless seeds | |
|---|---|---|---|---|
| | colored seedlings | colorless seedlings | colored seedlings | colorless seedlings |
| 51203 | 17 | 10 | 20 | 0 |
| 51301 | 18 | 10 | 22 | 0 |
| 51302 | 21 | 7 | 24 | 0 |
| 51303 | 19 | 9 | 22 | 0 |
| 51404 | 14 | 6 | 23 | 0 |
| 51407 | 23 | 11 | 32 | 0 |
| 51413 | 19 | 10 | 27 | 0 |
| 51503 | 20 | 29 | 30 | 0 |
| 51702 | 8 | 4 | 21 | 0 |
| 51707 | 18 | 8 | 19 | 0 |
| 51803 | 22 | 10 | 15 | 0 |
| 51904 | 13 | 8 | 11 | 0 |
| 51905 | 19 | 13 | 22 | 0 |
| 51906 | 15 | 9 | 23 | 0 |
| 52001 | 18 | 10 | 26 | 0 |
| 52203 | 15 | 8 | 25 | 0 |
| 52402 | 15 | 10 | 21 | 0 |
| 52502 | 25 | 10 | 17 | 0 |
| 52503 | 24 | 9 | 24 | 0 |
| 52505 | 12 | 7 | 25 | 0 |
| 52507 | 15 | 9 | 27 | 0 |

TABLE XIV-c.(Continued)

| 1925 ($F_3$) Selection No. | From colored seeds colored seedlings | From colored seeds colorless seedlings | From colorless seeds colored seedlings | From colorless seeds colorless seedlings |
|---|---|---|---|---|
| 52510 | 17 | 8 | 18 | 0 |
| 52901 | 17 | 9 | 20 | 0 |
| 52902 | 13 | 8 | 8 | 0 |
| 53003 | 16 | 8 | 7 | 0 |
| 53101 | 22 | 14 | 27 | 0 |
| 53204 | 12 | 16 | 29 | 0 |
| 53206 | 17 | 9 | 25 | 0 |
| 53305 | 14 | 8 | 22 | 0 |
| 53502 | 13 | 8 | 6 | 0 |
| 54804 | 16 | 9 | 17 | 0 |
| 55102 | 16 | 8 | 18 | 0 |
| 55104 | 18 | 7 | 20 | 0 |
| 55204 | 16 | 11 | 14 | 0 |
| 55306 | 16 | 9 | 15 | 0 |
| 55705 | 13 | 6 | 20 | 0 |
| 55805 | 20 | 8 | 21 | 0 |
| 56803 | 20 | 9 | 25 | 0 |
| 56904 | 19 | 10 | 21 | 0 |
| 57803 | 15 | 7 | 25 | 0 |
| 58003 | 15 | 6 | 24 | 0 |
| 58005 | 11 | 5 | 19 | 0 |
| 58203 | 19 | 8 | 23 | 0 |

TABLE XIV-c (continued)

| 1925 ($F_3$) Selection No. | From colored seeds colored seedlings | colorless seedlings | From colorless seeds colored seedlings | colorless seedlings |
|---|---|---|---|---|
| 58402 | 31 | 15 | 24 | 0 |
| 58408 | 19 | 11 | 24 | 0 |
| 58503 | 19 | 12 | 21 | 0 |
| 58504 | 12 | 5 | 23 | 0 |
| 58605 | 29 | 11 | 23 | 0 |
| 58609 | 29 | 15 | 21 | 0 |
| 58703 | 27 | 16 | 24 | 0 |
| 58801 | 33 | 20 | 20 | 0 |
| 58804 | 33 | 15 | 24 | 0 |
| 58905 | 24 | 16 | 22 | 0 |
| 59001 | 19 | 11 | 23 | 0 |
| 59202 | 35 | 16 | 44 | 0 |
| 59203 | 18 | 10 | 25 | 0 |
| Actual total | 1051 . . . . | 571 . . . . . | 1215 . . . | 0 |
| Expected total (2:1) | 1081.3 . . . | 540.7 | | |
| Deviation | -30.3 . . . | +30.3 | | |

$$\frac{\text{Dev.}}{\text{P.E.}} = \frac{30.3}{12.7} = 2.3$$

and 571 non-colored seedlings, where 1081.3:540.7 of colored to non-colored ones were expected. The deviation of 30.3 is 2.3 times its probable error; thus, the observation is fairly close to expectancy. The colored seedlings were, naturally, $AACCR^gr^r$, and the non-colored, $AACCR^gR^g$. All colorless seeds from these ears produced only colored seedlings as $r^rr^r$ was present. Their genotype was, of course, $AACCr^rr^r$ (see diagram b).

As shown in Tables XIV-d and XIV-e, of 56 9:7 ears 43 gave 835:443 of colored to non-colored seedlings where 852:426 are expected on a ratio of 2:1 ($\frac{Dev.}{P.E.} = 1.5$), just as in the case of $F_2$. The remaining 13 9:7 $F_3$ ears gave only non-colored seedlings from both colored and colorless seeds. This gives a substantial verification to the hypothesis designated in diagram b (page 70). Theoretically, there are two sorts of 9:7 $F_3$ ears, one with $R^gr^r$, and the other with $R^gR^g$ in the proportion of 2:1, hence the 43 9:7 $F_3$'s should be of the former type and the remaining 13 should be of the latter type. They are practically in a ratio of 2:1 when the deviation of 5.7 is 2.5 times its probable error (2.3). The conclusion is, then, that observations agree fairly well with expectation.

Twenty-nine 27:37 $F_3$ ears behaved in the same manner as in $F_2$ giving 652:344 of colored to non-colored seedlings where 664:332 are expected. This results in a deviation of 12, which is only 1.2 times its probable error. Observations are conclusively close to expectancy. The data are arranged in Table XIV-f.

Summarizing the above investigation, all data have accorded

**TABLE XIV-d.** Showing that 43 9:7 $F_3$ ears of the 27:37 $F_2$ group, produced colored and colorless seedlings in the ratio of 2:1, thereby indicating the presence of $R^g r^r$.

| 1925 ($F_3$) Selection No. | Number of seedlings colored | non-colored | 1925 ($F_3$) Selection No. | Number of seedlings colored | non-colored |
|---|---|---|---|---|---|
| 51209 | 35 | 22 | 58505 | 17 | 10 |
| 51210 | 34 | 18 | 58618 | 9 | 4 |
| 51212 | 41 | 19 | 58622 | 13 | 7 |
| 51213 | 40 | 21 | 58625 | 10 | 6 |
| 51306 | 23 | 8 | 58705 | 14 | 10 |
| 51308 | 27 | 12 | 58706 | 8 | 7 |
| 51314 | 35 | 14 | 50711 | 15 | 7 |
| 51408 | 35 | 19 | 58805 | 13 | 6 |
| 51409 | 22 | 6 | 58808 | 16 | 10 |
| 51415 | 20 | 9 | 58809 | 20 | 9 |
| 51512 | 12 | 6 | 58810 | 17 | 10 |
| 53806 | 15 | 11 | 58812 | 16 | 9 |
| 53811 | 16 | 9 | 58813 | 19 | 11 |
| 53812 | 19 | 10 | 58815 | 16 | 9 |
| 55310 | 21 | 7 | 58816 | 12 | 7 |
| 55312 | 20 | 10 | 58817 | 16 | 10 |
| 56908 | 14 | 9 | 58907 | 19 | 10 |
| 57205 | 14 | 7 | 58908 | 14 | 10 |
| 57207 | 23 | 13 | 59005 | 12 | 11 |
| | | | 59009 | 10 | 4 |
| 57507 | 22 | 10 | Total (43 ears) | | |
| | | | Actual | 835 | 443 |
| 57509 | 23 | 14 | Expected | 852 | 426 |
| | | | Deviation | -17 | +17 |
| 58412 | 17 | 11 | | | |
| 58417 | 21 | 11 | | | |

$$\frac{\text{Dev.}}{\text{P.E.}} = \frac{17}{11.3} = 1.5$$

TABLE XIV-e. Showing that 13 9:7 $F_3$ ears of the 27:37 $F_2$ group produced only non-colored seedlings from both colored and colorless seeds, thereby indicating the presence of RErE.

| 1925 ($F_3$) | From colored seeds | | From non-colored seeds | |
|---|---|---|---|---|
| Selection No. | colored seedlings | non-colored seedlings | colored seedlings | non-rolored seedlings |
| 51207 | 0 | 40 | 0 | 19 |
| 51208 | 0 | 50 | 0 | 25 |
| 51211 | 0 | 62 | 0 | 24 |
| 51307 | 0 | 51 | 0 | 26 |
| 51522 | 0 | 36 | 0 | 33 |
| 55311 | 0 | 32 | 0 | 30 |
| 56912 | 0 | 30 | 0 | 26 |
| 57810 | 0 | 28 | 0 | 24 |
| 58506 | 0 | 17 | 0 | 25 |
| 58806 | 0 | 25 | 0 | 30 |
| 58811 | 0 | 20 | 0 | 29 |
| 59007 | 0 | 17 | 0 | 17 |
| 58912 | 0 | 17 | 0 | 18 |
| Total-13 ears | 0 | 425 | 0 | 759 |

TABLE XIV-f. Showing that the colored seeds of 29 27:37 $F_3$ ears of the 27:37 $F_2$ group give colored and non-colored seedlings in a ratio of 2:1.

| 1925 ($F_3$) Selection No. | Number of seedlings colored | non-colored | 1925 ($F_3$) Selection No. | Number of seedlings colored | non-colored |
|---|---|---|---|---|---|
| 51214 | 38 | 24 | 58610 | 20 | 5 |
| 51217 | 36 | 20 | 58620 | 12 | 7 |
| 51218 | 40 | 17 | 58630 | 14 | 8 |
| 51219 | 36 | 21 | 58715 | 20 | 9 |
| 51220 | 42 | 18 | 58911 | 7 | 3 |
| 51221 | 39 | 23 | 58913 | 22 | 13 |
| 51315 | 23 | 11 | 58916 | 12 | 8 |
| 51316 | 24 | 14 | 58920 | 13 | 8 |
| 51421 | 20 | 12 | Actual total | 652 . . . | 344 |
| 51520 | 15 | 10 | Theoretical total (2:1) | 664 . . . | 332 |
| 53613 | 22 | 10 | Deviation | -12 . . . | +12 |
| 53814 | 20 | 9 | | | |
| 55316 | 22 | 12 | | | |
| 55317 | 15 | 17 | | | |
| 56814 | 17 | 10 | | | |
| 56914 | 17 | 8 | | | |
| 56919 | 23 | 10 | | | |
| 57213 | 17 | 9 | | | |
| 57815 | 17 | 8 | | | |
| 58318 | 21 | 9 | | | |
| 58415 | 26 | 11 | | | |

$$\frac{\text{Dev.}}{\text{P.E.}} = \frac{12}{10.0} = 1.2$$

with the hypothesis as indicated in diagrams a and b. Therefore, Emerson's A-tester, the male $P_1$ parent in the original crosses, contained $R^gR^g$ and its constitution was $aaCCR^gR^g$, and the maternal $P_1$ strains of corn contained $r^rr^r$ and their constitutions may be written as: $AACCr^rr^r$, $AACcr^rr^r$, or $AAccr^rr^r$.

SUMMARY

1. The work was started in 1923 by the late Professor F. A. Spragg and his associates with an aim to develop a commercial corn, called "A-tester Yellow Dent", for the Michigan farmer. Strains of such corn have been developed by this present work.

2. In order to develop this type of corn, 24 strains, which were used for corn breeding work here, were crossed with Emerson's A-tester corn which is a white flint having genetic constitution aaCCRR. It was hoped that, in the third generation ($F_3$), strains of this new corn, having the genetic constitution aaCCRR combined with the yellow dent character from the maternal $P_1$ strains, would be obtained by genetical breeding processes.

3. All maternal $P_1$ strains that have been tested were found to be AA and rr, but were inconsistent for the C factor. These results coincide with Dr. Emerson's. Some of the strains were CC, some were Cc, and some others had cc individuals. For instance, strains of M. A. C. had all three forms. Their compositions can be written as: AACCrr, AACcrr and AAccrr. Nelson X Bailey and Bailey were found to be AAccrr.

4. When these 3 types of corn, AACCrr, AACcrr and AAccrr were crossed with A-tester (aaCCRR), all $F_1$ ears were colored, but they bred differently in $F_2$ when self-pollinated. The $F_1$ genotype AaCCRr from AACCrr X aaCCRR gave ears in 9:7 ratio of colored to colorless seeds, while the $F_1$ genotype AaCcRr from AAccrr X aaCCRR produced ears in 27:37 ratios. The cross of AACcrr X aaCCRR resulted in 2 $F_1$ genotypes, AaCCRr and AaCcRr. This kind of $F_1$ ears produced both 9:7 ears and 27:37 ears in the $F_2$ generation in equal numbers.

5. Colored seeds from 9:7 ears and from 27:37 ears bred very differently in $F_3$ when self-pollinated. The former group gave ears with 1:0, 3:1. and 9:7 ratios of colored to colorless aleurones, in proportion of 1:4:4. Of the 3:1 ears, the colorless seeds were either the R-tester types or the A-tester types. The latter types were the ones looked for by the experiment at hand. The other group (27:37 $F_2$ ears) resulted in ears with 1:0, 3:1, 9:7 and 27:37 ratios of colored to colorless aleurones, in proportion 1:6:12:8. The colorless kernels of the 3:1 ears were of 3 sorts. They were the A-, C-, and R-tester types. Only the A-tester types were sought by this experiment, because only from them could the A-tester strains be developed.

6. The A-tester types could be distinguished from the R-tester types by the seedling test as the latter show anthocyanic pigment in seedlings and could be rogued out. However, the A-tester types in the 27:37 $F_2$ group could not be separated out from the C-tester types by this method, because both types resulted in the ears whose

seedlings were non-colored. As the multiple allelomorphic factor $R^gR^g$ was found to be involved in the A-tester types and the C-tester types, the only method of separating these 2 types was to cross them with Emerson's A-, C-, and R-testers in the field. The types which proved to be A-testers, gave colorless ears when crossed with A-testers and gave all-colored ears when crossed with C-testers and with R-testers. The C-tester types produced colorless ears when crossed with C-testers and resulted in all-colored ears when crossed with A-tester and R-tester. The R-tester types produced colorless ears when crossed with R-testers and gave all-colored ears when crossed with A- and C-testers. In such ways the A-tester types have been picked out from the C-tester types.

7. Some statistical data indicate that these A-tester types of corn which lack the A factor are not inferior in height, ear length, and ear weight when compared with the R-tester and the C-tester types which have the A factor.

8. From 371 selfed $F_4$ ears which were A-tester types, 36 with the yellow dent character were considered as desirable for the strains of the A-tester yellow dent corn. Of these 36 ears, 11 were selected as the most desirable ears and may be used in producing a possible commercial variety called "A-tester Yellow Dent".

9. If such a variety is successfully developed from these strains, it will benefit the farmers a great deal, as this corn will aid them in detecting contamination, which is a menace to the pedigree-corn growers.

10. The multiple allelomorphic factors $R^g$ and $r^r$ which are partially responsible for producing anthocyanins in the plant body were found to be involved in the crosses reported in this experiment. Here the factor $r^r$ is recessive for aleurone color and dominant for plant color; it aids in producing anthocyanins in the presence of the A factor. The factor $R^g$ is dominant for aleurone color and recessive for plant color; when it is in homozygous condition, it will cause the plants to be non-colored or green even in the presence of the A factor. It was assumed that $r^r$ was brought into the cross by the maternal $P_1$ strains ($AACCr^rr^r$, $AAccr^rr^r$ or $AACcr^rr^r$) and $R^g$ by the A-tester ($aaCCR^gR^g$). This assumption has been conclusively proved to be correct by the seedling color behaviors in the $F_2$ and $F_3$ generations.

## -BIBLIOGRAPHY-

----

Bregger, T. 1918. Linkage in maize, the C aleurone factor and waxy endosperm. Amer. Nat. 52:57-61.

Burtt-Davy, J. 1914. Maize, its history, cultivation, handling, and uses. XI + 831 pp. figs. 1-245. London; Longmans, Green & Co.

Collins, G. N. 1916. Correlated characters in maize breeding. Jour. Agr. Research 6:435-54

Czartkowski, Adam. 1914. Anthocyanbildung und Aschenbestandteile. Deut. Bot. Gesell. Ber. 32:407-410.

Darbishire, A. D. 1911. Breeding and the Mendelian discovery. VI + 282 pp. 34 figs. 6 pls. New York: Cassell & Co.

East, E. M. 1912. Inheritance of color in the aleurone cells of maize. Amer. Nat. 46:363-365.

East, E. M. and Hayes, H. K. 1911. Inheritance in maize. Conn. Agr. Exp. Sta. Bul. 167:1-142.

Elderton, W. Palin. 1901. Tables for testing the goodness of fit of theory to observation. Biometrika 1:155-163.

Emerson, R. A. 1911. Latent colors in corn. Amer. Breeders' Assoc. 6:233-237.

____________ 1912. The unexpected occurrence of aleurone colors in $F_2$ of a cross between non-colored varieties of maize. Amer. Nat. 46:612-615.

____________ 1918. A fifth pair of factors, Aa, for aleurone color in maize, and its relation to the Cc and Rr pairs. Cornell Univ. Agr. Exp. Sta. Memoir 16:225-289.

____________ 1921. The genetic relations of plant colors in maize. Cornell Univ. Memoir 39:1-156.

Etheridge, W. C. 1921. Characters connected with yield of corn plant. Mo. Agr. Exp. Res. Bul. 46:1-17.

Gernert, W. B. 1912. The analysis of characters in corn and their behavior in transmission. Pp.1-15 (Published by the author. Champaign, Illinois).

Grantham, A. E. 1917. Relation of the vigor of the corn plant to yield. Jour. Amer. Soc. Agron. 9:340-343.

Harris, J. A. 1912. A simple test of the goodness of fit of Mendelian ratios. Amer. Nat. 46:741-745.

Hayes, H. K. and Alexander, L. 1924. Methods of corn breeding. Minn. Agr. Exp. Bul. 210:1-22.

Hayes, H. K. and East, E. M. 1915. Further experiments on inheritance in maize. Conn. Agr. Exp. Sta. Bul. 188:1-31.

Hayes, H. K. and Garber, R. J. 1919. Synthetic production of high protein corn in relation to breeding. Jour. Amer. Soc. Agron. 11:309-318.

__________ 1921. Breeding crop plants. McGraw-Hill Book Co., New York.

Hutchison, E. B. and Wolfe, T. K. 1919. Relation between yield and ear characters. Int. R. Sci. and Prac. Agr. 10:1113-1114.

Jones, D. F. 1924. Methods of seed corn production being revised. Jour. Heredity 15:291-298.

__________ 1925. Genetics in plant and animal improvement. John Wiley & Sons, Inc., New York.

__________ 1920. Selection in self-fertilized lines as the basis for corn improvement. Jour. Amer. Soc. Agron. 12:77-100,

__________ 1922. The productiveness of single and double first-generation corn hybrids. Jour. Amer. Soc. Agron. 14:241-252.

Kirkpatrick, C. D. 1925. Experience in developing a high-yielding strain of corn. Jour. Amer. Soc. Agron. 17:487-8.

Lindstrom, E. W. 1917. Linkage in maize: aleurone and chlorophyll factors. Amer. Nat. 51:225-237.

__________ 1924. Complementary genes for chlorophyll development in maize and their linkage relations. Genetics 9:305-326.

Mendel, Gregor. 1913. Experiments in plant hybridization (Translation, in Mendel's Principles of Heredity by W. Bateson, pp. 317-336).

Pearson, Karl. 1914. Tables for Statisticians and Biometricians. Pp. lxxxiii + 143. London: Cambridge University Press.

Richey, F. D. and Willier, F. G. 1925. Statistical study of the relation between seed-ear characters and productiveness in corn. U. S. D. A. Bul. 1321:1-19.

____________ 1926. Moving average as a basis for measuring correlated variations in agronomic experiments. Jour. Agr. Res. 32:1161-1175.

Stroman, G. N. 1924. Genetic relations of Chlorophyll and Anthocyanin seedling characters in maize. Genetics 9:91-123.

Webber, H. J. 1906. Correlation of characters in plant breeding. Amer. Breeders' Assoc. 2:73-83.

Wheldale, M. 1911. On the formation of anthocyanin. Jour. Genetics 1:133-158.