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The Germination of Seed Corn and its Relation to the Occurrence of Molds During Germination

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Summary of Bulletin

1. It is evident from the preliminary survey of seed corn from twenty-four sources in five counties of eastern South Dakota that molds, amounting in some cases to destructive ear rots, may occur on seed corn. Page 3.

2. Ears of corn which are evidently rotted may of course be discarded on the basis of general appearance. Moreover kernels of corn may often be found on ears of seed corn appearing sound, that will develop molds when they are placed under the conditions of warmth and moisture that must be obtained when they are tested for germination in a "rag-doll" tester. Page 6

3. It appears from the data of this bulletin that although kernels of corn thus developing molds under conditions of germination may grow in spite of moldiness they have on the whole a lower percentage of germination, are less likely to grow than kernels which show no such indication. Page 12.

4. This relatively high percentage of germination of kernels free from molds, as compared with those showing molds on the same "rag-doll" tester was found to appear under conditions of five successive seasons, with the strains of corn used in these experiments. Page 12.

5. It is true that in certain seasons moldiness of kernels, as developed during testing on the "rag-doll" had more connection with germination than in other seasons. However without exception in all seasons kernels of seed corn that developed molds were consistently lower in germination than those developing none. Page 13.

6. It is a safe deduction that inasmuch as seed corn must be able to grow in order to be effective, that kind should be utilized which is free from moldy kernels. That being the case it may be regarded as one purpose of ear testing with the use of a "rag-doll" to help pick out and eliminate such ears as have moldy kernels.

7. The "rag-doll" corn tester is an inexpensive device which may be utilized under farm conditions. It consists essentially of an oblong strip of cloth, which may be moistened, and rolled upon itself after having kernels of corn to be tested laid upon it. A small milk pail may serve as a receptacle for the rag-doll to prevent evaporation of moisture during germination. Page 10.

8. Corn rots are caused by various organisms. Five of the ones commonly encountered are: Diplodia zeae, Fusarium Spp., Gibberella saubinetii, Cephalosporium acremonium, Rhizopos Spp. Appendix. Page 17.

The Germination of Seed Corn and Its Relation to the Occurrence of Molds During Germination

A. N. Hume, Agronomist and Superintendent of Substations, and C. J. Franzke, Assistant Agronomist

Importance of vigorous germination in corn intended for seed has been emphasized for many years.[1] More recently, within the present decade, not only vigor of germination has been emphasized but likewise the adverse effect of molds upon germinability has been freely asserted.

One of the objects in beginning the present study was to get some information upon the question of whether the corn crop in such a new part of the corn belt as South Dakota was indeed affected by ear rots and root rots and similar organisms. A preliminary survey of a number of seed houses where seed corn was stored as early as the winter of 1923-1924 emphasized the fact that corn ear rots are a condition as well as a theory in South Dakota, even though they may be less prevalent than in older sections of the corn belt.

Seed Corn Secured from Twenty-four Locations

Material for study was collected from separate sources, consisting of a number of ears of corn from each of 24 seed corn houses, 20 to 40 ears from each place. The sources of these seed ears which were to be inspected for corn diseases, and also the amount of corn taken from each source, were decided upon rather arbitrarily; the object being to secure corn that would represent fairly the quality of seed from the standpoint of possible corn diseases. It was easier to find seed corn evidently infected with various molds than had been expected.

Previous to making any consistent observation, the writers believed that it might be possible that corn ear rots and root rots in South Dakota part of the corn belt which is newer than some others would be rare enough so that they might not be called a problem. It is to be regretted that such was not the case. Corn ear rots were found present at all points visited. All corn growers who had seed corn stored, were familar

1. "The Testing of Corn for Seed" A. N. Hume, Illinois Experiment Station Bulletin 96 (1904).

with the process of throwing out rotten ears, either at husking time or later when seed ears were stored. In one or two instances where the area of corn was large the amount of rotten ears discarded and thrown out on a pile might amount to 25 bushels of ears—indicating that however much the fact might be regretted, ear rots apparently present a problem even in this newer part of the corn belt.

The problem therefore of possible connection between molds and germination is one of interest.

It is possible to tabulate the average percentages of the corn kernels developing mold of corn from different sources and locations. Such tabulation makes it possible to observe an actual occurrence of molds on the ears of corn harvested and intended for seed within the areas represented, and likewise make some general comparison possible in the degree of moldiness of kernels from different sources. Tabulation of the percentages of moldy kernels as indicated is put down in the following Table 1:

TABLE 1.—Percentages of corn kernels from several sources in various counties developing molds during germination.

No. of sample	Kind of corn	County where grown	Percent of kernels developing molds in germination	Average per cent germination
1	Yellow dent	Minnehaha	25.0	93.76
2	Yellow dent	Minnehaha	16.7	79.17
3	Yellow dent	Minnehaha	27.1	72.92
4	Yellow dent	Minnehaha	35.4	91.66
5	Yellow dent	Minnehaha	43.7	64.60
Average			**29.6**	**80.42**
6	Yellow dent	Lake	47.5	86.63
7	Yellow dent	Lake	58.3	76.2
8	Yellow dent	Lake	74.6	71.07
9	Yellow dent	Lake	37.5	72.93
10	White dent	Lake	41.7	82.7
11	White dent	Lake	37.5	78.4
12	Yellow dent	Lake	20.9	80.7
13	Yellow dent	Lake	29.1	75.5
14	White dent	Lake	27.1	73.6
15	White dent	Lake	12.5	88.1
16	White dent	Lake	16.7	58.1
17	Yellow dent	Lake	22.9	82.2
18	Yellow dent	Lake	62.5	74.0
19	White dent	Lake	20.9	88.4
Average			**36.4**	**77.75**
20	Brookings 86	Brookings	12.5	88.8
21	All Dakota	Brookings	20.9	88.8
22	Northwestern dent	Brookings	25.0	91.8
Average			**19.5**	**89.8**
23	White dent	Moody	**46.9**	**82.9**
24	Reid's Yellow dent	Brown	**31.3**	**61.05**

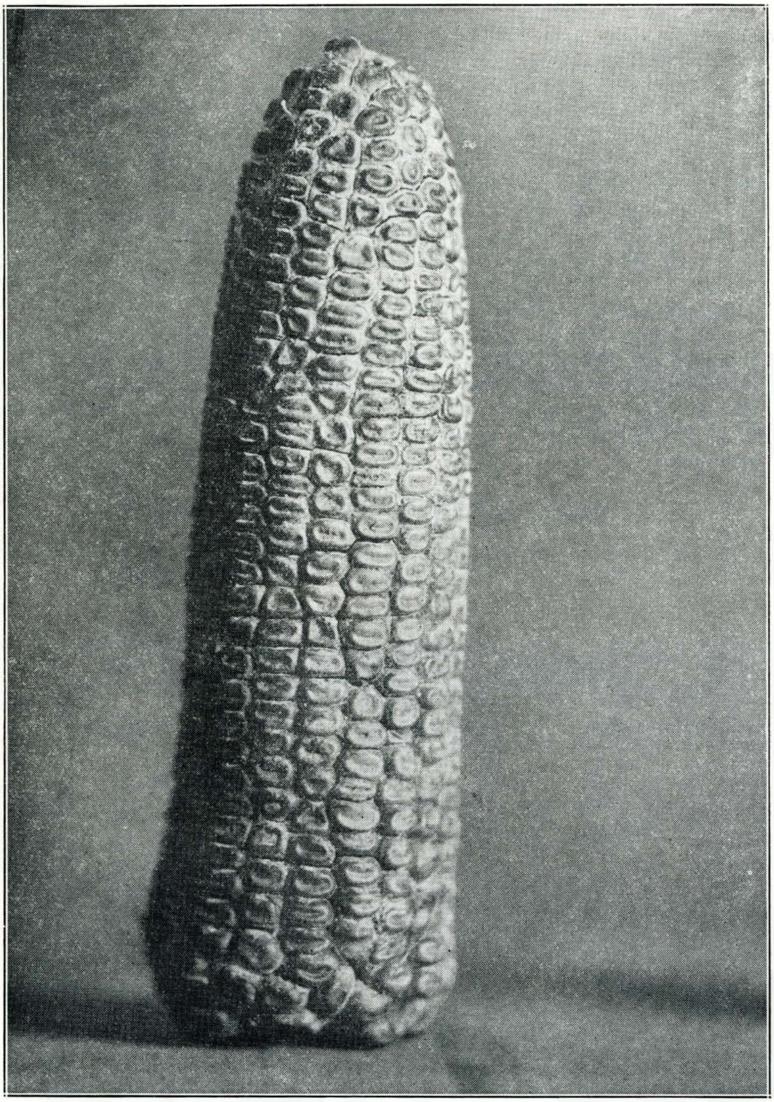

Fig. 1.—A moldy ear typical of many discarded at husking time. They represent loss of time, labor, land, and corn harvested.

Molds Were Observed on Ears and Kernels

The foregoing Table 1 will serve to indicate that seed corn from various localities secured in the season of 1924 was infected in some instances with molds which were capable of developing and growing under conditions favorable to the germination of the corn. The next to the last column of the table serves to indicate that the percentages vary from 12.5 per cent to as high as 74.6 per cent. It is not attempted at this point to draw conclusions with regard to differences which may appear in percentages of moldy kernels from different locations. It may be observed that the average per cent of kernels from Minnehaha county developing mold was 29.6, whereas the average per cent for Lake county was 36.4, in the same year 1924. Such differences based on comparatively small numbers of samples for only one season do not establish it as a fact that seed corn is infected to a greater degree in one location than another.

In the last column of the foregoing Table 1, are placed the corresponding percentages of germination directly opposite the percentages of mold on kernels in the same lots of corn. In the three instances where it was possible to compute averages, it is indicated that lower percentages of moldy kernels are associated with higher average percentages of germination.

Method of Testing for Germination

The method used for germinating the kernels of corn taken from the 24 samples heretofore mentioned was the "rag-doll" method.

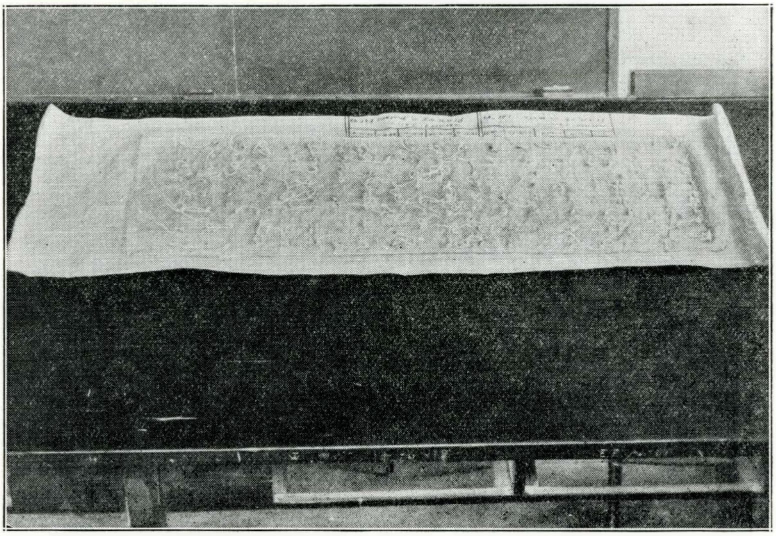

Fig. 2.—The rag-doll germinator—germinating kernels, on cloth removed from germinating chamber, unrolled for inspection.

This method is described briefly in order to make the process clear in the present connection.

The term "rag-doll" is descriptive of the method because the corn kernels intended for testing are placed on a rectangular piece of cloth which is later rolled upon itself thus making an oblong bundle which is either tied around the ends with cord or perhaps held in place with rubber bands. After the cloth is thus rolled and tied it roughly resembles a "rag-doll."

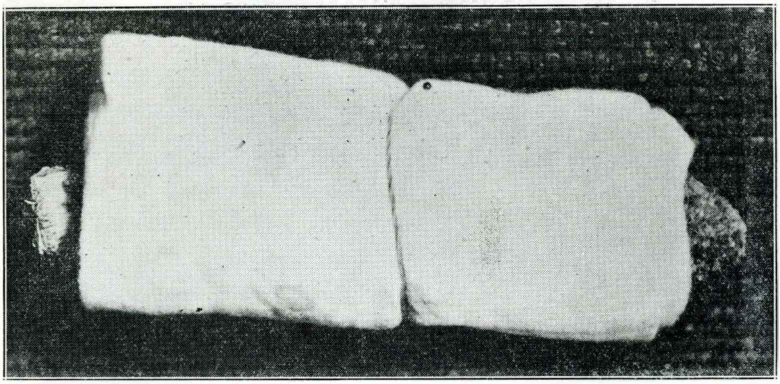

Fig. 3.—The rag-doll rolled—cloth in Fig. 2 moistened with kernels in place, rolled, ready for placing in germination chamber.

In order to place the kernels to be tested in suitable locations for germination on the cloth of the rag-doll, it is well to lay the latter on a flat surface as a table top. (Fig. 2) After the cloth is thus spread out, it will assist in keeping the kernels in position to moisten the cloth immediately by sprinkling it with water enough to make it damp. Another way to moisten the cloth is to wring it out of water before spreading it out on the table. The kernels of corn to be tested will hold the position on the cloth better if it is moistened before, rather than after placing them in position.

In case a given number of kernels of corn are to be tested each from separate ears, it will likewise be worth while to rule off the surface of the cloth, thus moistened, into squares, by drawing a number of lines horizontally and others vertically at distances apart to make the squares a convenient size for placing one kernel in each square. It has been observed that the squares may well be 2½ inches across in each direction.

In making preparation for germination tests of the present experiment eight kernels were taken from each ear of corn to be tested, exceptions being made in only a few instances where the number of kernels available from certain ears was small. The eight kernels were laid in rows across the short dimension of the cloth, as in Fig. 2, one short row thus representing a single ear of corn. Obviously, if the kernels were thus placed in squares of 2½ inches for both dimensions, the short dimension of the cloth making up the rag-doll would be at least 20 inches. The longer dimension of the cloth may vary. A convenient length is 78 inches, 6½ feet, which is long enough for 30 rows of corn kernels, thus representing 30 ears in one rag-doll.

In the present experiment the eight kernels of corn from each of the separate ears to be tested for germination were taken as far as possible from portions representing the entire ear.

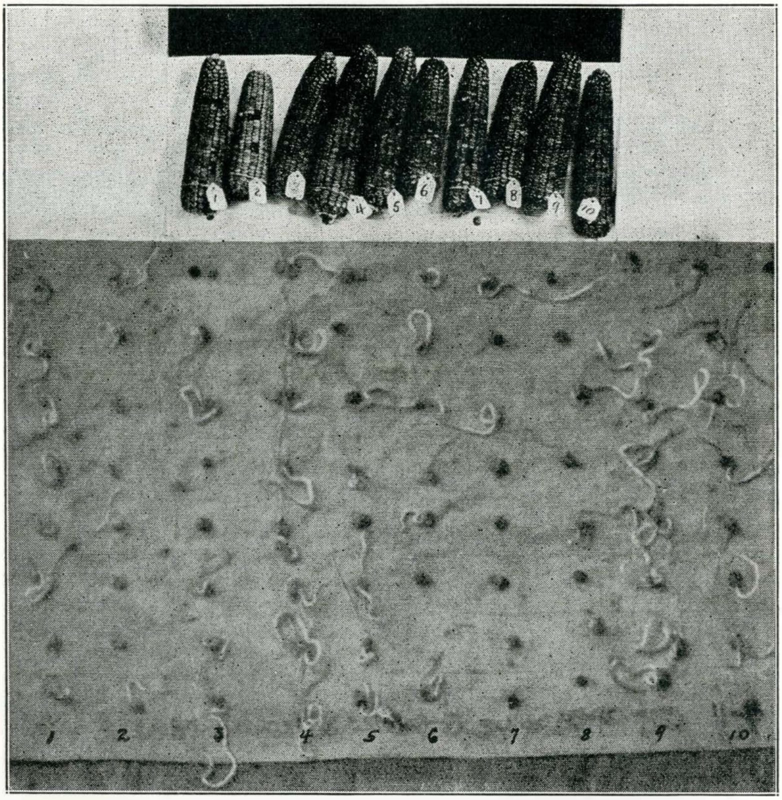

Fig. 4.—Kernels of corn placed in this instance in rows from separate ears ready for rolling into a rag-doll, preparatory to germination.

Kernels were removed with a knife blade beginning near the tip of the ear and turning the ear slightly to the left with the removal of each kernel, also taking each kernel from a position somewhat closer to the butt of the ear until the last one would come from a position not far removed therefrom. During the process of removing kernels from each of the separate ears, the ears themselves were numbered serially as in Fig. 4, to correspond to the rows of kernels thus placed on the rag-doll; thus making it possible to keep a record of the number of rows of kernels in relation to the particular ears from which they were taken.

After the kernels are placed in position on the cloth prepared as indicated, the cloth is rolled upon itself into a rag-doll and thereafter placed in some convenient receptacle to remain until the kernels have had enough time to germinate. In the present experiment it was possible to place the moistened rag-doll in a Minnesota germinator, which is an especially constructed chamber provided with electrical equipment for regulating the temperature and also with a compartment below containing water so that the air in the chamber will contain sufficient moisture. The greater number of germination tests conducted in the present experiment were carried out at a summer temperature, without artificial heat. The temperature varied naturally during the day and night.

Germination tests of corn may readily be made by practical growers and others wherever exact temperature regulation is not considered necessary. Without requiring any specially constructed storage chamber for

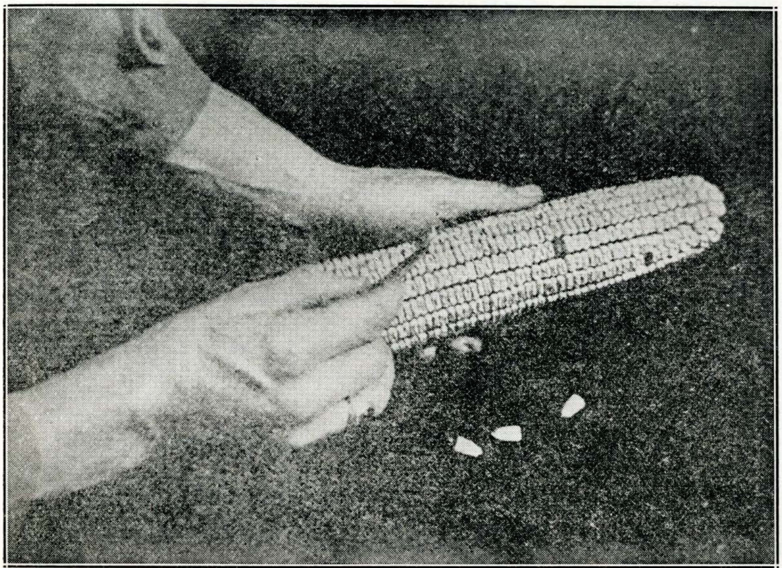

Fig. 5.—Removing kernels from the ear.

(Courtesy University of Missouri, Extension Circular 48.)

the rag-doll tests, any covered pail or possibly an ordinary milk can will serve the purpose well due to the fact that such a vessel is provided with a cover and prevents rapid evaporation of moisture from the cloth of the rag-doll.

The kernels should remain moist but not wet during germination, and in case the rag-dolls are found to dry out, they should be sprinkled with

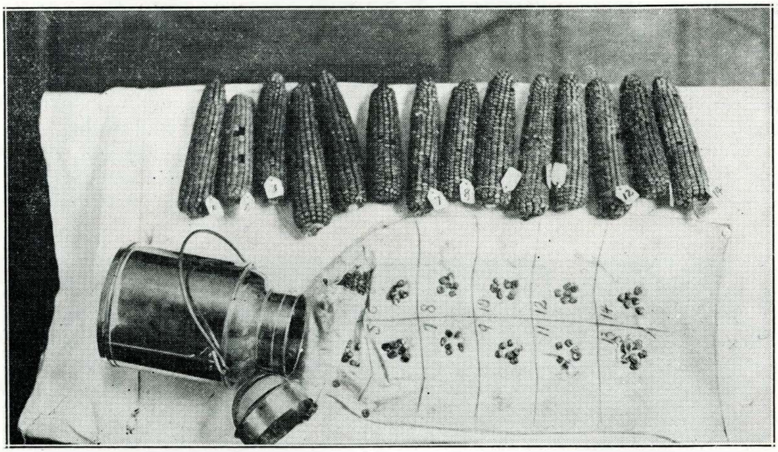

Fig. 6.—The rag-doll is removed from the container (in this case a milk pail with cover) and unrolled to examine whether all kernels have germinated.

water occasionally during the process. Germination is likely to be found complete after a period of seven to ten days. In the present experiment ample time was allowed for complete germination of seed corn and for making observations of the development of molds thereon during the process.

The Distribution of Mold on Germinating Kernels

Experimenters, and also a number of practical corn growers who have had experience with testing corn for germinability, are likely to be familiar with the fact that molds of one or more species are likely to develop on or close to these kernels during the process of their germination.

In some instances these molds are easily visible on the outside surface of the ears of corn before kernels are removed (Fig. 1). In other instances the molds are not so easy to observe previous to putting the kernels into a germinator. No doubt one of the reasons why molds develop on kernels of corn during germination is because the conditions for germination in corn are also conditions which are favorable to the growth of various molds. These conditions are (1) moisture; (2) sufficient temperature. When the conditions for seed corn storage are ideal, humidity or moisture in the atmosphere is kept low enough so that neither corn kernels themselves nor the molds in or on them will begin to grow

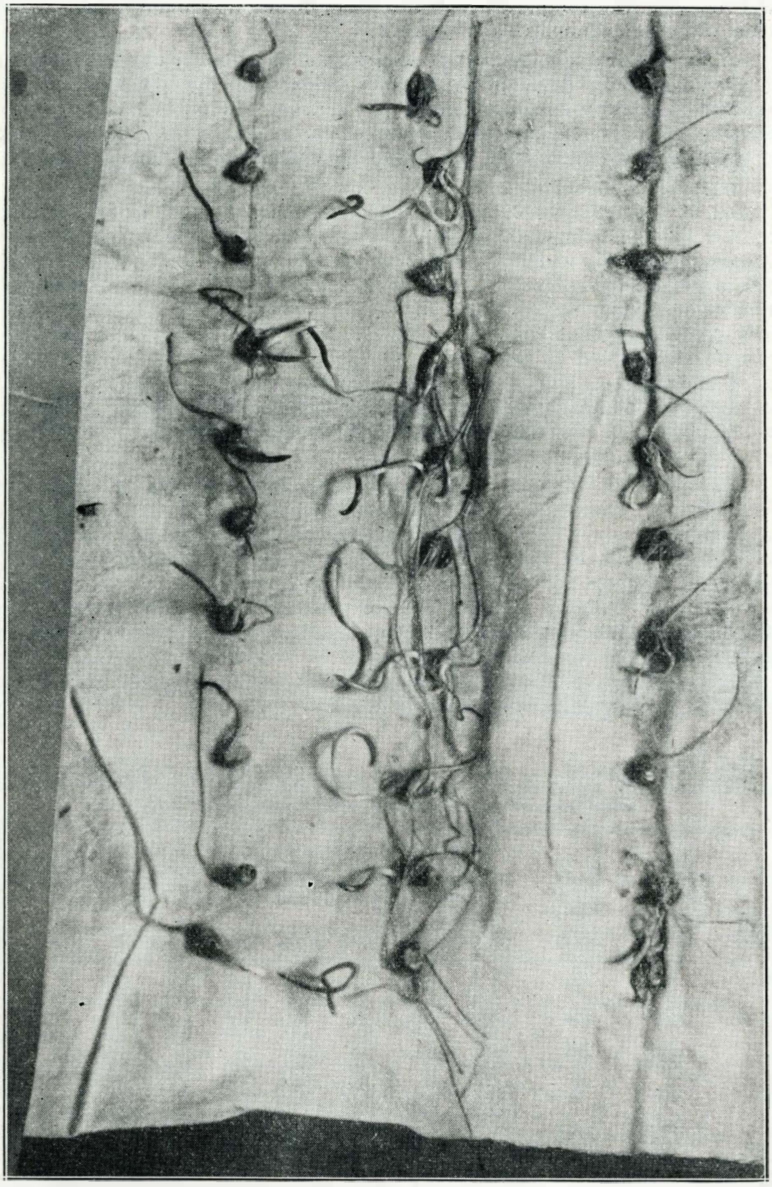

Fig. 7.—Kernels from three separate ears in process of germination. Observe vigorous germination of center row, and larger numbers of dark and discolored kernels, indicating molds and weaker germination on both outside rows.

and likewise, the temperature is low enough not to promote such growth even when some moisture is present.

In the present experiment it was easily possible to observe not only that molds often develop on various kernels during germination, but likewise that such development of molds where found is likely to affect kernels from the various ears consistently. If molds affect any kernels of corn on given ears, they are likely to affect many or all of them.

Repeated general observation of the process of germination is conducted in this experiment and of the occurrence of mold on germinating kernels led the writers to the belief that such molds were most likely to appear on kernels which were of low vitality and which therefore might fail to germinate entirely. Such observations taken along with such tabulation of results as put down in Table 1 would make it seem to be a safe conjecture that there is a visible correlation between numbers of kernels that failed to make vigorous growth on one hand and development of molds on the other. This indication made it seem worth while to arrive at some definite comparison between the number of kernels which germinate and the number which furnish a base for the development of molds during germination.

The question whether molds which may and evidently do develop on corn kernels either during the course of germination or upon their failure to germinate come from inside or outside the kernels themselves is bound to have influence on the present correlation. In this connection it is obviously necessary not only from a practical but from an experimental standpoint to utilize a sterile cloth for making the rag-doll germinators. It will be evident that if molds were permitted to accumulate within the cloth with which the rag-doll germinator is constructed that would cause a failure of the entire process to represent accurately the presence of molds in or upon the corn kernels themselves.

TABLE 2.—The percentage of ears from given strains of corn found to have the given percentages of kernels germinating in comparison with the percentages of kernels from the same group of ears developing molds during germination.

Degree of selfing	Year when strain was germinated and planted	No. of ears of strain in given trial	(Upper line) Percentage of the given number of ears found to germinate the given percentage of kernels tested therefrom. (Lower line) Percentage of the given number of ears found to develop the given percentage of moldy kernels.								
			100%	87.5%	75%	62.5%	50%	37.5%	25%	12.5%	0%
Bulk	1924	131	66.4 3.8	9.9 1.5	6.9 3.1	6.1 13.7	5.3 11.5	1.5 16.8	3.8 14.5	0 13.7	0 21.4
Bulk	1925	120	60.8 6.7	18.3 0.8	11.7 1.7	5.0 6.7	1.7 13.3	0.8 10.8	1.7 24.2	0 19.1	0 16.7
S_1	1926	102	81.4 6.9	10.8 0	5.9 2.0	0.9 4.9	0 3.9	0 8.8	0 18.6	0 16.7	0 38.2
S_2	1927	93	60.2 7.5	15.1 5.4	9.7 9.7	6.5 15.1	0 8.6	5.4 8.6	2.2 16.9	1.1 10.8	0 19.4
S_3	1928	120	38.3 16.7	16.7 0	11.7 4.2	2.5 8.3	7.5 16.7	1.7 11.7	4.2 15.0	5.0 8.3	12.5 19.2
5-year average		566	61.4 8.3	14.1 1.5	9.1 4.1	4.2 9.7	2.9 10.8	1.9 11.3	2.4 17.8	1.2 13.7	2.5 23.0

In the present experiment where a given piece of cloth was utilized more than once it was boiled in water for a number of minutes, after being used for each germination test. It was believed that such boiling might serve as a precaution against the actual accumulation of organisms in the material used.

The foregoing Table 2 serves as a summary of data secured in five successive seasons:

Explanation of Foregoing Table

The foregoing Table 2 is intended at once to summarize percentages of germinable kernels in the several ears of corn harvested at five successive years, along with percentages of mold developing on the same several kernels during the process of germination, and likewise make comparison between the two percentages easy.

In the third column of the table the number of ears in each separate lot of corn for the season indicated is put down. The percentages at the right of these numbers in both upper and lower lines both refer to these given numbers used as a base. For instance, in 1924, 131 ears were tested; 66.4% of these individual ears were found to germinate 100%—eight kernels from each ear were tested in a rag-doll; 3.8% of this same 131 ears were found to have 100% of moldy kernels when they were germinated in a rag-doll.

Careful examination of the percentages of kernels germinating from the ears of the several lots of corn in comparison with the percentages of the same ears that developed molds on the germinator may indicate that the percentage of germination and the percentages of mold in the successive years tend to increase in opposite directions. In short, observation of Table 2 indicates that there is some correlation between relatively low percentages of germination and relatively high percentages of moldy kernels in the same ears of corn. The two lowest lines of the table contain the average percentages of germination along with the corresponding average percentages of moldy kernels. Likewise these average percentages of germination of kernels from the separate ears, reading from left to right, decrease with a general increase of the percentages of mold.

Thus the general tendency judging from the figures of this Table 2 appears to be that the ears of corn which germinate high percentages of kernels have lower percentages of moldy kernels, and vice versa. Such a conclusion is relative rather than absolute; a certain number of kernels which germinate strongly nevertheless become moldy, and the opposite is true that a number of moldy kernels are found to germinate. The tendency is, nevertheless, for the ears of corn having the highest percentages of germination to develop the lowest percentage of moldy kernels, and vice versa.

Correlation

A definite statement of the foregoing tendency has been computed by working out the correlation coefficients between percentage of germination of kernels and percentage of kernels developing molds during germination, for all of the ears tested from the several lots of corn in the five successive years. These correlations are as follows:

TABLE 3.—Correlation coefficients in successive years between percentages of germination and percentages of the same kernels, developing mold during germination.

Season when germination test was made	Percentage of germination (average)	Percentage of kernels developing molds	Coefficient of correlation between molds and germination
1924	86.8±1.4	33.6±1.6	r equals —.4346±.0587
1925	92.6±0.7	30.1±1.7	r equals —.3506±.0615
1926	97.0±0.5	20.3±1.7	r equals —.3322±.0579
1927	90.1±1.1	41.1±1.2	r equals —.7705±.0274
1928	60.0±3.3	43.0±2.6	r equals —.1505±.0556

Comments Upon the Foregoing Table

It has been mentioned that the figures set down in the right-hand column of the foregoing table gave correlations for the several years, 1924-1928 inclusive.

Readers will understand that correlation in general means the degree of relationship between different characters in an individual or group of individuals whereby these characters tend to move together. If and when a given character in corn or any organism is invariably accompanied by another, then the correlation between these two characters is absolute unity. It may be expressed arithmetically as +1. Furthermore if and when two characters are mutually exclusive, correlation would also be unity but it would be negative, and might be expressed as –1. In case the correlation of characters is neither expressed by +1, nor again by –1, it will be found to fall between the two foregoing. Such is generally the case with correlation and is evidently the case in the foregoing table, as expressed for the several ears in the right-hand column.

All coefficients of correlation in the right-hand column are negative, and preceded by the minus (–) sign. That may be interpreted in this case to mean that whenever there is an increase in the number of kernels developing molds during the process of germination under the conditions of this experiment the percentage of germination of the kernels are reduced. In short, high germination and high mold-bearing percentages tend to go in the opposite direction; they are not, however, mutually exclusive.

It is possible to observe from Table 3 that there is some tendency for the higher average percentages of germination to be accompanied by relatively low percentages of mold. If the condition indicated were unvarying the coefficients of correlation in the last column would be found to increase or decrease accordingly with regularity—which, however, is not the case.

Correlation is a Relative Expression, Not Necessarily a Cause

When it is found that two or more characters move together, said correlation is a matter of fact. One character is not necessarily the cause of the other. An illustration in the foregoing table is the fact that the germination of corn carrying a comparatively high development of molds in a given season may be higher than the germination of corn in some other season when the percentage of molds is lower. In this connection one may note that the percentage of germination for 1927 is high with nevertheless a high percentage of kernels developing molds. In that year the negative coefficient of correlation between molds and germination appears in the last column to be the largest in five years.

On the contrary the negative coefficient of correlation for the year following was found to be the lowest in five years, for the apparent reason also that average percentage of germination in that year was relatively low, and the percentage of mold was relatively high.

Causes Affecting Degree of Correlation Relate to the Condition of Corn

For example, the season of 1927 when the seed was produced for planting in 1928, was indeed backward from the standpoint of corn production. The corn crop in that season was about two weeks late in maturity and much soft corn was produced. This seed, which was picked in the fall of 1927 and tested for planting in the spring of 1928, was picked in the late dough stage rather than in the matured glazed stage. Its immature condition and high moisture content were indicated by the difficulty of curing it. A number of the ears of corn from this crop became moldy during the process of curing, even before any attempt was made to shell them for seed.

The evident fact that seasonal conditions for the development and maturity of corn were thus unfavorable, may well have been one direct cause of low germination of seed corn in the spring of 1928 rather than the presence of molds during germination. The high percentage of molds in the given year may have been incidental to rather than the cause of the low germination.

Reduction of Germination Per cent, As Correlated with Percentages of Mold though Varying in Different Seasons, is Consistently in the same Direction in all Seasons; may be Summarized in one Coefficient.

It was pointed out in the foregoing section that the development of molds on kernels of corn may be affected by seasonal conditions. If it may be affected by season it may also be concluded that other conditions of growth in corn may relate to the development of mold. Even though these conditions cannot all be defined they may become factors which influence the ultimate degree of correlation. The fact remains in the present computations there is some negative correlation in every separate season between the germination and molds on kernels.

It is reasonable to make an assortment of all ears germinated according to the percentages thereof, and also the percentage of molds on the same without regard to season. Such an assortment is put down in the following Table 4.

TABLE 4.—Distribution of percentages of germination of kernels from all ears tested throughout five seasons, with relation to percentage of germination and percentages of mold developed thereon.

	Percentage of germination										Average germination
	0.0	12.5	25.0	37.5	50.0	62.5	75.0	87.5	100.0	Frequency	of class
0.0	1	2			5		4	8	104	124	94.1
12.5	2				1		7	14	54	78	92.3
25.0	3	1	2		2	2	5	15	68	98	89.5
37.5	2	1		1	2	6	11	12	31	66	83.3
50.0				1	3	8	12	15	25	64	84.4
62.5		1	4		2	3	7	9	28	54	83.6
75.0	1	2	2	1	1	1	2	3	10	23	71.2
87.5			1	1		3	2		4	11	72.7
100.0	[illegible]	1	3	6	3	2	2	4	21	48	66.4
										566	

r equals —.2966±.0258

Deductions from Foregoing Table 4

The foregoing table indicates by labels above and at the left that the two coordinates which are under comparison are (1) percentage of germination, and (2) percentage of mold developing on the same kernels during the germination.

The general heading of the table explains the fact that the germination tests which furnish the basis for the computation extended over a period of five seasons, obviously with seasonal differences. It may be recalled that the germination tests for each of the several ears in all seasons were made with few exceptions with the use of eight kernels from each ear. The various numbers of ears of corn falling within each of the several ranges of germination and coordinate percentages of moldy kernels are grouped according to the two characteristics indicated.

The total numbers of these kernels extend in the various instances from 1 to 104. It is possible to observe that the numbers of kernels in the several groups tend to increase in the direction from the lower left diagonally to the upper right. In that respect this arrangement of coordinated numbers in an **array** indicates the **trend** or tendency for kernels of corn in this experiment with high percentages of germination to have relatively low percentages of mold and vice versa. The actual coefficient of correlation r equals –.2966 ± .0258 is the mathematical expression of the foregoing statement, and may be regarded as a summary of the degree with which molds occurring on kernels of corn retard their germination.

Conclusion

Table 4 which may be said to summarize the results of this bulletin indicates that there is an appreciable correlation between the amount or percentage of moldiness which may develop in or upon such corn as was used in these experiments and its germination or growing ability. It is more accurate to say that this correlation exists between moldiness of kernels and their possible **lack** of ability to grow under artificial germination.

It was found by these investigations that kernels of corn which fail to grow when tested in "rag-doll" germinator were more likely to be or become moldy during the process than kernels which did grow. Conversely, kernels which were found to be or become moldy during the process of germination were less likely to grow than kernels of corn otherwise similar but without the appearance of molds. Some kernels which germinated developed molds nevertheless and others upon which molds appeared failed to germinate. Accordingly it cannot be determined from these data whether moldiness of kernels during the process of germination is a cause or an affect, or both.

The actual negative coefficient of correlation r equals $-.2966 \pm .0258$, which may be said to summarize the conclusion established in this bulletin showing the tendency of moldy corn not to grow, is not a high correlation judged mathematically. That being the case similar results on further germination tests of moldy corn might vary considerably therefrom. The fact that the correlation was negative in all several five years of this test seems to corroborate the idea that future tests may be expected to give negative correlations whether high or low.

In short, although some proportion of moldy seed corn may germinate and grow, a smaller percentage of it will grow than seed corn free from molds. Practical and scientific corn growers are evidently warranted in taking advantage of this consideration. There is no reason to doubt that it is desirable to plant kernels of corn that will germinate and grow, which in turn must mean that it is worth while to select seed corn that is relatively free from the kinds of molds which appear on kernels during the process of germination.

It also means that the use of the "rag-doll" tester for making "ear tests" of seed corn previously picked over with care for throwing out moldy ears is recommended wherever practicable, as a means for discovering and eliminating additional moldy kernels.

Appendix

In order to emphasize the fact that "corn rot diseases" are caused not by one organism, but by several, and also to mention five of the commonest diseases topically, the following statements are abstracted, in some instances word for word, from Illinois Agricultural Experiment Station bulletin No. 255, (by James R. Holbert, W. L. Burlison, Benjamin Koehler, C. M. Woodworth, and George H. Dungan.)

Diplodia, Root Rot, Ear Rot, and Seedling Blight

One of the commonest rots of corn is that caused by Diplodia zeae (Schw.).

Diplodia develops abundantly on infected kernels in a germination test and causes a decay of the shoots in the region near the kernel. In advanced stages the fungus itself appears as a dense white mold, covering part of the kernel.

Planting seed which is apparently good but infected with this organism usually results in a reduced stand . . . . and irregular growth.

Many weak plants infected with this parasite wilt and die during the season near the crown—others marked by reduction in vigor and in height of plants. The mesocotyls of young corn plants grown from Diplodia infected seed usually appear dry and brown, in contrast to the white healthy appearance—from good seed.

Frequently early infection of the young ear shoots results in barrenness.

Fusarium Root Rot and Ear Rot

Ears conspicuously rotted with Fusarium may be recognized by the characteristic pinkish color of the kernels. Frequently a number of individual kernels on an ear may be badly rotted by Fusarium Spp., while other kernels on the same ear are unaffected.

Fusarium infected seedlings on the germinator indicate the pink colored fungous growth on the exterior of the kernels.

Gibberella, Corn Root Rot, and Wheat Scab

Gibberella saubinetii (Mont.) Sacc., on the germinator may sometimes be observed in the form of seedling blight.

Gibberella, the wheat scab organism, may cause seedling blight of corn, and a reduction in early vigor.

The spores of Gibberella saubinetii on infected wheat heads and infested corn stalks are * * * blown * * * on corn plants where they find medium for growth in the moist pollen and dust collected on the ligules at the bases of the leaves * * * in the cavity surrounding the shanks. Late in the fall and in the following summer perithecia may develop in abundance near the nodes of infected corn stalks * * * G. saubinetti may do damage as an ear rot producing organism.

Black Bundle Disease

(Cephalosporium acremonium)

The following, after Reddy and Holbert:

"Usually symptoms * * * do not become evident during the first half of the growing season. During ear development various symptoms may develop, such as abnormal leaf and stalk colors, barren stalks, nubbin ears, or prolific stalks. Such stalks usually show blackened fibrovascular bundles. * * * A red coloration appears first at or near the mid-vein of the topmost leaf, and progresses downward on the plant affecting several leaves before progress on the stalk commences. In extreme cases the stalk and all the leaves become reddish purple * * *. * * * the blackened fibrovascular bundles are considered the most distinguishing characteristic, hence the name "black bundle disease of corn."

Scutellum Rot

The germination test indicates kernels that are subject to attack of certain molds among which Rhizopos Spp., is the most common.

Scutellum rotted seedlings in germination show poor root development and spindly plumules.

The most outstanding difference between corn grown from seed effected on the germinator with Scutellum rot and that grown from good seed is the reduction of early vigor of the plants in the field.

Many Scutellum rotted seedlings on the germinator have Rhizopos growing on the exterior of the kernels. Occasional seedlings have a healthy appearance and can be detected only by cutting the kernels.

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