INHERITANCE STUDIES OF WHITE-CAPPING IN YELLOW DENT MAIZE

THESIS FOR DEGREE OF M. S.

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1926

Maize

Farm crops

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Thesis

Respectfully submitted in partial fulfillment for the degree of Master of Science at Michigan State College of Agriculture and Applied Science

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THESIS

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(1). Statement as to how the question arose.

The late Professor F. A. Spragg had observed from time to time in the course of his researches and observations on corn that when a yellow corn is pollinated by some white corns the resulting F_1 kernels of these crosses were white-capped thus indicating that white-capping was dominant to yellow-capping. He would have investigated the occurance of the white cap, but due to the plant breeding problems of a more important nature which he had at hand, he did not go on with it further, and the problem was allowed to rest.

A new impetus was given to the problem of investigating white cap when Mr. J. R. Duncan, Research Assistant at the Michigan Agricultural Experiment Station brought for analysis to Professor F. A. Spragg a few ears of corn some grains of which were white-capped. These kernels were the open pollinated crosses between Duncan and Silver King, Duncan being the female parent. The former is a yellow corn and the latter a white corn.

(2). The problem.

As stated above, in the case of dent corns, white cap was observed to be dominant to the yellow cap although no exact investigation had been carried on up to 1924, when the writer came to work under the late Professor F. A. Spragg as a graduate student. All the material pertaining to the white cap was given to the writer for further investigation. The problems to be investigated were:-

(1) Whether white cap was due to a Mendelian factor or purely to the effect of the environmental conditions.

(2). Is this factor an inhibitor, and if so, what tissues does it affect?

(3) Previous work on the yellow endosperm color.

An observation of a white-capped kernel reveals that the yellow pigment, so characteristic of a yellow corn, is entirely lacking in the cap region at the crown. This shows that white-capping is a condition of the endosperm. Therefore it was thought desirable to review very briefly the previous work on the yellow endosperm color.

Two factors for the yellow endosperm color in maize have been described. The factor (Y) was first described by East (1910) although Correns (1901) had described it without giving it any symbol. Emerson (1911) also describes it. The factor (Yp) was first described by East (1910) and Emerson (1911). Correns (1901) describes a pale aleurone pigment in maize and this pale yellow was shown by Kvakan (1924) to be identical with brown aleurone (Bn). The factor (Y) gives a dark yellow color, when the modifying factors are present the factor (Y) also gives a deep orange color in the endosperm (Anderson 1924). This orange color is due to the (Y) factor together with the modifying factors because the kernels having the orange color show linkage with (Pl) factor, a factor for plant color in maize (Emerson, 1921; Anderson, 1924.).

II--Material used in this investigation.

As all the material used in this investigation came from different sources, it was thought desirable to tabulate it to make it more intelligible to the reader. The following material was used in this investigation.

Accession number	Name	Description
235	Duncan	Yellow-cap yellow
254	Duncan	Yellow-cap yellow
257	Bailey Connecticut yellow	Yellow-cap yellow
265	Clement's White Cap	White cap yellow
266	Folk's White Cap	White cap yellow
267	Silver King	White
286	Northwestern Dent	Red Pericarp

Accessions 235 and 254 are two inbred strains of yellow-cap yellow endosperm corn.

Accession 257 is a cross between two inbred yellow-cap yellow endosperm strains.

Accession 265 and 266 are two different strains of white cap yellow grown in the State of Michigan.

Accession 267 is a commercial variety of the white corn.

Accession 286 is also a commercial variety of corn.

Accessions 235 and 254 were received from the Farm Crops department of Michigan State College.

Accession 257 was given to the writer by the late Professor F. A. Spragg, while Accessions 265, 266, 267, and 286 were received from Mr. J. R. Duncan, Research Assistant at the Michigan Agricultural Experiment Station.

III--Technic.

(1). Laboratory.

Classification and sorting.

For the purpose of this investigation the above material

was sorted into four classes:

(1). Those grains whose caps were judged to be as white as any caps on the established white-capped variety, furnished by Mr. Duncan.

(2). Grains with white caps all somewhat darker than the lightest, some of them coming from the ears also showing segregation.

(3). This class consisted of grains whose caps were still darker than those in the second class. These came from the ears which were segregating for the pure yellow-capped grains.

(4). Ordinary yellow-capped grains.

For the purpose of classification there were assumed three dominant factors (Wc_1, Wc_2, Wc_3,) and their allelomorphs, which are considered to be the absence of white capping.

Wc_1 is considered to be powerful enough to produce a fully white-capped yellow in the presence of (Y) the factor for the yellow endosperm.

Wc_2 is considered less powerful, and Wc_3 still less powerful producing only light cap of very slight intensity.

This hypothesis was not in the end substantiated, but was found useful in the analysis of the data. It worked out there was only one factor for the white capping, the other conditions being due to modifying factors.

It was comparatively easy to sort the material in 1923 as the material received was well matured. But in 1924, due to the shortness of the growing season, classification was difficult and the material was not entirely mature when harvested. If the

material is even slightly immature it is very hard to differentiate the various shades of white-capping. In 1925 the material was in an excellent condition for classification, as it had a long growing season and hence was thoroughly mature.

(2). Field.

The following method of selfing and crossing was used:-

Various methods of corn pollination have been tried and some of them have been found to be satisfactory and the others are still in the process of experimentation. As soon as the ear buds appeared they were sacked with the glacine bags before any silks appeared. These bags were fastened in such a manner with a clasp that the wind would not blow them away and at the same time the ear buds would have ample room for their development. The ear buds were watched from day to day. (If two or three inches of silks are exposed, about a third of the kernels are represented, when six inches of silks are exposed at least three-fourths of the kernels are represented). When the silks were six inches long pollination was made. The tassels were sacked the day prior to the pollination, so that abundant viable pollen might be obtained for the pollination the next day. In sacking the tassel twelve-pound grocer's paper sacks of heavy quality (NO. 1., 40 lb. Kraft, pinch bottom type) were used. The heavy grade of paper had the advantage of not being torn away by the wind. The two upper leaves were removed before the tassel was sacked. The leaves were not sacked because they transpire and injure the pollen and sometimes collect large quantities of pollen on their surface. The sacks were clasped firmly with a clasp around the stalk below the tassel to prevent the tassel from being broken by the weight of the sack. To accomplish this in a most satisfactory manner, the mouth of the sack was folded as it was folded in the

bundle, and then the corners were folded towards the stalk and the folds, thus formed, were turned together and fastened with a clasp. This method would also keep the sack from being blown away in a heavy wind. The tassel sack was then dated.

The pollination was done in the following way:-

The tassel sack was shaken horizontally and unfastened very carefully to prevent the loss of any pollen. The anthers and the other rubbish that first appear were discarded while the main mass of the pollen still remained in the sack as the fine yellow powder. The glacine sack on the ear was torn off at the top to make an opening and the contents of the pollen sack were carefully emptied onto the silks. The glacine sack was then given a light shake to affect an abundant pollination. The pollen sack was used to cover the ear and fastened with a clasp in such a way that it would not be blown away by the wind, and thus eliminate the danger of foreign pollination. A second date, the date of the pollination, was written on the outside of the sack. A small tag with the date of the pollination, the nature of the pollination (crossed or selfed) and the pedigree number was tied, just above the ear, to the stalk that the ear might be recognized in case the sack was blown away by the wind later in the season. The sacks were left on the ears until the harvest time. In the above method no alcohol was used to disinfect the hands after each pollination, as many investigators suggest, as the hands do not come in contact with the silks.

IV--Description of the white cap.

White-capped grain is easily distinguished from an unmodified yellow cap by the fact that the apex of the grain is white.

Sections of the grain show that the soft starch portion of the endosperm which reaches the apex is in one case pure white and in the other slightly tinged with yellow. The yellow pigment that is so characteristic of the yellow grains having the yellow endosperm is entirely lacking the cap region and as one examines a kernel having a white cap the characteristic yellow pigment is seen clearly just below the cap. Hence, the white-capping is due to the elimination of the color by an inhibitor.

V--Inheritance of white cap (Wc_1).

(1). In Clement's White Cap.

In order to determine the inheritance of Clement's White Cap it was crossed by Bailey Connecticut Yellow, the former being the female parent. These crosses were made in the year 1924. The F_1 seeds of these crosses gave only grains that were white-capped yellow. In Table 1 are summarized the results of these crosses.

When the F_2 white-capped seeds of the above crosses were selfed in 1925, they gave a ratio of 3:1 of the white-capped grains to the yellow grains, thus establishing that the white-capping in this case was due to a single dominant Mendelian factor. Table 2 shows the results of the analysis of these crosses.

That the white capping is due to a single factor in this strain can also be seen by the results of the backcrosses which are summarized in Table 3.

(2). In Folk's White Cap.

Folk's White Cap gives the same results as the Clement's White Cap. When it is crossed by a yellow the F_1 kernels are all white-capped yellow (Table 4). When these F_1 kernels were selfed they gave a ratio in F_2 of three white-capped grains to one yellow-capped grain

(Table 5), showing that the white-capping in this strain is also due to a single dominant Mendelian factor.

The backcrosses substantiate the same conclusions (Table 6).

(3). In Silver King.

In order to establish the existance of a white-capping factor definitely in Silver King, which might not be able to express itself in the absence of the yellow, Silver King was crossed by Bailey Connecticut Yellow. The F_1 seeds of these crosses were all white-capped yellow, thus proving the existance of a white capping factor in Silver King. In Table 7 are summarized the results of these crosses. These white-capped seeds of F_1 generation when selfed the next year, gave a ratio of 3:1 for yellow to white grains. (Table 8)

The yellow grains on further classification of the white caps gave a ratio of 3:1 for the white caps to the yellows. (Table 9).

The backcross data substantiate the same conclusions. (Table 10)

This indicates that the white cap obtained by crossing Silver King x Bailey Connecticut Yellow acts in the same way as did the Clement's White Cap and the Folk's White Cap, in that it is dominant in F_1 and segregates into a 3:1 ratio for the white-capped to the yellow-capped grains in F_2.

VI--1925 data for the determination of the dominance of the white cap.

The material was very hard to classify in 1924 due to the extreme immaturity and because some kernels on each ear could not be classified (Tables 1, 4, 7, last column) it seemed desirable to make some crosses in 1925 of white caps onto the yellow in order to determine definitely the dominance of the white cap. With this aim in view, crosses were made between Duncan and Clement's White Cap, Duncan and Folk's White Cap, and Duncan and Silver King.

The F_1 data of the cross Duncan x Clement's White Cap, as summarized in Table 11, those between Duncan and Folk's White Cap, as summarized in Table 12, and those between Duncan and Silver King, as summarized in Table 13, indicate that the white-capping is dominant in all the cases, because all the grains from these crosses were only white-capped.

VII--Inheritance of white-capping in Northwestern Dent Corn.

Northwestern Dent corn, with a colored pericarp except in the cap region, having been selected for the white endosperm was crossed onto Duncan. The resulting F_1 grains were all white-capped yellow (Table 14) thus proving that in this case also the white-capping factor was dominant.

VIII--Inheritance of white cap (Wc_2).

The F_2 data and the backcrosses both in Clement's White Cap, Folk's White Cap and Silver King show Wc_2 to be dominant to the yellow-cap and give a ratio of 3:1 for the white-capped to the yellow-capped grains in the F_2 generation, when selfed. The white caps in the F_2 generation are of all the shades (Wc_1, Wc_2, Wc_3). This indicates that there must be modifying factors that cause the various shades of the white-capping. If there should be no modifying factors it would be expected that it would segregate in F_2 in a distinctly 3:1 ratio for Wc_2 to yellow on the basis of independent inheritance, which is not the case. (In Tables 15, 16, 17, and 17A) are listed the results of these crosses.

The presence of the modifying factors can also be ascertained by studying the backcrosses wcY x (Wc_2Y x wcY) from each of the above strains. The results of these backcrosses are listed in Tables 18, 19, and 20).

If Wc_2 was an independent factor it would segregate into a 1:1 ratio for Wc_2 to yellows in the backcrosses mentioned above, which is not the case. The white caps obtained are not only Wc_2 but all the shades (Wc_1, Wc_2, Wc_3). This again substantiates the conclusions made above as to the modifying factors.

IX--Inheritance of white cap (Wc_3).

Wc_3 from all the three strains mentioned above acts the same way as Wc_2 in all the crosses and the backcrosses as can be seen from the data presented in Tables 21, 22, 23, 24, and 25. The data also indicate that Wc_3 is not inherited independently as was assumed at the beginning, but is the outcome of the action of the modifying factors.

X--Summary.

(1). A white-capping factor is described and is designated as Wc. It is inherited in a simple Mendelian way, the character being due to a single factor. It is dominant to the yellow-capping in the first generation and segregates in the second generation in a 3:1 ratio for the white-capped grains to the yellow-capped grains in Clement's White Cap, Folk's White Cap, and Silver King.

(2). White-capping is due to an inhibitor which drives the color away from the crown of the kernel.

(3). Silver King, a white corn, carries a white capping factor but is unable to express it in the absence of the yellow endosperm.

(4). Various shades of white-capping are possibly due to the presence of modifying factors.

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It is very unfortunate to see that Professor F. A. Spragg who helped the author to lay out this piece of research and gave many suggestions did not live to see the work completed. To his memory the author humbly dedicates this work, as this is the first piece of research turned out after his death by one of his students. The author is indebted to Professor E. E. Down and Mr. H. M. Brown for advice and criticism thruout the work and the preparation of the manuscript; to F. H. Clark for valuable suggestions. Appreciation is due to Professor J. F. Cox, Professor E. E. Down, Mr. H. M. Brown and Doctor E. A. Bessey for the final review of the manuscript. Thanks are also due to Professor H. H. Bartlett and Doctor E. G. Anderson, University of Michigan, for reading over and making many valuable suggestions on the manuscript. The writer is thankful to Mr. J. R. Duncan, Research Assistant, at Michigan State College for supplying the material.

Table 1.

F_1 progeny of the cross Clement's White Cap (WcY) Ac. 265 x Bailey Connecticut Yellow (wcY) Ac. 257.

No.	Wc_1	Wc_2	Wc_3	Kernels that could not be classified due to immaturity.
48901	188	51	62	13
48902	215	55	54	0
48903	311	195	196	0
48904	295	70	118	0
48905	343	164	147	0

There were about twenty ears of this cross but only five of them were classified, the others were discarded due to extreme immaturity. No. 48905 was reserved for further planting.

Table 2.

F_2 progeny of the cross Clement's White Cap (WcY) Ac. 265 x Bailey Connecticut Yellow (wcY) Ac. 257.

No.	White Cap Yellow (Wc_1Y)	Yellow (Y)	Deviation from 3:1 ratio.
544802	372	129	3.75 ± 6.54
544804	289	94	1.75 ± 5.72
544806	338	120	5.50 ± 6.25
544806 A	317	109	2.50 ± 6.03
544808	523	184	7.25 ± 7.77
544809	296	100	1.00 ± 5.81
544813	310	100	2.50 ± 5.91
544815	143	53	4.00 ± 4.09
544815 A	430	141	1.75 ± 6.98
544818	363	120	0.75 ± 6.42
544819	312	106	1.50 ± 5.97
544819 A	368	127	3.25 ± 6.50
544821	187	61	1.00 ± 4.60
544823	404	148	10.00 ± 6.86
Total	4652	1592	
Calculated 3:1	4683	1561	
Deviation		31.00 ± 23.07	

Table 3.

Progenies of the backcrosses Duncan (wcY) Ac. 235 x (Clement's White Cap (WcY) Ac. 265 x Bailey Connecticut Yellow (wcY) Ac. 257)

No.	White Cap Yellow (Wc_1Y)	Yellow (Y)	
542917 x 544812	158	209	
542902 x 544810	212	216	
542917 x 544821	194	199	
542920 x 544806	148	151	
Total	712	775	
Calculated 1:1	743.5	743.5	
Deviation		31.5 ± 13.01	

Table 4.

F_1 progeny of the cross Folk's White Cap (WcY) Ac. 266 x Bailey Connecticut Yellow (wcY) Ac. 257.

No.	Wc_1	Wc_2	Wc_3	Kernels that could not be classified due to immaturity.
49001	196	125	109	5
49002	503	70	77	16
49003	505	145	47	10

There were about thirty ears of this cross of which only three were classified the others were discarded due to extreme immaturity. No. 49002 was reserved for further planting.

Table 5.

F_2 progeny of the cross Folk's White Cap (WcY) Ac. 266 x Bailey Connecticut Yellow (wcY) Ac. 257.

No.	White Cap Yellow (Wc_1Y)	Yellow (Y)	Deviation from 3:1 ratio.
545101	354	123	3.75 ± 6.38
545101 A	284	91	2.75 ± 5.66
545105	214	75	2.75 ± 4.97
545105 A	327	112	2.25 ± 6.12
545106	373	123	1.00 ± 6.50
545109	261	96	6.75 ± 5.52
545110	361	128	5.75 ± 6.46
545113	277	89	2.50 ± 5.59
Total	2451	837	
Calculated 3:1	2466	822	
Deviation		15.00 ± 16.73	

Table 6.

Progenies of the backcrosses Duncan (wcY) Ac. 235 x (Folk's White Cap (WcY) Ac. 266 x Bailey Connecticut Yellow (wcY) Ac. 257.)

No.	White Cap Yellow (Wc_1Y)	Yellow
542909 x 545107	198	196
542941 x 545112	172	167
543943 x 545113	260	254
542943 x 545117	180	180
Total	810	797
Calculated 1:1	803.5	803.5
Deviation	6.5 ± 13.52	

Table 7.

F_1 progeny of the cross Silver King (wcy) Ac. 267 x Bailey Connecticut Yellow (wcY) Ac. 257.

No.	Wc_1	Wc_2	Wc_3	Kernels that could not be classified due to immaturity.
49101	108	65	199	143
49102	39	37	61	0
49103	79	38	125	141
49104	70	32	47	165
49105	128	56	91	236

There were about thirty five ears of this cross but only five were classified the others were discarded due to extreme immaturity. No. 49101 was reserved for further planting.

Table 8.

F_2 data of the Cross Silver King (wcy) Ac. 267 x Bailey Connecticut Yellow (wcY) Ac. 257.

No.	Yellow (Y)	White (y)	Deviation from 3:1 ratio
545501	327	101	6.00 ± 6.04
545501 A	502	165	1.75 ± 7.54
545502	394	134	2.00 ± 6.71
545503	204	62	4.50 ± 4.76
545504	387	146	12.75 ± 6.74
545509	197	64	1.25 ± 4.72
545511	377	114	8.75 ± 6.47
545513	497	174	6.25 ± 7.57
545514	263	72	11.75 ± 5.35
Total	3148	1032	
Calculated 3:1	3135	1045	
Deviation		13.00 ± 18.86	

Table 9.

Further classification of the yellow grains of Table 8.

No.	White Cap Yellow (Wo_1Y)	Yellow (Y)	Deviation from 3:1 ratio.
545501	240	87	5.25 ± 5.38
545501 A	375	127	1.50 ± 6.54
545502	291	103	4.50 ± 5.80
545503	152	52	1.00 ± 4.17
545504	292	95	1.75 ± 5.75
545509	149	48	1.25 ± 4.10
545511	282	95	0.75 ± 5.67
545513	373	124	0.25 ± 6.51
545514	198	65	0.75 ± 4.74
Total	2352	796	
Calculated 3:1	2361	787	
Deviation		9.00 ± 16.38	

Table 10.

Progenies of the backcross Duncan (wcY) Ac. 254 x (Silver King (Wcy) Ac. 267 x Bailey Connecticut Yellow (wcY) Ac. 257.

No.	White Cap Yellow (Wc_1Y)	Yellow (Y)
545914 x 545509	202	212
546032 x 545511	130	114
543806 x 545514	128	135
Total	460	461
Calculated 1:1	460.5	460.5
Deviation	0.5 ± 8.86	

Table 11.

F_1 progeny of the cross Duncan (wcY) Ac. 235 x Clement's White Cap (WcY) Ac. 265.

No.	White Cap Yellow (WcY)	Yellow (Y)
542937 x 542312	335	0
542212 x 542317	486	0
542801 x 542318	453	0
542932 x 542402	387	0
542804 x 542405	332	0
542803 x 542406	499	5
542238 x 542416	385	0
542805 x 542505	432	0
542003 x 542505	323	0
542918 x 542507	404	0
542019 x 542513	323	0
542924 x 542602	267	0
542927 x 542606	368	0
542808 x 542612	264	0
542911 x 542702	328	0
542902 x 542703	314	0
542903 x 542704	297	0
542920 x 542710	237	0

Table 12.

F_1 progeny of the cross Duncan (wcY) Ac. 235 x Folk's White Cap (WcY) Ac. 266.

No.	White Cap Yellow (WcY)	Yellow (Y)
542921 x 543002	295	0
542913 x 543004	225	0
542808 x 543108	357	0
542811 x 543111	389	10
542816 x 543112	402	0
542942 x 543302	439	0
543702 x 543308	296	0
542938 x 543512	308	0
542933 x 543515	244	0
542817 x 543516	156	0

Table 13.

F_1 progeny of the cross Duncan (wcY) Ac. 235 x Silver King (Wcy) Ac. 267.

No.	White Cap Yellow (WcY)	Yellow (Y)
542931 x 543406	376	0
542218 x 543408	482	0
542814 x 543409	256	0
542234 x 543415	247	0
543728 x 543601	308	0
543801 x 543604	92	0
542933 x 543606	356	0

Table 14.

F_1 progeny of the cross Duncan (wcY) Ac. 235 x Northwestern Dent (Wcy) Ac. 286.

No.	White Cap Yellow (WcY)	Yellow (Y)
542223 x 544501	426	0
546010 x 544503	368	0
544705 x 544507	289	0
542219 x 544508	536	0
546009 x 544511	395	0
542227 x 544513	145	0
542226 x 544514	375	4

Table 15.

F_2 progeny of the cross Clement's White Cap (Wc_2Y) Ac. 265 x Bailey Connecticut Yellow (wcY) Ac. 257. Wc_2 grains from F_1 planted and selfed.

No.	Wc_1Y	Wc_2Y	Wc_3Y	Total white cap yellow	yellow	Deviation from 3:1 ratio
544901	86	306	133	525	178	2.25 ± 7.74
544902	79	292	124	495	160	3.75 ± 7.47
544904	73	285	129	487	170	5.75 ± 7.49
544906	56	149	95	300	97	2.25 ± 5.82
544908	64	267	93	424	141	0.25 ± 6.94
Total	358	1299	574	2231	746	
Calculated 3:1				2232.75	744.25	
Deviation				1.75 ± 15.94		

Table 16.

F_2 progeny of the cross Folk's White Cap (WcY) Ac. 266 x Bailey Connecticut Yellow (wcY) Ac. 257.

Wc_2 grains from F_1 planted and selfed.

No.	Wc_1Y	Wc_2Y	Wc_3Y	Total white cap yellow	yellow	Deviation from 3:1 ratio
545202	46	108	66	220	74	0.50 ± 5.01
545204	60	143	100	303	109	6.00 ± 5.93
545208	52	124	83	259	93	5.00 ± 5.48
545209	30	77	55	162	60	4.50 ± 4.35
545211	43	105	67	215	76	3.25 ± 4.98
Total	231	557	371	1159	412	
Calculated 3:1				1178.25	392.75	
Deviation				19.25 ± 11.58		

Table 17.

F_2 progeny of the cross Silver King (Wcy) Ac. 267 x Bailey Connecticut Yellow (wcY) Ac. 257.

Wc_2 grains planted and self pollinated.

No.	Yellow (Y)	White (y)	Deviation from 3:1 ratio
545605	384	128	0 ± 6.61
545606	389	116	10.25 ± 6.56
545608	345	99	12.00 ± 6.15
545610	386	122	5.00 ± 6.58
Total	1504	465	
Calculated 3:1	1476.75	492.25	
Deviation		27.25 ± 12.96	

Table 17 A.

Further classification of the yellow grains of Table 17.

No.	Wc_1Y	Wc_2Y	Wc_3Y	Total white cap yellow	Yellow (Y)	Deviation from 3:1 ratio
545605	41	185	63	289	95	1.00 ± 5.72
545606	45	179	66	290	99	1.75 ± 5.76
545608	36	170	53	259	86	0.25 ± 5.42
545610	49	167	74	290	96	0.50 ± 5.74
Total	171	701	256	1128	376	
Calculated 3:1				1128	376	
Deviation				0 ± 11.33		

Table 18.

Progenies of the backcross Duncan (wcY) Ac. 254 x (Clement's White Cap (Wc_2Y) Ac. 265 x Bailey Connecticut Yellow (wcY) Ac.257)

Wc_2 grains planted.

No.	Wc_1Y	Wc_2Y	Wc_3Y	Total white cap yellow	Yellow (Y)
542914 x 544903	29	118	82	229	224
545914 x 544909	20	94	45	159	172
542906 x 544910	24	113	61	198	204
Total	73	325	188	586	600
Calculated 1:1				593	593
Deviation				7.00 ± 11.60	

Table 19.

Progenies of the backcross Duncan (wcY) Ac. 254 x (Folk's White Cap (WcY) Ac. 266 x Bailey Connecticut Yellow (wcY) Ac.257).

Wc_2 grains planted.

No.	Wc_1Y	Wc_2Y	Wc_3Y	Total White Cap yellow	Yellow
545903 x 545202	22	63	39	124	110
546028 x 545203	34	89	54	177	166
544711 x 545211	44	107	65	216	249
Total	100	259	158	517	525
Calculated 1:1				521	521
Deviation				4.00 ± 10.88	

Table 20.

Progenies of the backcross Duncan (wcY) Ac. 254 x (Silver King (Wcy) Ac. 267 x Bailey Connecticut yellow (wcY) Ac. 257.

Wc_2 grains planted.

No.	Wc_1Y	Wc_2Y	Wc_3Y	Total white cap yellow.	Yellow (Y)
544721 x 545602	9	47	16	72	73
546014 x 545606	15	77	30	122	134
Total	24	124	46	194	207
Calculated 1:1				200.5	200.5
Deviation			6.5 $\pm$ 6.75		

Table 21.

F_2 progeny of the cross Clement's white cap (Wc_3Y) Ac. 265 x Bailey Connecticut yellow (wcY) Ac. 257.

Wc_3 grains from F_1 planted and selfed.

No.	Wc_1Y	Wc_2Y	Wc_3Y	Total white cap yellow	Yellow (Y)	Deviation from 3:1 ratio.
545001	15	23	48	86	29	0.25 ± 3.13
545004	44	105	200	349	118	1.25 ± 6.31
545006	31	86	125	242	75	4.25 ± 5.20
545011	35	84	155	274	91	0.25 ± 5.58
545012	54	129	248	431	141	2.00 ± 6.99
545014	34	88	180	302	98	2.00 ± 5.84
Total	213	515	956	1684	552	
Calculated 3:1				1677	559	
Deviation				7.00 ± 13.83		

Table 22.

F_2 progeny of the cross Folk's white cap (Wc_3Y) Ac. 266 x Bailey Connecticut yellow (wcY) Ac. 257.

Wc_3 grains from F_1 planted and selfed.

No.	Wc_1Y	Wc_2Y	Wc_3Y	Total white cap yellow	Yellow (Y)	Deviation from 3:1 ratio.
545301	59	46	149	254	83	1.25 ± 5.36
545302	89	65	232	386	127	1.25 ± 6.62
545305	101	79	260	440	160	10.00 ± 7.15
545307	72	55	178	305	97	3.50 ± 5.86
545308	97	74	238	409	139	2.00 ± 6.84
545310	107	81	260	448	145	3.25 ± 7.11
Total	525	400	1317	2242	751	
Calculated 3:1				2244.75	748.25	
Deviation				2.75 ± 15.97		

Table 23.

Progenies of the backcross Duncan (wcY) Ac. 254 x (Clement's white cap (Wc_3Y) Ac. 265 x Bailey Connecticut yellow (wcY) Ac.257)

Wc_3 grains planted.

No.	Wc_1Y	Wc_2Y	Wc_3Y	Total white cap yellow	Yellow (Y)
543807 x 545004	19	42	77	138	141
546009 x 545010	15	36	67	118	119
542916 x 545011	29	69	128	226	230
Total	63	147	272	482	490
Calculated 1:1				486	486
Deviation			4.00 $\pm$ 10.51		

Table 24.

Progenies of the back cross Duncan (wcY) Ac. 254 x (Folk's white cap (Wc_3Y) Ac. 266 x Bailey Connecticut yellow (wcY) Ac. 257.)

Wc_3 grains planted.

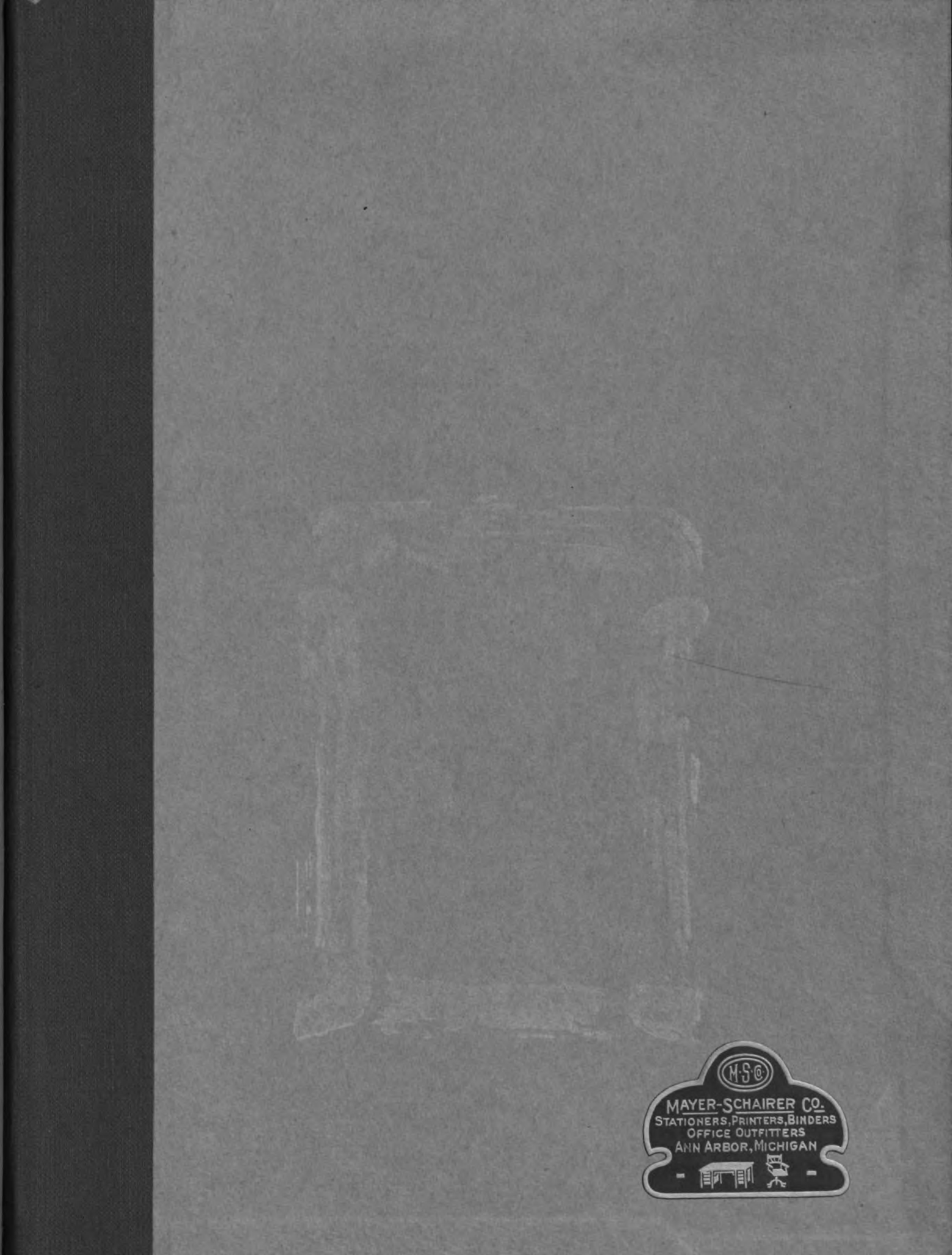
No.	Wc_1Y	Wc_2Y	Wc_3Y	Total white cap yellow	Yellow (Y)
544707 x 545304	29	22	67	118	128
544604 x 545308	50	38	118	206	208
Total	79	60	185	324	336
Calculated 1:1				330	330
Deviation				6.00 ± 8.66	

Table 25.

Progenies of the backcross Duncan (wcY) Ac. 254 x (Silver King (Wcy) Ac. 267 x Bailey Connecticut yellow (wcY) Ac. 257.)

Wc_3 grains planted.

No.	Wc_1Y	Wc_2Y	Wc_3Y	Total white cap yellow	Yellow (Y)
546024 x 545704	21	30	78	129	130
545905 x 545710	17	22	71	110	115
545904 x 545715	23	36	69	128	133
Total	61	88	218	367	378
Calculated 1:1				372.5	372.5
Deviation				5.5 ± 9.20	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