UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE

AGRICULTURAL EXPERIMENT STATION

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Corn Hybrids for Missouri[1]

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The commercial utilization of hybrid corn is a rather recent development, but one that is increasing in importance every year. This method of corn breeding is an outgrowth of experiments on inbreeding and crossing. In the early stages of this work the commercial application of this method of increasing yields was not apparent. Subsequently numerous investigators have developed the inbred lines and the modifications of methods which have made the commercial production of hybrid corn practicable.

In Missouri, inbreeding and crossing experiments were started in 1922. The first commercial production of hybrid corn in this state was in 1933. Since that time the severe droughts of 1934 and 1936 and the equally disastrous early freeze of 1935 have retarded progress. Commercial quantities of seed were produced in 1937, and in 1938 approximately 525 acres of "double-crossing" fields were certified.

The purpose of this circular is to point out the value and limitations of hybrid corn, to recommend specific hybrids, and to answer the questions most commonly asked about their production.

The designation, hybrid corn, is usually restricted to the first generation of a cross involving two, three, or four inbred lines. The possible crosses are designated and defined as follows:

(1) Single-cross—The first generation hybrid between two inbred lines.

(2) Three-way cross—The first generation of a hybrid between a single cross and an inbred line.

(3) Double-cross—The first generation of a hybrid between two single crosses.

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Other combinations such as top crosses involving an inbred crossed by an open pollinated variety and multiple crosses which involve more than four lines are seldom used commercially and hence will not be discussed in detail here.

The development of hybrids involves several steps: the establishment of lines through inbreeding and selection, the testing of these lines in hybrid combinations to determine which have commercial possibilities, and finally the production of the most desirable hybrids on an extensive scale for commercial utilization.

Specific hybrids have been shown to exceed adapted open-pollinated varieties in resistance to lodging, to drought injury, to disease, and to certain kinds of insect damage. Improvement in any of these characteristics is of immediate value to the farmer. Since the cost of production of an acre of corn is relatively constant, any increase in grain yield represents an increase in net profit. An increased resistance to lodging results in a better quality product and a material decrease in harvesting costs.

The attainment of the desirable qualities listed above is best realized by using the first generation of a cross between inbred lines. It is necessary to know something of the flowering habits of corn to fully appreciate the importance of this statement. The tassel bears the pollen, which contains the male sex cells of the plant. The ear bears the ovules, each of which when fertilized by the sperm from a pollen grain produces a single grain of corn. Each of the many kernels on an ear is the result of a separate fertilization. This is accomplished by a pollen grain falling on a receptive silk, where it germinates, sending out a pollen tube with its sperms which grows down the silk to the egg, where fertilization is effected. It is thus theoretically possible for each of the kernels on an ear of corn to have a different male parent. The variability present in all corn varieties results from the fact that corn is naturally cross-pollinated. (Figure 8). In established inbred strains this condition does not exist. Inbred strains are produced by self-fertilization, that is, pollen from the tassel of a given plant is applied to the silk of the same plant. Thus each kernel of the ear is of known and constant parentage and the offspring are uniform and constant as to type from year to year. This constancy of performance is essential to the development and evaluation of hybrids.

The Technic of Inbreeding

Corn is normally cross-pollinated, and to effect inbreeding it is necessary to control the pollination. The tassel normally emerges from the upper leaves a few days before pollen shedding. The upper ear "silks out" about one or two days after pollen shedding begins. Pollen may be shed over a period of three to seven days.

Self-fertilization is accomplished by collecting pollen from the tassel and applying it to the silks of the same plant. It is thus necessary to protect both tassel and silks from contamination by stray pollen. Small bags, 2 7/8 x 6 inches, made of glassine, a semi-transparent paper, are used to cover the ear shoot. These bags are placed over the shoot and held in place by the pressure of the leaf sheath and the stalk. An ear shoot ready for bagging is shown in Figure 1. Figure 2 illustrates the glassine bag in place. The

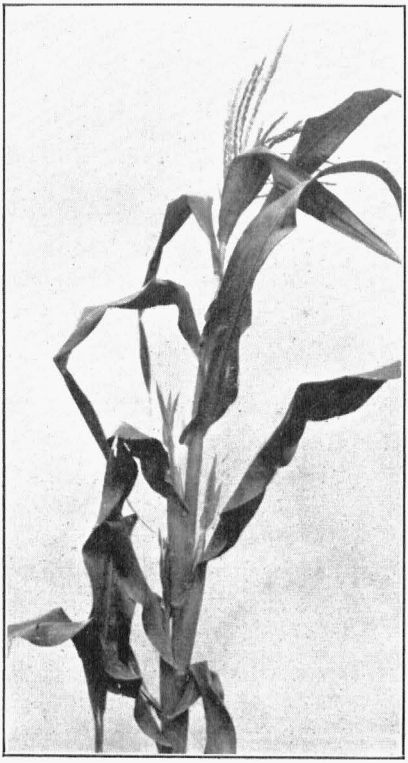


Fig. 1.—A Corn Plant with the Ear Shoot Ready to Bag.

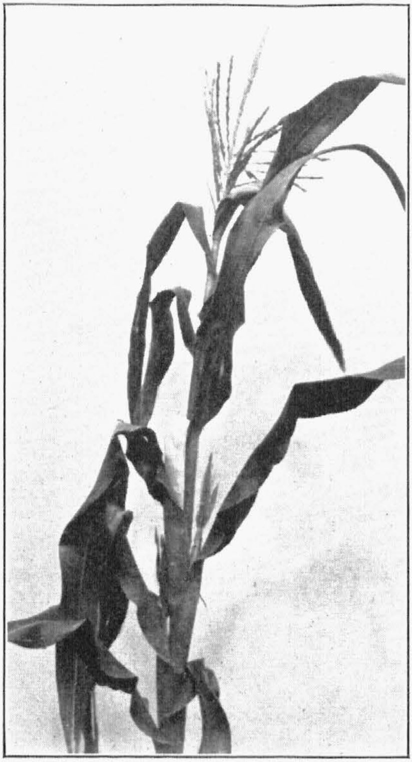


Fig. 2.—The Shoot Bag on the Upper Shoot to protect the Emerging Silks from Foreign Pollen.

bags must be carefully placed or they may be blown off by the wind and leave the silks exposed. In some strains the ear shoots attain a considerable size before silking and in such cases it is necessary to loosen the bag or the shoots will grow out through the top.

Since the bags are semi-transparent, it is possible to see when the silks have attained a suitable length. When the tassel is shedding abundantly and the silks have reached the proper length, about one to two inches long, the glassine bag is raised slightly, and the tip of the shoot, about one inch below the tip of the husk, is cut off. The shoot bag is then returned to its former position. Cutting back the shoots produces an even brush of silk which results in a better seed-set when pollen is limited. At the time the silks are cut back the tassel is bagged. A 12-pound bag made of heavy paper of the kraft type is commonly used. The flat, or satchel-bottom, bags are usually poorly glued on the bottom, thus leaving small holes through which pollen can enter. The pointed, or square-bottom, bags are much better in this respect and are used almost exclusively. Regardless of the style of bottom on the bag, it is essential that they be glued with a good waterproof glue.

There are many minor variations in the manner of putting on tassel bags. The following method has proved quite satisfactory. The bags are opened slightly and the tassel inserted. The edges of the bag are then brought together and the corner folded over and fastened with a paper clip. Folding the bags through the middle the long way before placing on the tassel results in the exposure of less area to the wind and results in fewer tassel losses by breakage. It also provides a convenient trough for pouring out the pollen dur-

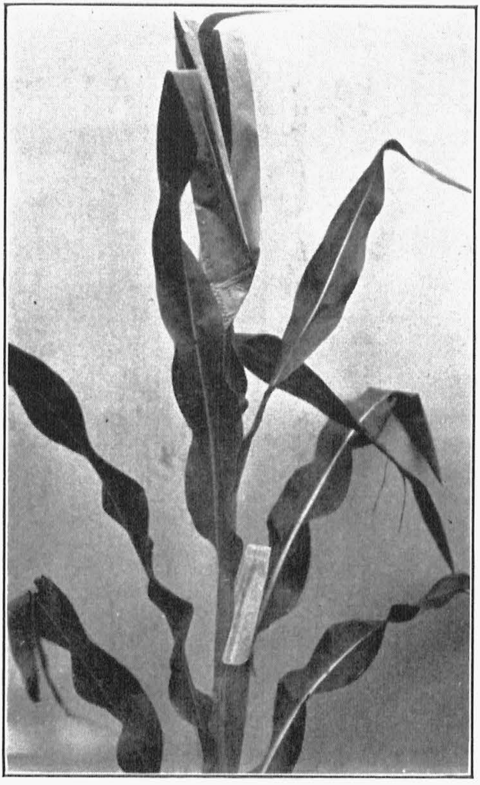


Fig. 3.—Shoot and Tassel Bag in Place. The tassel bag serves to protect the tassel from any stray pollen and also collects the pollen shed by the enclosed tassel.

ing pollination. A plant with shoot and tassel bag in place is shown in Figure 3. Normally the tassel bag is placed on the tassel about 24 hours before pollination. Corn pollen exposed to the air in a thin layer will die in one hour or less, so this lapse of 24 hours is sufficiently long to insure that any stray pollen on the tassel at the time of bagging will be dead.

Pollination is accomplished by carefully removing the tassel bag so as to avoid spilling the pollen. The top of the shoot bag is then torn off, the pollen quickly poured on the silks, and the glassine bag crumpled down. This helps to avoid contamination if grasshoppers should later eat holes in the bag. The tassel bag is then

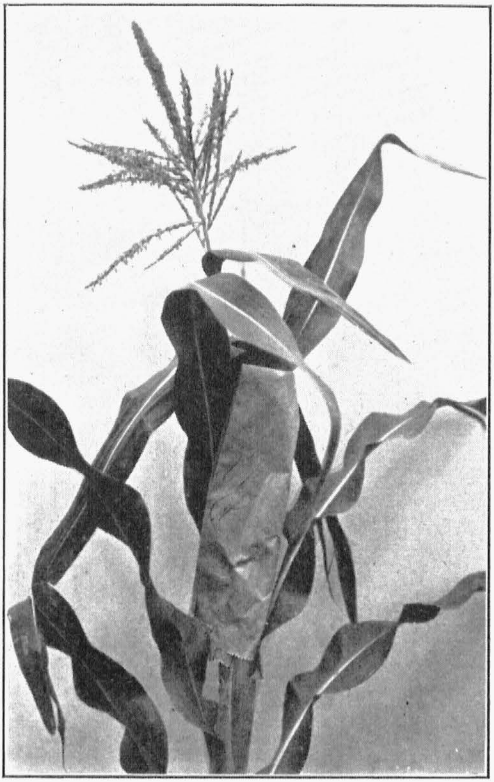


Fig. 4.—The Pollination Completed. The tassel bag has been transferred from the tassel to the developing ear, where it will stay until harvest time. The type of pollination and date are usually recorded on the bag.

placed over the shoot, two or three of the edges brought around the stalk and clipped in place as shown in Figure 4. In ears which attain a large size it is sometimes necessary to loosen and refasten these bags to prevent the developing ears from growing through them and thus exposing the silks. Silks may remain receptive for ten to fourteen days.

The supplies necessary for corn pollination are usually carried in an apron. This apron has a large pocket for carrying the 12-pound tassel bags and smaller pockets for paper clips and glassine bags. A small paring knife is worn, suspended from a thong around the wrist, for cutting back silks.

How Inbred Strains Are Produced

All open-pollinated corn varieties possess a high degree of variability. This variability is due to the fact that the individual plants have received different assortments of the inherited characteristics. Inbreeding tends to emphasize this variability because it brings to light characters which are normally partially masked by cross pollination. As a result of the expression of these latent characters

Fig. 5.—The second generation of the single cross shown in Fig. 6. This progeny resulted from selfing a hybrid plant and shows the segregation for plant height and tendency to suckering.

many abnormal types appear (Figure 9). White and yellow seedlings, dwarf plants, many types of chlorophyll-defective plants such as striped, golden, and yellow green, and various sorts of sterility are quite common. Even among the apparently normal plants there is a marked variation in plant height, tendency to suckering and lodging, disease susceptibility, and a wide assortment of ear types. The great majority of these combinations of characters are undesirable and are discarded. Some idea of the degree of variation can be had from Figure 5.

After inbreeding is begun, each of the ears saved is grown in a separate row. This permits selection both within and between rows. Among the plants resulting from the first generation of inbreeding the most desirable plants are again selfed (inbred). Those plants having the best combinations of plant and ear characters at maturity are kept for further inbreeding, the undesirable types are discarded (Figure 9). Normally this process is repeated for three or more years before testing in hybrid combinations is begun.

Along with inbreeding there is a marked reduction in vigor. This reduction in vigor is greatest in the first generation and on the average is one-half the total loss which will occur from the open-pollinated condition to the final inbred. This loss is decreased by a further halving of the remainder in each succeeding generation. Further decreases in vigor are not important after about three to five generations of inbreeding. After seven or more generations of inbreeding, the lines are true breeding or "fixed," and self-pollination and open-pollination within the strain are essentially similar. Upon crossing, with other inbreds the vigor lost during inbreeding is restored and in desirable combinations is markedly greater than the average of the open-pollinated condition. The vigor and uniformity typical of a first generation hybrid is shown in Figure 6.

Fig. 6.—The first generation hybrid between two inbred lines is quite uniform for all characters and in desirable combinations is more vigorous than the average of the open pollinated condition.

Inbreeding in itself is not the cause of high yield in hybrid combinations; through selection it serves as a method of choosing the desirable and eliminating the undesirable and harmful characters and of attaining uniformity of type and performance. The characters noted in selection are: yield; color of foliage and freedom from chlorophyll defects; resistance to lodging, to drought injury, and to disease; good tassels with abundant pollen production; and the ear type.

There is a marked tendency for inbreds to transmit to their hybrids the characteristics which they exhibit as inbred lines. For example, hybrids between weak rooted strains are commonly weak rooted and susceptible to lodging, crosses between lines susceptible to disease commonly produce hybrids also susceptible to disease, and so on for various other characters which might be mentioned. In general, the most productive hybrids come from crosses involving the most productive lines. This is quite fortunate for the economy of hybrid corn production.

Testing of Lines

It is readily apparent that the commercial production of hybrids is most economical when vigorous inbreds serve as the parents. In open-pollinated varieties there is very little correlation between the various plant and ear characters and yielding ability. The correlation is also low between the various plant and ear characters of the inbred and the yielding ability of its hybrids. This requires that the final evaluation of inbreds be on the basis of their hybrid-combining ability.

Hybrids involving inbred lines are of several types, as partially explained on page 2. A *top cross* involves one inbred and a variety; a *single cross* is made by crossing two inbreds; a combination of an inbred and a single cross is called a *three-way* cross; a *double cross* involves two single crosses. Occasionally combinations of a larger number of lines are used. A *double-double* cross involves eight lines, while a combination of many lines is called a *synthetic*. While each of these types of hybrids has its use, the majority of commercial hybrids are either single or double-cross combinations.

Top crosses are used extensively by the corn breeder as a preliminary means of evaluating lines. On the basis of this test the lines giving low yielding or undesirable hybrids are discarded.

The lines involved in high yielding hybrids are tested further in single and double-cross combinations. Only a small percentage of the various combinations are good enough to merit their use commercially.

Single crosses are used extensively in sweet corn production where a high degree of uniformity is desirable. Some three-way crosses are in commercial production, but the great bulk of hybrid field corn is grown from double-cross seed.

Double-double and synthetic hybrids have received little attention. When defined legally such combinations are usually excluded from the designation "hybrid corn." From theoretical considerations it appears they may have some promise for regions where the regular production of hybrid corn is uncertain. It seems possible that significant increases in yield over open-pollinated varieties may be obtained, but these increases will be much less than can be expected from adapted double-crosses.

The main advantage of double-over single-cross seed is one of economy of production. Single-cross seed is produced on an inbred parent and has the seed size, shape, and quality of that parent. Likewise, the yield of seed is low, as all inbreds are lower yielding than open-pollinated varieties. The use of double-crosses overcomes these limitations. Seed is produced on a single-cross parent which is high yielding and which usually has desirable seed size, shape, and quality. From the standpoint of the grower of the hybrid seed, single and double-crosses are about equally valuable since they have approximately equal yielding ability.

Commercial Production of Hybrids

The methods of the breeder to control pollination are unsuited to large scale commercial production. The inbred seed necessary for the production of single-crosses is usually produced by open pollination within an isolated plot. It is desirable that the foundation seed for planting this increase plot never be more than two or three generations removed from controlled pollination. The distance from other corn should be at least 60 rods and a still greater distance is desirable.

Single-crossed seed, the first generation of a cross between two inbreds, is also produced in an isolated plot. Of the two inbreds in each single cross, one will possess certain characteristics which make its use as a female parent desirable. These characteristics are high yield, good quality, and desirable seed shape. It is essential that the inbred to be used as the male be a good pollen producer.

The inbreds to be used as male and female may be planted in alternate rows across the field. A more common ratio of the two parents is two rows of the female stock alternate with single rows of the male. This is subject to some variation, depending on the pollen producing ability of the male stock. Many producers have found it convenient to have an extra planter box containing the male seed which is used to replace one of the boxes containing the female stock. Changing the entire box is more convenient than removing the female stock, cleaning the box and replacing the male stock.

When the tassels emerge they are removed from the rows serving as female parents. Under favorable conditions the tassel has completely emerged before shedding begins. It can be removed easily by a sharp

Fig. 7.—The method of producing doublecross seed on detasseled plants in four row blocks. The detasseled or female rows were grown from one single cross, and the pollen rows from an unrelated single cross. Under Missouri conditions, it may be desirable to use ratios of 1 or 2 pollen rows to 3 or 4 female rows.

upward pull. If this is done properly, at the right stage, the tassels come out cleanly and little damage is done the plant. If detasseling is done at too early a stage, one or more leaves are apt to be removed along with the tassel. Under droughty conditions the complete emergence of the tassel is delayed, relative to time of silking, and it may start to shed while still partially enclosed by leaves. Under such conditions it is necessary to pull the tassels before shedding, regardless of damage to the plant. The field must be gone over daily throughout the entire tasseling period. All tassels, whether on the main stalks or tillers should be removed before any shedding begins, otherwise an inferior product will result.

Double-crossed seed is produced in a similar manner. Single crosses function as the male and female parents, and the ratio of female to male rows is usually three or four to one. Under more unfavorable conditions, ratios of four to two may be desirable. Only the seed harvested from the female rows is sold commercially as hybrid corn. The seed from the male rows should not be used in further crosses since it may have been contaminated by stray pollen. A picture of a detasseling block after detasseling has been completed is shown in Figure 7.

Occasionally it may be necessary to substitute *one generation advanced seed* (seed produced from a single cross in an isolated plot) for the single cross. This can be done with no harmful effect on the yield of the resulting double cross since crossing with the unrelated single cross restores the vigor. The seed production per acre of crossing block, however, is materially reduced.

Second Generation Hybrid Seed is Undesirable

The crop produced from planting commercial hybrids should not be used for seed the next season. Occasionally reports are received of the satisfactory performance of such seed, but it is an unsafe practice. In general such seed can be expected to be lower yielding and more variable than the original double-cross. This reduction in yield is related to the similarity in hereditary constitution of the parent lines. The four lines involved in a particular hybrid represent only a small part of the hereditary make-up of the original variety. As a result, in the normal cross pollination of the commercial double-cross, the chances for unlike matings is materially reduced. Crosses between plants of similar type are essentially inbreeding in a mild form.

Comparisons of the yielding ability of first-generation and second-generation seed of double-crosses have indicated that first-generation seed may be expected to outyield the second-generation seed of the same cross by 15 to 30 per cent. This reduction appears to be greatest in the higher yielding hybrids. The nature of this reduction can be visualized by comparing Figures 5 and 6. Figure 6 illustrates the first-generation plants of a single-cross, while the plants in Figure 5 are from the second generation of the same cross.

Seed Production a Specialized Undertaking

The maintenance of pure inbred lines and the production of single-cross seed is a highly specialized undertaking, one which only a relatively few farmers are equipped to undertake. The limitations which will be encountered are several.

1. **Adequate Isolation.**—The maintenance and increase of inbred lines or the production of single- or double-crossed seed requires isolation from any other corn by a distance of 60 rods. The production of commercial double-cross seed, beginning with the hand-pollinated inbreds, requires seven isolated plots. These are made up as follows: one isolated plot for the increase of each inbred, or a total of four; one isolated plot for the production of each single cross, or a total of two; and finally, one plot for double-cross production. The majority of farmers will have difficulty in locating even one such isolated plot; consequently arranging for seven such plots will be out of the question except for a very few favorably situated individuals. Most individuals desiring to produce double cross seed for sale will find it most economical in the long run to buy the necessary single cross seed.

2. **Labor Requirements.**—The production of either single or double-cross hybrid seed requires a large amount of labor at the time of detasseling. Detasseling must be done at the time the tassels emerge regardless of the pressure of other work, such as haying, harvesting, or threshing. This emergency demand for labor will cause a serious problem on many farms.

3. **Climate and Soil.** The increase of inbred stocks or the production of single or double-cross seed is expensive as compared with the production of open-pollinated corn. On soils of low fertility or in regions of periodic droughts farmers will find it more economical to buy than to produce hybrid seed.

Quantities of Hybrid Seed Needed for Missouri

If Missouri's entire corn acreage, approximately 5,000,000 acres, were planted to hybrid corn, it would require approximately 715,000 bushels of seed. The additional seed necessary for replanting would increase this figure slightly. This is a large amount of seed, but the following calculations will show that overproduction is easily possible. If we assume an average acre yield of 25 bushels, since seed production presumably will be attempted only on the better land and since one-fifth to one-third of the crossing blocks will be planted to male rows which do not produce salable seed, approximately 28,600 acres of double-crossing blocks would be required to produce Missouri's entire seed supply.

Since most inbred and single-crossed seed is somewhat smaller in size than open-pollinated varieties, a smaller amount of seed per acre, about five pounds, is required. Single-crossed seed is produced on inbred plants, and consequently the resulting yield per acre will be lower. Assuming an average yield of usable seed of five bushels per acre, approximately 520 acres of single-crossing block would be required to furnish the seed necessary for double-crossing. On the same yield assumptions, the inbred seed necessary for planting the single-crossing plots would be supplied by less than 48 acres. Thus the natural increase from 240 pounds of inbred seed would supply all seed for the single and double-crossing blocks necessary for the production of sufficient commercial seed for the state's entire corn acreage. Approximately 120 pounds of inbred seed was released in the spring of 1938. This was in addition to the seed stocks already in the hands of commercial producers. Since the corn acreage of the state presumably will never be planted entirely to hybrid corn, the preceding calculations indicate that overproduction is easily possible.

Certification of Hybrid Corn

Certification is necessary for the maintenance of a high quality product. Even a good hybrid poorly produced may actually be inferior to open-pollinated corn. Certification insures the grower that a particular lot of seed has been produced in accordance with the recommended procedure, that isolation has been adequate, that detasseling has been carefully done, that grading and processing have been such as to insure a uniform product, and that the seed possesses a satisfactory germination. The various regulations governing the certification of hybrid corn are formulated by the Missouri Corn Growers' Association. Copies of these regulations may be obtained from the secretary of this organization or the county extension agents.

In general these regulations require that certified double-cross seed must be produced from certified single-cross stocks, which in turn have been produced from certified inbreds. Only those inbreds are eligible for certification which have been tested and approved by the Missouri Agricultural Experiment Station. All plots involving inbred increase, single- and double-cross seed production, must be isolated from other corn by a distance of 60 rods. Detasseling must be done often and carefully enough to insure that never more than one-half of one per cent of the female plants are shedding pollen during the detasseling period.

At least three inspections—two field and one crib—are made before the corn is processed.

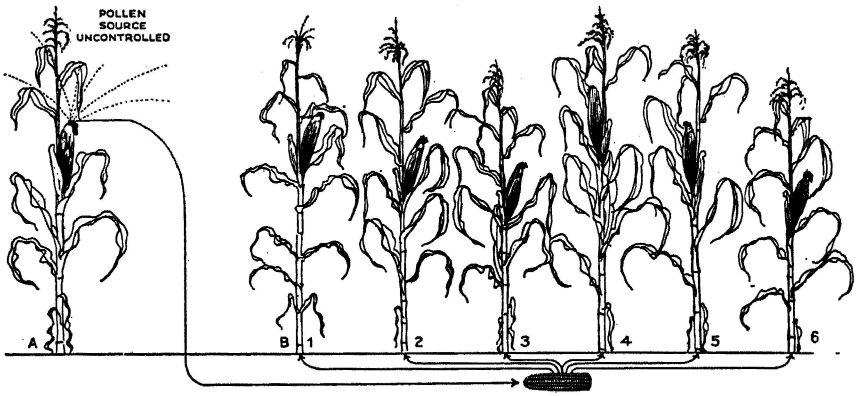


Fig. 8.—(A) A plant from an open-pollinated variety. The individual kernels are related on the female side but may be quite unrelated on the male side, the pollen having come from numerous plants within the field. Each kernel is the result of a separate fertilization. (B) The plants grown from the seed of an open pollinated ear of corn are variable in height, size of ear, etc., but on the average retain the general type of the parent variety.

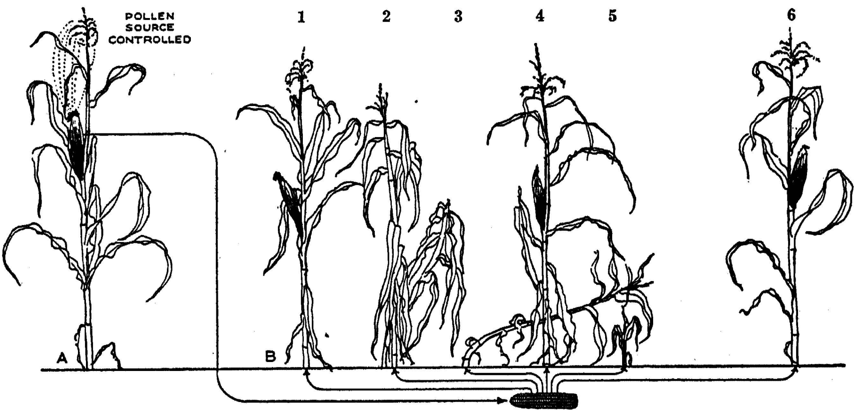


Fig. 9.—When a plant grown from open pollinated seed (A) is self-pollinated, the individual kernels are related on both the male and female side. When seed from this ear are planted (B), segregation for plant and ear characters occurs. Many of the plants are undesirable, e. g. 2, 3, and 5, and are discarded. The plants possessing desirable characters, e. g. 1, 4, and 6, are used for further self pollinations. Self pollination and selection continue until the lines have become "fixed" or true breeding. This usually requires from 3 to 7 generations.

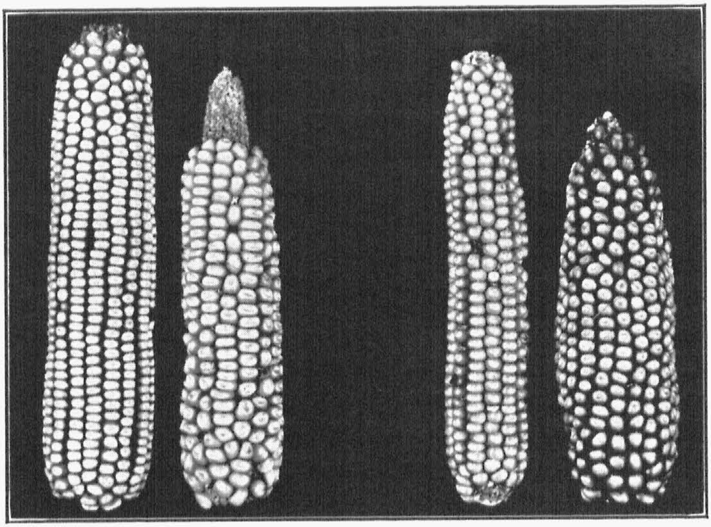


Fig. 10.—Representative Ears of the Four Inbreds Involved in Missouri No. 8. These lines from left to right are K4, B2, L3, and G. These lines are combined into single crosses as follows: K4xB2 and L3xG. Each of these lines has been selfed 10 or more generations.

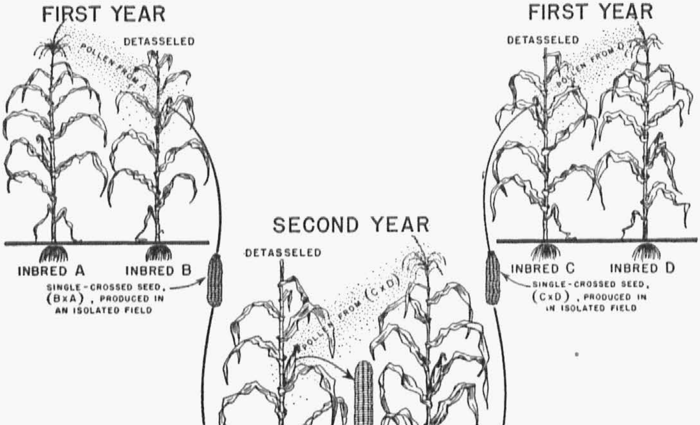


Fig. 11.—Method of producing single and double crosses. (Courtesy Iowa Agricultural Experiment Station.)

Know Your Hybrids

It cannot be too strongly emphasized that not all hybrids are good. Many are no better than, or may actually be inferior to, open-pollinated varieties. The only sure way of obtaining good hybrid seed is to buy only those hybrids with a good performance record under Missouri conditions. It is also essential to know that the seed has been produced properly, that is, that the detasseling operation was done correctly, and that the seed has been handled in such a way as will insure a uniform and satisfactory product.

In choosing a hybrid, adaptation is just as important as in an open-pollinated variety. However, there is a real difference in the two cases. The adaptation of a variety is largely determined by the conditions under which it has been grown for the past several years. In the case of hybrids, adaptation is largely determined by the characteristics of the parental inbreds and is influenced but little by the particular region where the hybrid is produced.

The performance of a particular hybrid in adjoining states does not provide a safe basis for estimating its value under Missouri conditions. Iowa or Illinois hybrids of the earlier maturity groups, such as 115 days to maturity, will be found to be materially earlier than standard Missouri varieties locally classified as requiring 115 days to reach maturity. The only safe way to judge the value of a hybrid for Missouri is to test it under Missouri conditions.

Hybrids Available to Missouri Growers

The corn hybrids available to growers may be divided into two groups, experiment station hybrids and privately developed hybrids. The station hybrids have been developed by various experiment stations, have been adequately tested, and are of known and constant pedigree. The constitution of most of the privately developed hybrids usually is kept secret, the hybrid being designated solely by a trade name and number. The privately developed hybrids may be made up of released station lines or in some cases may contain lines of their own development. Other than the integrity of the company, the buyer has no assurance that a hybrid designated by a particular number is the same from year to year. This introduces a serious difficulty from the standpoint of the testing of these hybrids under Missouri conditions and their subsequent recommendation.

Recommended Hybrids

Three hybrids are eligible for certification and are recommended for Missouri. These are Missouri No. 8 and No. 47 and Iowa 13. Missouri No. 8 and No. 47 are being grown throughout the entire state. Iowa 13 is recommended only for extreme northern Missouri.

Missouri No. 8 has been tested for a six-year period. This hybrid has given its best performance in the southern two-thirds of Missouri. However, data are presented here on its performance over the entire state. The tests resulting in yield data have been located as follows: 1933, Maryville, Columbia, and Sikeston; 1934, Sikeston; 1935, Maryville and Sikeston; 1936, Sikeston; 1937 and 1938, Maryville, Montgomery City, Grain Valley, Columbia, Sikeston, and Jasper. The average yield of Missouri No. 8 for the six-year period for the above stations is 53.4 bushels. The comparable yields for the standard open-pollinated varieties Midland and Reid are 43.5 and 39.1 respectively. Thus for the six-year period Missouri No. 8 has exceeded Midland in yield by 22.8 per cent and Reid by 36.6 per cent. This hybrid is also considerably more resistant to lodging than are these two varieties.

Missouri No. 8 (K4 x B2) x (L3[1] x G) should be made as indicated, using L3 and K4 as the female parents of their respective single crosses. In the production of the single-cross K4 x B2 it is desirable to plant the male stock, B2, approximately ten to fourteen days later than K4. K4 is a two-eared strain and somewhat later than B2. The delay in planting of the male parent, B2, is necessary to insure that both ears on the K4 plants will be adequately pollinated.

Missouri No. 47 (R4 x Hy) x (L3 x G) has been tested for only a three-year period. The location of these tests were as follows: 1936, Sikeston; 1937 and 1938, at Maryville, Montgomery City, Grain Valley, Columbia, Sikeston, and Jasper. Its average yield for the three-year period for the above stations is 55.0 bushels. Comparable yields for Midland and Reid are 41.5 and 37.2 bushels respectively. The indicated percentage increase over these varieties is 32.5 and 47.8 per cent respectively. In the southern two-thirds of the state, Missouri No. 8 and No. 47 have been nearly equal in yielding ability. In northern Missouri, Missouri No. 47 has exceeded No. 8 in yield.

[1]The inbred line L3 is very closely related to L317. Preliminary tests indicate that these strains can be used interchangeably under Missouri conditions.

Iowa 13 (L317 x Bl 349) x (Bl 345 x Mc401) was developed at the Agricultural Experiment Station at Ames, Iowa. It has been grown commercially in that state since 1933, where it is recommended for the southern half of Iowa. In Missouri this hybrid is recommended only for the extreme northern section of the state. Yield data are available for a four-year period as follows: Maryville in 1933, 1935, 1937, and 1938; and Montgomery City for 1937 and 1938. The average yield of Iowa 13 for these years and for these stations is 69.3 bushels as compared with 54.1 bushels for the open-pollinated variety Reid. This represents a yield increase of 28.1 per cent.

Iowa 13 is quite satisfactory from the standpoint of yielding ability. However, it has some undesirable features. It is more susceptible to ear rots than is Missouri No. 8 or No. 47. It also tillers profusely which some growers find objectionable. In addition it is somewhat susceptible to the attack of second-brood chinch bugs.

The single-cross (Bl. 345 x Mc401) is recommended as the pollen parent for two reasons: These plants produce tillers which would increase detasseling costs if used as the female, and this single cross is somewhat inferior in quality and yield to the single cross (L317 x Bl 349).

During the past six years numerous commercial hybrids have been included in the regular yield tests. Many of these were found to be ill-adapted to Missouri conditions and were discontinued. Hybrids which have shown promise for a two-year period at one or more stations are Illinois 960; Iowealth C. I.; Funk G46, G53, G56, and G235; Jewett Nos. 3, 6 and 11; and National 125. These and other hybrids which appear promising on the basis of a single year's test are being continued. According to the present policy, no hybrid will be recommended by the Missouri Experiment Station until adaptation and yielding ability have been demonstrated through tests conducted by this station.

Release of Inbreds

It is the policy of the Missouri Experiment Station to release only those lines which enter into certified hybrids. These will be furnished in small quantities, as the seed supply permits, to prospective growers. The six lines involved in Missouri No. 8 and No. 47 can be obtained from the Field Crops Department at Columbia, Missouri. The lines involved in Iowa 13 were developed at Ames, Iowa. Lists of the producers of certified seed stocks of this hybrid can be obtained from the Iowa Experiment Station, Ames, Iowa.

Description of Inbred Lines

The various plant and ear characteristics of an inbred line are quite uniform as compared with an open pollinated variety, but, nevertheless, they do exhibit some variation, depending on seasonal conditions and soil fertility. For this reason it is not possible to describe each line exactly. It is possible, however, to list their distinctive characteristics. Descriptions of the six lines involved in Missouri No. 8 and No. 47 are presented in the following paragraphs. The lines involved in Iowa 13 have been adequately described in Bulletin 366 of the Iowa Experiment Station.

L3.—The inbred L317 was developed at the Iowa station from the variety Lancaster Surecrop. Prior to its commercial release in

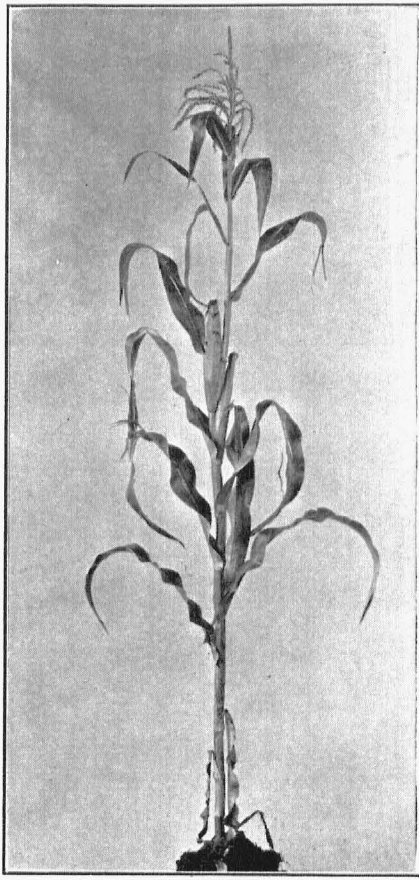


Fig. 12.—Typical Plant of L3.

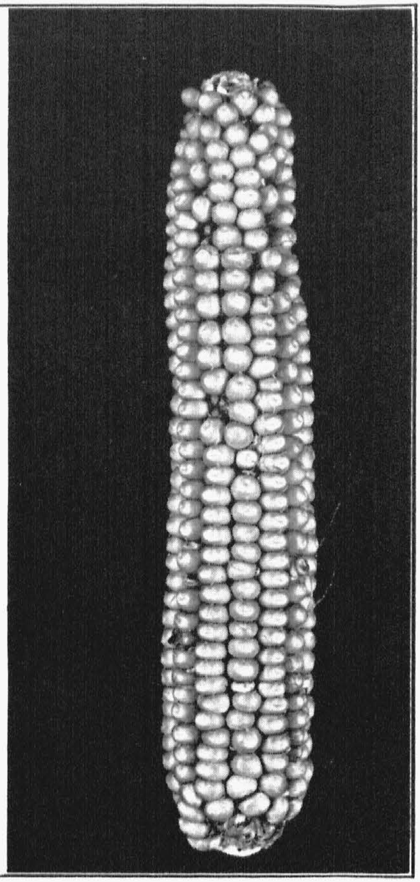


Fig. 13.—Typical Ear of L3.

Iowa it was sent to several state stations where corn breeding work was in progress. In Missouri the line appeared to have considerable promise but possessed certain faults, one of the most serious of which was poor pollen production. The present line L3 is the result of an attempt to improve L317 by crossing with line Kys which produces ample pollen under Missouri conditions, repeated backcrossing to L317 with rigorous selection and finally selfing.

This line is dark green in color, with numerous small leaf blotches as the plant nears maturity. The ears are borne rather high on the stalk. This line and its hybrids have shown marked drought resistance.

The ears are long, with about 12-16 kernel rows. The kernels are rather flinty and often crack before maturity.

G.—This line was developed at the Missouri station from the Pennsylvania variety Mastadon. It is characterized by a heavy tassel,

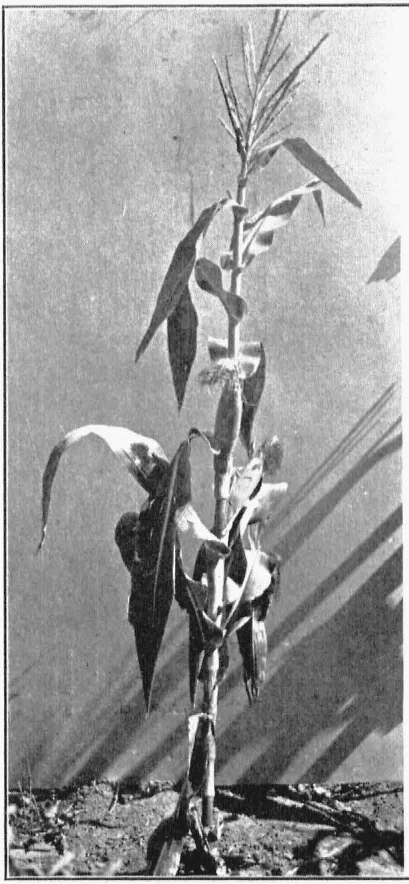


Fig. 14.—Typical Plant of G.

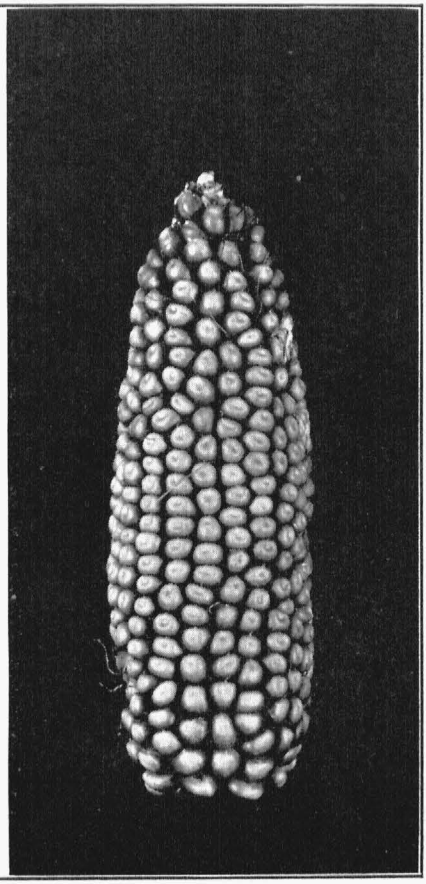


Fig. 15.—Typical Ear of G.

abundant pollen production, heavy stalk, wide leaves, and a greyish-green leaf color. The ears are short, usually under six inches and have 16-20 kernel rows. The ears are often terminated by a thickened tassel branch.

The kernels are a reddish yellow, dimple dented, and a desirable size and shape.

The line is quite susceptible to smut and often exhibits a considerable amount of ear rot. The single-cross for both hybrid No. 8 and No. 47 is best made using L3 as the female and G as the male parent.

B2.—This line was developed by the Indiana Station from Reid Yellow Dent. The plants are low eared, stiff stalked, and have a con-

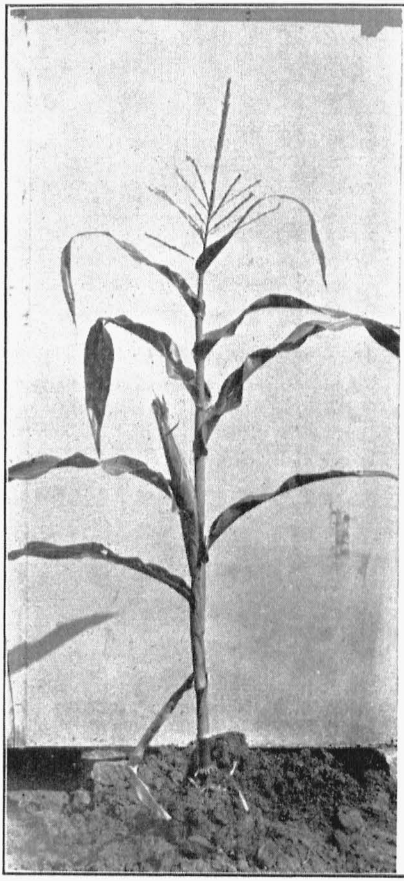


Fig. 16.—Typical Plant of B2.

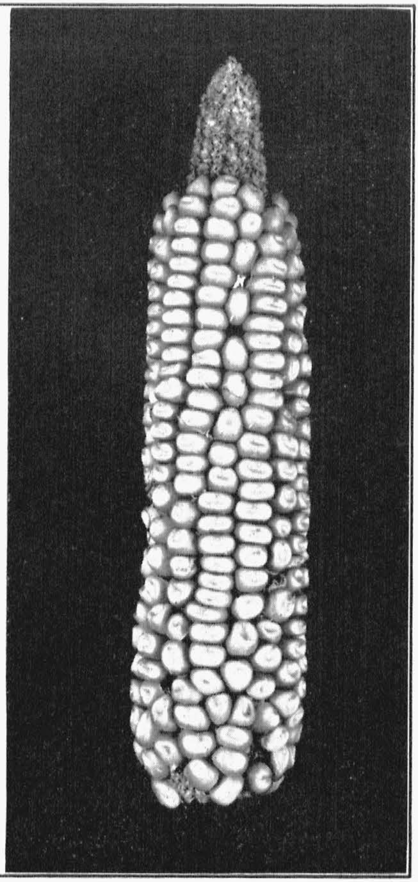
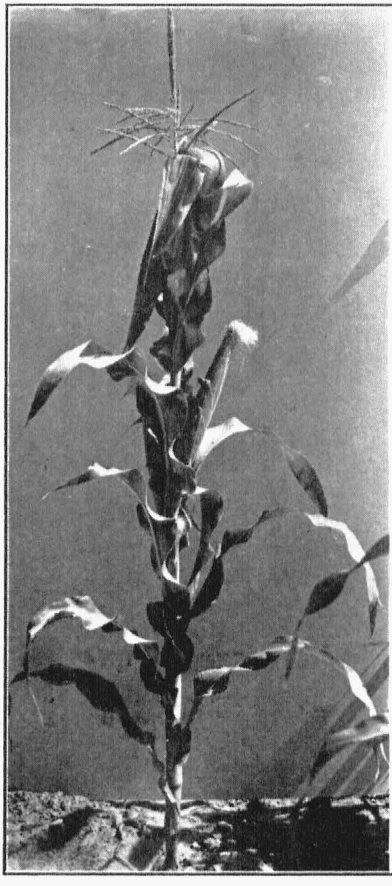


Fig. 17.—Typical Ear of B2.

siderable susceptibility to firing. The tassels are sparsely branched and the pollen shedding period is relatively short.

The kernels are large in size with rather thin pericarps and are susceptible to ear rots. Because of the small ear size this line is best used as the male in the single-cross (K4 x B2). It should be planted 10-14 days later than K4.

K4.—This line was received as a six-generation inbred from the Kansas station. The parent variety was Kansas Sunflower. This line is predominantly two-eared, the ears being borne on rather long shanks. The ears are 14-16 rowed. The kernels are rather small, dimple dented, and usually free from rots.



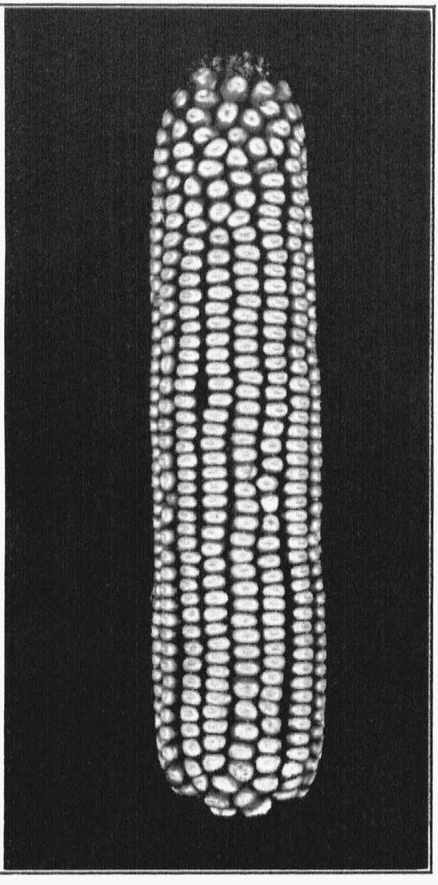


Fig. 18.—Typical Plant of K4. **Fig. 19.—Typical Ear of K4.**

The upper leaves are short and taper rapidly. The leaves are slightly more heavy than average and are dark in color. The line possesses considerable resistance to heat and drought. Because of its high yielding ability, it is best used as a female parent in the single cross (K4 x B2).

R4.—This line was obtained from the variety Funk Yellow Dent. The inbreeding was done at Bloomington, Illinois, by the U. S. Department of Agriculture.

This line is two-eared and somewhat weak stalked. Both of these characteristics are transmitted to its hybrids. The plants die rather early in the fall before the ears are well ripened. The tassel is sparse-

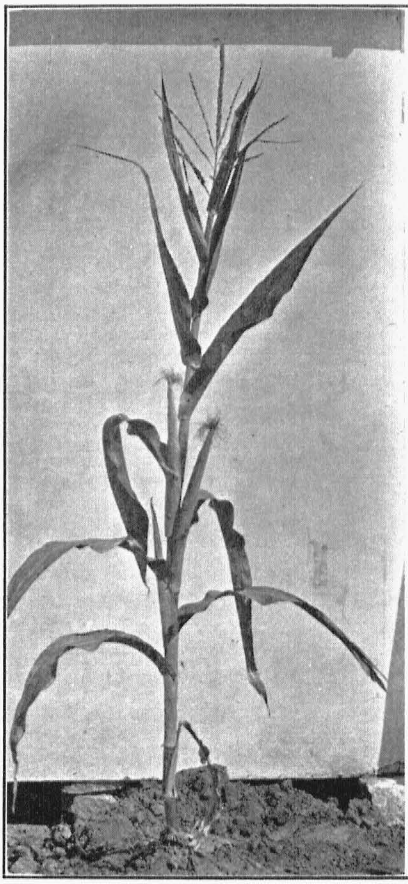


Fig. 20.—Typical Plant of R4.

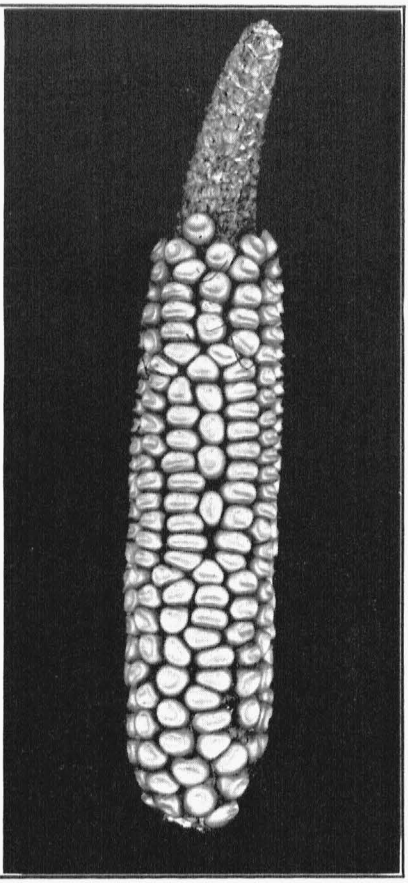


Fig. 21.—Typical Ear of R4

ly branched, and the period of pollen shedding is short. The surface of the leaves is characteristically roughened.

The kernels are dimple dented and rather square in cross section.

Hy.—This line was obtained from the variety Illinois High Yield. The first three generations of selfing were done at the Kansas station. Subsequent inbreeding was done at Bloomington, Illinois, by the U. S. Department of Agriculture.

This line has a good root system and introduces stiffness of stalk to its hybrids. The plants are somewhat light green in color. The tips of the tassel branches are usually sterile. This line is best used as the female parent in the single-cross (Hy x R4).

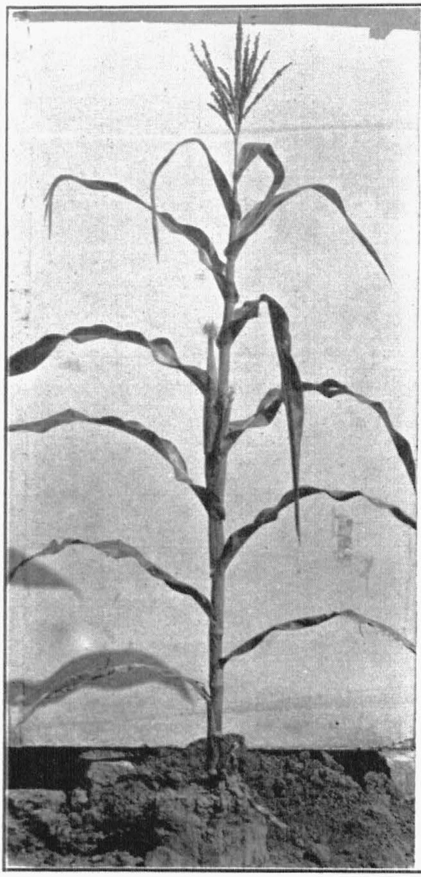


Fig. 22.—Typical Plant of Hy.

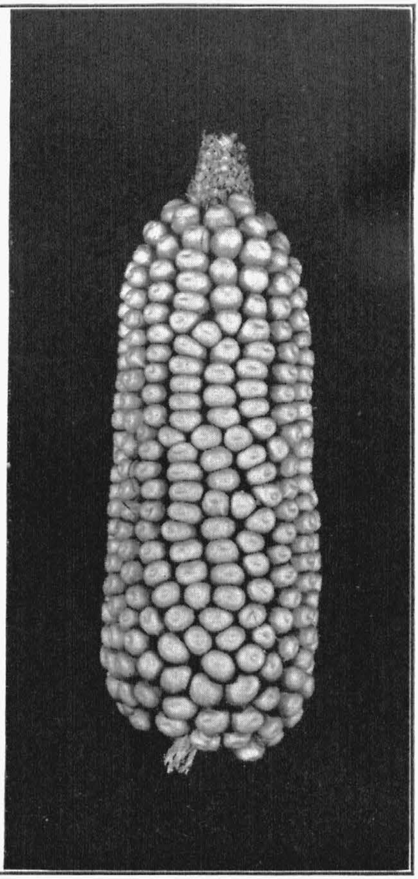


Fig. 23.—Typical Ear of Hy.

RECOMMENDATIONS

Three hybrids are recommended for Missouri. These are Missouri No. 8, No. 47, and Iowa 13. Missouri No. 8 and No. 47 may be grown throughout the state, although No. 47 will usually exceed No. 8 in yield in northern Missouri. Iowa 13 is recommended only for extreme northern Missouri.

During a six-year period data have been obtained on the performance of Missouri No. 8 in nineteen tests. As an average for this period it has outyielded Midland and Reid, two standard open-pollinated varieties, by 22.8 and 36.6 per cent respectively.

Missouri No. 47 has been included in thirteen tests during a three-year period. Its yield has exceeded that of Midland and Reid by 32.5 and 47.8 per cent respectively.

In seven tests covering a four-year period, Iowa 13 has exceeded the yield of Reid by 28.1 per cent. This hybrid should be grown only in northern Missouri.

There is no magic in the term "hybrid corn." Some hybrids are decidedly superior to open-pollinated varieties. Others may be no better or even poorer than standard adapted varieties. It is recommended that the purchase of hybrid seed corn be limited to those hybrids which have been adequately tested and have shown promise under Missouri conditions.