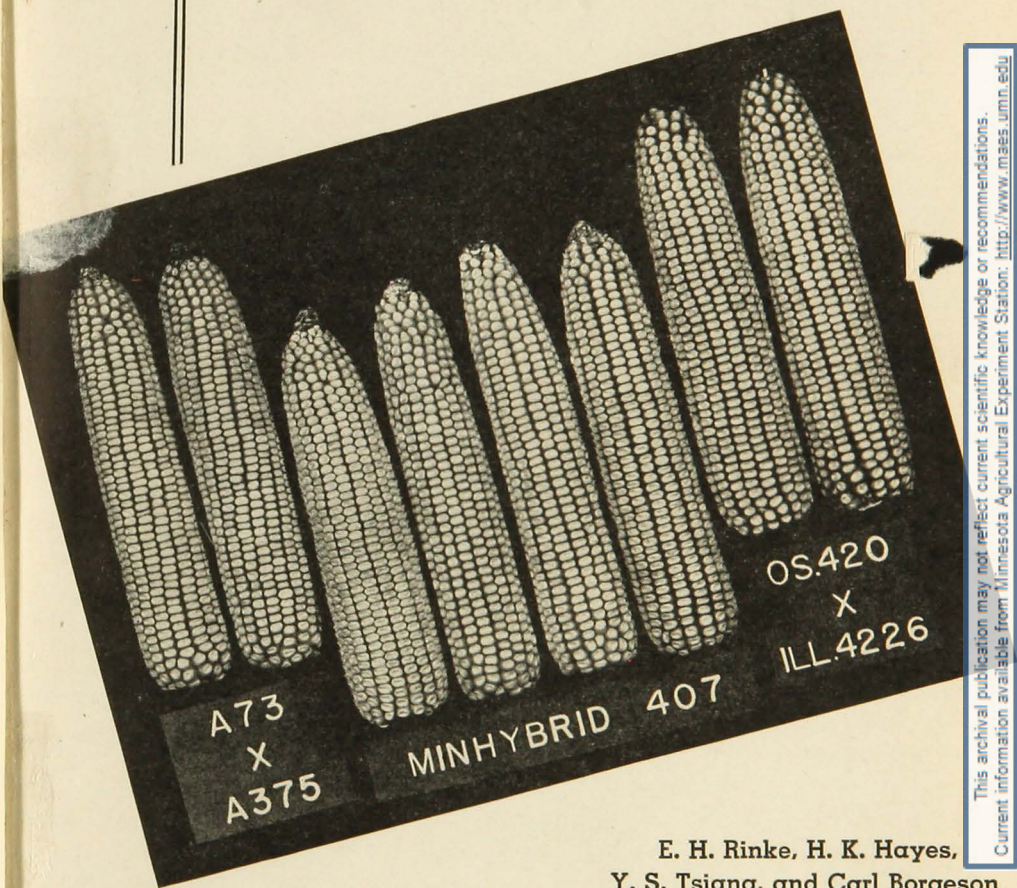


# Minhybrid Corn Varieties for Minnesota



E. H. Rinke, H. K. Hayes,  
Y. S. Tsiang, and Carl Borgeson

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# Minhybrid Corn Varieties for Minnesota<sup>1</sup>

E. H. Rinke, H. K. Hayes, Y. S. Tsiang, and Carl Borgeson

THE expansion of the use of hybrid corn in Minnesota and other important corn-producing states continues at a rapid pace. Approximately 52 per cent of the 1943 corn acreage in the United States was planted to hybrid seed. The hybrid corn acreage in Minnesota has increased 34 per cent since 1940. The percentage of acres planted to hybrid corn in 1943 in some of the important corn-growing states is as follows: Iowa 99, Illinois 96, Indiana 96, Ohio 92, Minnesota 88, Wisconsin 81, and Nebraska 63.

## VALUE OF CORN IN MINNESOTA

Corn is the most important crop in Minnesota with a total value over twice that of any other crop. Acreage production and average yields in bushels per acre are as follows:

Year	Acreage	Yield per acre	Total production
		Bushels	Bushels
1932-41 .....	4,581,000	33.4	153,017,000
1942 .....	4,763,000	43.5	207,190
1943 .....	5,284,000	42.5	224,698

Crops and Markets, United States Department of Agriculture, October, 1943, and Crop Production, U.S.D.A., November, 1943.

There has been a marked increase in yield per acre in the corn belt states in recent years owing to the use of hybrid seed corn. In comparison with other crops the yield of total digestible nutrients per acre is much greater for corn than for any other seed crop. The summary in the following table is based on the yields at the central and branch stations and total digestible nutrients in 100 pounds of feed, adapted from Morrison, "Feeds and Feeding," 20th edition. The results given are for harvested grain only and are comparisons of corn with its nearest competitor at each of five stations.

<sup>1</sup>The following members of the Minnesota Branch Experiment Stations have given material aid in the yield trials: R. E. Hodgson, Waseca; R. O. Bridgford and T. H. Fenske, Morris; R. S. Dunham, Crookston; and C. H. Griffith, Grand Rapids.

Station	Total digestible nutrients per acre	
	Corn	Nearest competitor
	Pounds	Pounds
University Farm .....	2,056	Barley 1,568
Waseca .....	2,989	Barley 1,923
Morris .....	2,153	Barley 1,432
Crookston .....	1,566	Barley 1,341
Grand Rapids .....	1,460	Rye 1,399

Hayes, H. K., Minn. Agr. Expt. Sta. Bul. 365. 1943.

### The Value of Hybrid Corn

Controlled selection during the process of inbreeding makes it possible during the production of inbred lines to select for the characters desired in the hybrid. The value of inbred lines from the standpoint of their use in hybrids is determined from actual field trials of crosses.

Some plants in an open-pollinated variety are equal and sometimes superior to any plant in the hybrid variety, but the open-pollinated variety shows wide variation from plant to plant. In the hybrid variety there is much less variation in inherited characters from plant to plant than in the open-pollinated variety. Consequently the yield of adapted hybrids, on the average, may be expected to be from 10 to 30 per cent greater than that of adapted open-pollinated varieties.

Hybrids are now available in Minnesota that are adapted to particular soil and climatic conditions and to different periods of maturity, and that excel in lodging resistance, smut resistance, plant characters, and in yielding ability. All hybrids, however, are not equally desirable and the selection of a hybrid adapted to a particular region is essential if the grower is to obtain the maximum benefit of hybrid corn.

Minhybrid corn varieties are hybrids developed for the several corn-growing regions of the state of Minnesota by the University of Minnesota Agricultural Experiment Station.

This bulletin presents information pertaining to 12 new Minhybrids released by the experiment station in 1943 and gives added information regarding Minhybrids released previously to 1943.

### DESCRIPTION OF TERMS AND METHODS

Definitions and descriptions of terms and a discussion of methods commonly used will be given for the grower not familiar with the procedures and techniques that are involved.

**Inbred Line**—An inbred line of corn usually is produced by selection in self-pollinated lines. Self-pollination consists of pollinating the silks of a plant with pollen produced on the tassel of the same plant. Brother-sister mating, called sib-pollination, another form of inbreeding, consists of pollinating the silks of a plant with pollen from another plant of the same inbred line. Any form of inbreeding tends toward homozygosis, i.e., purity of type. The approach to homozygosis is about one third as rapid by brother-sister mating as by self-pollination. In the production of inbred lines for use in hybrids, inbreeding and selection is continued until the line is relatively pure for type which usually requires at least five generations of self-pollination. All inbred lines of field corn now available are less vigorous than normal corn, although some are much better producers than others.

**Inbred-Variety Cross**—An inbred-variety cross is a cross between a commercial variety and an inbred line. When many inbred lines are available, inbred-variety crosses are used by the breeder as a method of selecting inbreds with high combining ability. The method of selection is to test the inbred-variety crosses in yield trials, and on the basis of these trials select for testing in single crosses those inbreds which gave a good performance in hybrid combination.

**Single Cross**—A single cross is a cross between two inbred lines. Such a cross gives maximum vigor although some single crosses naturally are much more vigorous than others.

**Three-way Cross**—A three-way cross is produced by crossing a single cross with an inbred line. Three-way crosses are used

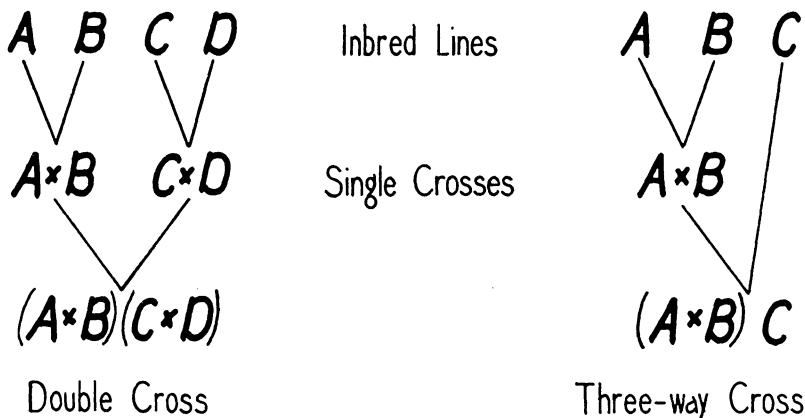


FIG. 1. The double and three-way cross plan

to some extent to produce seed for the commercial crop. The inbred line used as the male parent must be an excellent pollen producer.

**Double Cross**—A double cross is produced by crossing two single crosses, and this is the most common method of the utilization of hybrid vigor in field corn. Figure 1 illustrates the double cross and three-way cross plan.

**Multiple Cross**—A multiple cross is any cross in which more than four inbred lines have been utilized in its production. Such crosses have not been used by the Minnesota Agricultural Experiment Station.

**Advanced Generation**—An advanced generation of a cross is the product of normal uncontrolled pollination. A first advanced generation of a single cross is the first progeny of a single cross planted in an isolated field and allowed to interpollinate freely. In a similar manner advanced generation of three-way, double, or multiple crosses may be produced. Second and third advanced generations are produced by further generations of growing and selecting for seed under open or uncontrolled pollination.

From the standpoint of the breeder it is important to remember that crosses between advanced generations of single crosses usually yield as well as the double cross made by crossing two single crosses. Thus the double cross (AxB) (CxD) yields about the same as a double cross between advanced generation AxB crossed with advanced generation CxD.

An advanced generation usually yields approximately 15 to 20 per cent less than the first cross. Much of the benefit obtained by growing hybrid corn is lost if the seed crop is not produced by a controlled cross.

The extensive production of crossed seed is carried out by growing the lines to be crossed in alternate rows or plots and detasseling one parent line before the silks appear on that line.

## MATURITY ZONES IN MINNESOTA

The well-known early double crosses of mixed seed color, Minhybrids 401 and 402, the three-way cross, Minhybrid 301, and the double cross, Minhybrid 403, have been grown extensively in the regions of their adaptation in Minnesota. These hybrids and the standard varieties of Golden King, Murdock, and the various strains of Minnesota No. 13 have been grown for many years in yield trials. The results of these tests have been used to

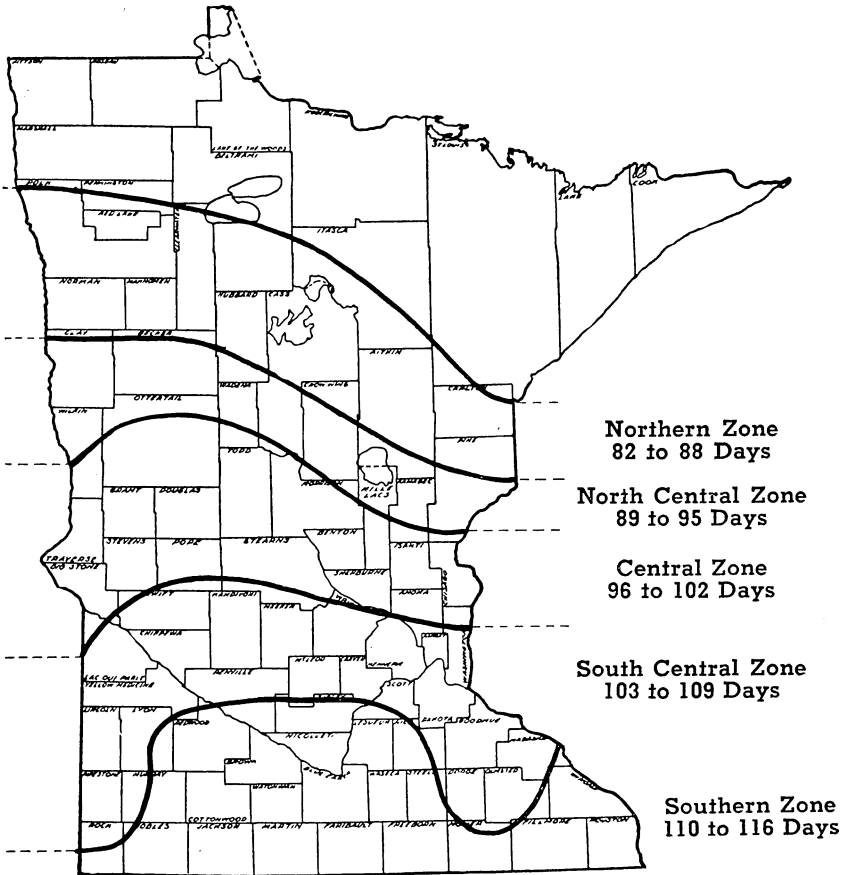


FIG. 2. Maturity or adaptation zones for corn in Minnesota

determine maturity zones in various parts of the state. A map indicating these zones is given in figure 2.

Days of maturity represent the time from emergence of the seedlings until the corn is approximately at 40 per cent moisture content, which is often called the approximate point at which corn is physiologically mature. A plan for numbering Minhybrids for the various maturity zones is given here.

Minhybrid Numbers	Maturity Zone	Days to Maturity	Average
800 series	Northern	82 to 88	85
700 series	North Central	89 to 95	92
600 series	Central	96 to 102	99
500 series	South Central	103 to 109	106
400 series	Southern	110 to 116	113

## BREEDING METHODS USED IN PRODUCTION OF MINHYBRIDS

**Development of Inbred Lines**—The inbred lines used in the various Minhybrids have been obtained by (1) self-pollination and selection from open-pollinated varieties, (2) self-pollination and selection from crosses, (3) backcrossing, and (4) by introduction of lines from corn-breeding programs outside of the state of Minnesota. Forty-two inbred lines are used in Minhybrids.

Nine of these 42 inbred lines have been obtained by self-pollinating open-pollinated varieties and selecting for desirable agronomic characteristics during the segregating generations. Some of the agronomic characteristics selected for are general vigor, lodging resistance, disease resistance, length of ear, and tassel type.

Nineteen of the inbreds used have been developed by self-pollinating and selecting in the segregating generations of definitely planned crosses. These crosses were planned so as to introduce a diversified germ plasm, the use in each parental cross of at least one line of good standing ability, and to combine in one inbred as many desirable agronomic characters as possible. It appears easier to obtain a larger number of desirable inbred lines from equal amounts of work by selfing and selecting in planned crosses rather than by selfing open-pollinated varieties.

Four inbred lines developed from open-pollinated varieties have been improved by backcrossing. This method of breeding is useful if it is desired to maintain an inbred largely as it is and to add to it some desirable character or characters which it lacks. B164 is an inbred which is vigorous and has good combining ability but is highly susceptible to smut. C-37 is an inbred which possesses good smut resistance. From crosses of B164 with C-37 and then backcrossing to B164 for two generations before selfing, lines have been selected that closely resemble B164 and with excellent smut resistance.

Ten of the inbred lines are introductions from other corn-breeding programs outside of Minnesota. These inbred lines offer a wide diversity of germ plasm as well as high combining ability, as they are highly selected lines from many different sources. As used in Minhybrids they aid in introducing the benefits of genetic diversity as well as of combining ability. The reader will have some appreciation of the relative vigor of inbred lines, single and double crosses by a comparison of the ear size of inbreds (see figure 3) with the ears of single cross parents and of double crosses



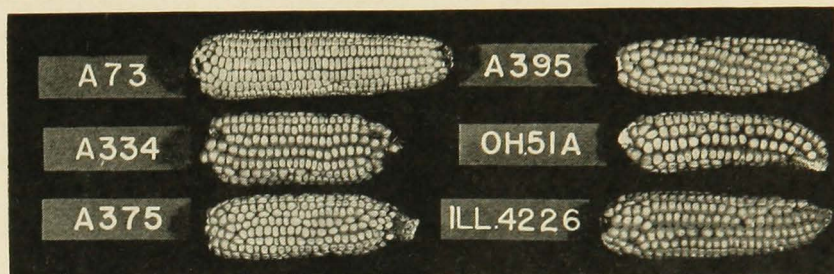


FIG. 3. Inbred lines used in recently introduced Minhybrids 503, 504, and 505. Five of these inbreds and two others, A25 and Os420, are used in Minhybrids 406, 407, and 408

shown in other figures, and reproduced on the same scale of reduction.

The origin of the inbreds shown in figure 3 illustrates some of the methods of breeding. A334 was obtained by selection in selfed lines of Golden King and is used extensively in Minhybrids; A395 was obtained by backcrossing; A375 was obtained by further selection from an inbred line introduced from Illinois; A73, Oh51A, and Os420 were obtained from other breeders (A73 from Wisconsin, Oh51A from Ohio, and Os420 from Iowa).

**Selection of Inbred Lines for Testing as Hybrids**—It is difficult to select the more desirable inbred lines by comparing them with each other. The inbred-variety cross is a method frequently used for determining which of a large group of inbreds possesses the greatest ability to transmit yield and other desirable characters to their offspring. This is accomplished by crossing the inbred lines with an open-pollinated variety which is not related to the inbreds being tested. The inbred-variety crosses are grown in test plots and the information obtained from these plots is used to aid in selecting inbreds for testing in single cross combination.

**Genetic Diversity**—After inbred lines have been selected on the basis of inbred-variety crosses, it is desirable to combine the inbred lines of like maturity into all possible single cross combinations as a means of testing them for the most desirable hybrid combinations. The single crosses are grown in yield trials (see method of conducting trials) and the data obtained are used for the purpose of predicting the yield of some of the various possible double cross combinations.

It is not always necessary to predict the yield of all possible double cross combinations as inbred lines originating from the same single cross will usually not yield as well when crossed

together as inbred lines originating from different sources of germ plasm. Consequently, one may eliminate the necessity of predicting the yields of all double cross combinations that have an inbred in one of the single cross parents which is derived from the same planned single cross as an inbred used in the other single cross parent.

**Use of Single Crosses in Predicting Double Cross Yields**—The method of predicting the yield of double crosses from the performance of certain single crosses of inbred lines has become a standard practice in recent years. The method was first tested by Jenkins<sup>2</sup> in comparison with other methods of predicting double cross yields. Jenkins stated, "In any double cross the genes of each of the four parental lines are united only with allelomorphs of the two lines which entered the double cross from the opposite parent."

Doxtator and Johnson<sup>3</sup> and Anderson<sup>4</sup> gave further data regarding the value of this method of predicting and concluded that the method was a promising one.

In a later study, by Hayes and others,<sup>5</sup> a comparison was made of the yield and moisture content of 114 such selected double crosses, grown as a part of the regular plant breeding program, where the predicted yields were made from single cross trials grown one season and the actual yields determined in a different year. Of these, 111 gave actual yields and moisture content that were not greatly different from their predicted performance. This led to the conclusion that the method of prediction was highly reliable. A detailed study was made of eight double crosses that exhibited rather wide differences in performance, where the predicted performance of double crosses was determined from yield trials of single crosses made at the same time that the actual yields of double crosses were obtained. Differences in yield and moisture content between predicted and actual doubles were not so large that they greatly affected the relative performance of these eight hybrids.

In 1939 a considerable number of relatively early maturing superior inbred lines from the corn belt and some of the more

<sup>2</sup> Jenkins, M. T. Methods of estimating the performance of double crosses in corn. *Jour. Amer. Soc. Agron.*, 26:199-204. 1934.

<sup>3</sup> Doxtator, C. W., and Johnson, I. J. Prediction of double cross yields in corn. *Jour. Amer. Soc. Agron.*, 28:460-462. 1936.

<sup>4</sup> Anderson, D. C. The relation between single and double cross yields in corn. *Jour. Amer. Soc. Agron.*, 30:209-211. 1938.

<sup>5</sup> Hayes, H. K., Murphy, R. P., and Rinke, E. H. A comparison of the actual yield of double crosses of maize with their predicted yield from single crosses. *Jour. Amer. Soc. Agron.*, 35:60-65. 1943.

desirable inbred lines developed by the Minnesota Agricultural Experiment Stations were crossed in all possible combinations. This group of 190 single crosses was tested at four locations in southern Minnesota in 1940. On the basis of unfavorable maturity and yield reactions in single cross combinations the original group of 20 inbred lines was reduced to 12. The moisture content and yield of the 1,485 possible double crosses were predicted by using the data obtained for the 66 possible single cross combinations of these 12 lines.

Double cross seed was produced in the summer of 1941 for 150 double crosses which had superior double cross predictions in 1940. The 66 single crosses were again tested in 1941 and the 1,485 double crosses were again predicted by using the average yield and moistures for the years 1940 and 1941. On the basis of the two-year prediction data the number of doubles selected for testing in 1942 was reduced to a total of 56. Three of these 56 hybrids were selected for release in the South Central maturity zone and have been numbered Minhybrids 503, 504, and 505. Three additional ones were selected for release in the Southern Zone and have been numbered Minhybrids 406, 407, and 408.

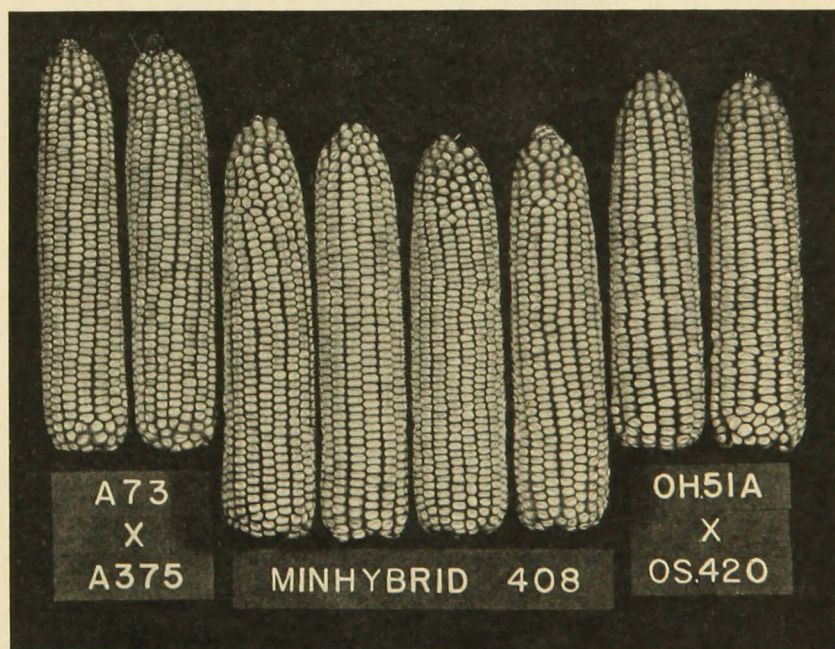


FIG. 4. Ears of single cross parents and Minhybrid 408

**Table 1. Method for Predicting the Yields of the Three Possible Double Crosses that Can Be Made from the Four Inbred Lines A73, A375, Oh51A, Os420. Average of Eight Locations, Three Replications per Location**

Single cross	Predicted double cross (A73xA375) (Oh51AxOs420)		Single cross	Predicted double cross (A73xOs420) (Oh51AxA375)	
	Moisture	Yield		Moisture	Yield
	Per cent	Bushels		Per cent	Bushels
A73xOh51A .....	22.2	81.3	A73xOh51A .....	22.2	81.3
A73xOs420 .....	26.9	88.3	A73xA375 .....	23.9	71.0
A375xOh51A .....	21.8	73.2	Os420xOh51A .....	26.1	78.2
A375xOs420 .....	25.6	81.5	Os420xA375 .....	25.6	81.5
Average .....	24.1	81.1	Average .....	24.5	78.0
	Predicted double cross (A73xOh51A) (A375xOs420)				
Single cross	Moisture	Yield			
	Per cent	Bushels			
A73xA375 .....	23.9	71.0			
A73xOs420 .....	26.9	88.3			
Oh51AxA375 .....	21.8	73.2			
Oh51AxOs420 .....	26.1	78.2			
Average .....	24.7	77.7			

An illustration of the method of prediction will be given for Minhybrid 408 produced by the double cross method of combining the four inbred lines (A73 x A375) (Oh51A x Os420).

From a series of four inbred lines it is possible to make six different single crosses and three different double crosses. These six single crosses were included among the 66 tested for yield, maturity, and other characters by growing them in replicated field trials in four localities in 1940 and 1941. Using the data obtained from these trials, the yield and moisture values for the three possible double cross combinations are predicted in table 1.

It will be noted that the predicted yield of (A73 x A375) (Oh51A x Os420) exceeded the predicted yield of the other two predicted double crosses using the same four inbred lines. It was outstanding also in comparison with other predicted double crosses. This high yielding double cross has now been tested for two additional years as an actual double cross and has been named Minhybrid 408.

The predicted yield and moisture content of six double crosses of greatest promise in comparison with Minhybrid 403 are given in table 2.

Three of these Minhybrids, 503, 504, and 505, had a slightly lower moisture content at husking than Minhybrid 403 and after testing in the South Central Zone have proven desirable hybrids for this zone. Minhybrids 406, 407, and 408 appear better adapted

**Table 2. Predicted Double Cross Values for Yield and Moisture of Six Minhybrids in Comparison with Minhybrid 403. Values Obtained by Averaging Appropriate Single Cross Yields and Moistures from Tests Grown in 1940 and 1941**

Hybrid	Moisture	Yield
	Per cent	Bushels
Minhybrid 503 .....	22.8	78.1
Minhybrid 504 .....	22.5	76.8
Minhybrid 505 .....	22.0	75.3
Minhybrid 406 .....	24.7	77.8
Minhybrid 407 .....	23.7	76.8
Minhybrid 408 .....	24.2	81.8
Minhybrid 403 .....	23.8	66.9

for the Southern Zone. Further data will be presented later in the bulletin when these six new hybrids will be compared with previously released hybrids.

### Method of Conducting Yield Trials

Each hybrid being tested is grown in the zone to which it is believed to be adapted. Before a hybrid is released it will have been tested for three or more years, at three or more locations each year, with from three to four replications per location.

Double cross trials are planted at the rate of four viable kernels per hill and no adjustment is made for differences in stand. Single cross trials are planted at the rate of five kernels per hill, each hill is thinned to three plants when plants are about six inches high and only three-stalked hills surrounded on all sides by corn are harvested for yield. Single cross trials are handled in this manner so as to obtain a yield for prediction purposes which is not influenced by stand differential and therefore is a good indication of the genetic potentialities of a specific combination.

### PERFORMANCE OF MINHYBRIDS

**Northern Zone—800 Series of Minhybrids**—On the basis of the trials made in the Northern Zone the conclusion has been reached that many of the open-pollinated dent varieties and hybrids available are later in maturity than is desirable. In the region north of this zone the lack of sufficiently early maturing hybrids is even more evident. The open-pollinated strain of Haney's Minnesota No. 13 is grown rather widely in the Northern Zone. The per cent moisture at time of harvest and yield in bushels per acre for the Minhybrids grown in the Northern Zone yield trials and for Haney's No. 13 are presented in table 3. Both

Table 3. Performance of Minhybrids in the Northern Zone in Comparison with Haney's No. 13 (Mellum)

Hybrid	Years tested	Number trials	Stand	Moisture at husking		Yield per acre	Per cent of Haney's No. 13 as 100	
				Per cent	Per cent		Moisture	Yield
Minhybrid 800 .....	4	10	87	40.2	42.2	93.3	108.5	
Minhybrid 402 .....	4	10	82	40.1	41.2	93.0	105.9	
Haney's No. 13 .....	4	10	83	43.1	38.9	100	100	
Level of significance at 5 per cent point .....	..	.....	.....	0.8	2.2	.....	.....	
Wisconsin 275 .....	3	7	87	40.7	40.8	97.8	105.4	
Wisconsin 279 .....	3	7	78	38.5	35.8	92.5	92.5	
Minhybrid 700 .....	3	7	82	40.6	40.2	97.6	103.9	
Minhybrid 702 .....	3	7	85	40.2	39.2	96.6	101.3	
Minhybrid 800 .....	3	7	85	38.9	42.3	93.5	109.3	
Minhybrid 801 .....	3	7	85	37.9	41.3	91.1	106.7	
Minhybrid 402 .....	3	7	81	38.8	40.0	93.3	103.3	
Haney's No. 13 .....	3	7	82	41.6	38.7	100	100	
Crookston N. W. D. ....	3	7	74	35.7	25.2	85.8	65.1	
Pearl Flint .....	3	7	82	34.0	27.4	95.2	70.8	
Level of significance at 5 per cent point .....	..	.....	.....	1.1	2.9	.....	.....	

moisture percentage and yield in bushels per acre are given also on the basis of 100 for Haney's No. 13.

Minhybrids 800 and 801 are the only Minhybrids recommended by the Minnesota Agricultural Experiment Station for the Northern Zone. In the yield trials these two hybrids have contained only about 92 per cent as much moisture at husking as Haney's Minn. No. 13 (Mellum) and have yielded about 8 per cent more than this variety. These hybrids stand up somewhat better than Haney's No. 13 and Minhybrid 402. Maturity rating in days is given on the basis of trials reported previously where these hybrids have been compared with the commercial hybrids offered for sale in the various zones and registered with the state commissioner of agriculture.

Minhybrid 800, 85-89 days maturity classification, is earlier in maturity than Haney's No. 13 (Mellum) but not as early as the earliest strains of Haney's No. 13. It has about the same maturity as Minhybrid 402 and is slightly later than Minhybrid 801. It has yielded about the same as Minhybrids 801 and 402.

Minhybrid 801, 84-88 days maturity classification, is earlier in maturity than Haney's No. 13 (Mellum). It has had slightly lower moisture content at husking than Minhybrid 800.

Wisconsin 279, 84-88 days maturity classification, is similar in maturity to Minhybrids 800 and 801 and on the basis of trials it appears adapted to the Northern Zone. Because of poor stands in station trials it has not yielded as well as other hybrids.

Minhybrids 700 and 702 and Wisconsin 275 also have been tested in this maturity zone. They are later than Minhybrid 800 and have yielded slightly less when grown in the Northern Zone.

**North Central Zone—700 Series of Minhybrids**—Haney's No. 13 (Mellum) and Minhybrid 402 have been grown in the North Central Zone for a considerable number of years. The per cent moisture at time of harvest and yield in bushels per acre for Minhybrids grown in the North Central Zone yield trials are presented in table 4. They are rated also for moisture content and yield in percentages of Haney's No. 13 as 100.

**Table 4. Performance of Minhybrids in the North Central Zone in Comparison with Haney's No. 13 (Mellum)**

Hybrid	Years tested	Number trials	Stand	Moisture at husking	Yield per acre	Per cent of Haney's No. 13 as 100	
						Moisture	Yield
			Per cent	Per cent	Bushels	Per cent	Bushels
Minhybrid 702 .....	5	12	89	30.4	45.1	93.8	116.5
Minhybrid 402 .....	5	12	87	29.7	42.5	91.7	109.8
Haney's No. 13 .....	5	12	82	32.4	38.7	100	100
Level of significance at 5 per cent point .....	..	.....	.....	0.9	2.4	.....	.....
Minhybrid 700 .....	4	10	86	33.7	45.8	97.4	109.0
Minhybrid 701 .....	4	10	91	34.7	47.6	100.3	113.3
Minhybrid 402 .....	4	10	86	31.7	43.6	91.6	103.8
Haney's No. 13 .....	4	10	87	34.6	42.0	100	100
Level of significance at 5 per cent point .....	..	.....	.....	1.0	2.6	.....	.....
Minhybrid 800 .....	4	9	91	28.9	46.3	90.3	121.2
Haney's No. 13 .....	4	9	80	32.0	38.2	100	100
Level of significance at 5 per cent point .....	..	.....	.....	0.9	2.5	.....	.....
Wisconsin 275 .....	3	7	85	32.7	43.9	94.8	102.8
Wisconsin 279 .....	3	7	82	31.7	43.0	91.9	100.7
Minhybrid 700 .....	3	7	86	33.6	46.6	97.1	109.1
Minhybrid 701 .....	3	7	91	34.8	47.8	100.6	111.9
Minhybrid 702 .....	3	7	90	32.4	47.4	93.6	111.0
Minhybrid 703 .....	3	7	89	31.9	50.2	92.2	117.6
Minhybrid 402 .....	3	7	85	31.6	42.2	91.3	98.8
Minhybrid 401 .....	3	7	91	35.2	51.4	101.7	120.4
Minhybrid 705 .....	3	7	91	34.0	53.2	98.3	124.6
Minhybrid 706 .....	3	7	89	34.2	52.3	98.8	122.5
Haney's No. 13 .....	3	7	89	34.6	42.7	100	100
Level of significance at 5 per cent point .....	..	.....	.....	1.2	3.2	.....	.....
Minhybrid 603 .....	2	5	81	40.3	47.2	115.8	113.5
Haney's No. 13 .....	2	5	87	34.8	41.6	100	100
Level of significance at 5 per cent point .....	..	.....	.....	1.5	3.9	.....	.....
Minhybrid 602 .....	1	5	80	36.8	55.8	107.6	140.6
Minhybrid 604 .....	1	5	92	37.5	60.3	109.7	151.9
Haney's No. 13 .....	1	5	84	34.2	39.7	100	100
Level of significance at 5 per cent point .....	..	.....	.....	1.2	4.6	.....	.....

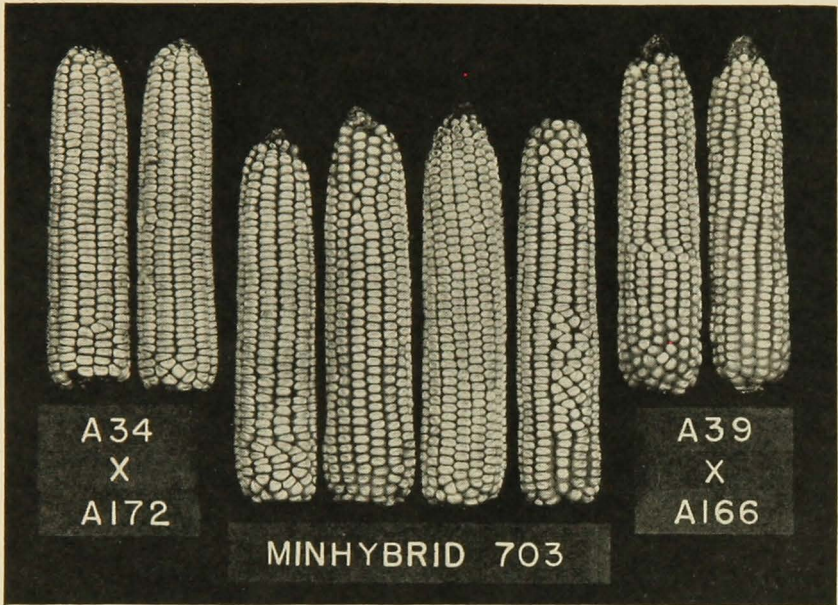


FIG. 5. Single cross parents and Minhybrid 703

The six Minhybrids numbered 700, 701, 702, 703, 705, and 706 are recommended for the North Central Zone. The first three are yellow endosperm hybrids whereas the latter three are white. The average increase in yield for this group of Minhybrids over Haney's No. 13 is 17 per cent. The average moisture content is about 96 per cent of Haney's No. 13.

Minhybrid 700, 88-92 days maturity classification, is somewhat earlier in maturity than Haney's No. 13 (Mellum), midway in maturity between Minhybrids 701 and 702, and somewhat later than Minhybrids 703 and 402. It has yielded about the same as Minhybrids 701 and 702, somewhat more than Minhybrid 402, and less than the three white hybrids, 703, 705, and 706. Minhybrid 700 has a tendency to produce chaffy ears when grown under unfavorable conditions. All other agronomic characteristics are desirable.

Minhybrid 701, 88-92 days maturity classification, is slightly later in maturity in these trials than Minhybrid 700 and has had about the same moisture content at husking as Minhybrids 705 and 706. It has yielded about the same as Minhybrids 700 and 702. Minhybrid 701, like Minhybrid 700, has a tendency to produce chaffy ears when it is grown under unfavorable conditions.



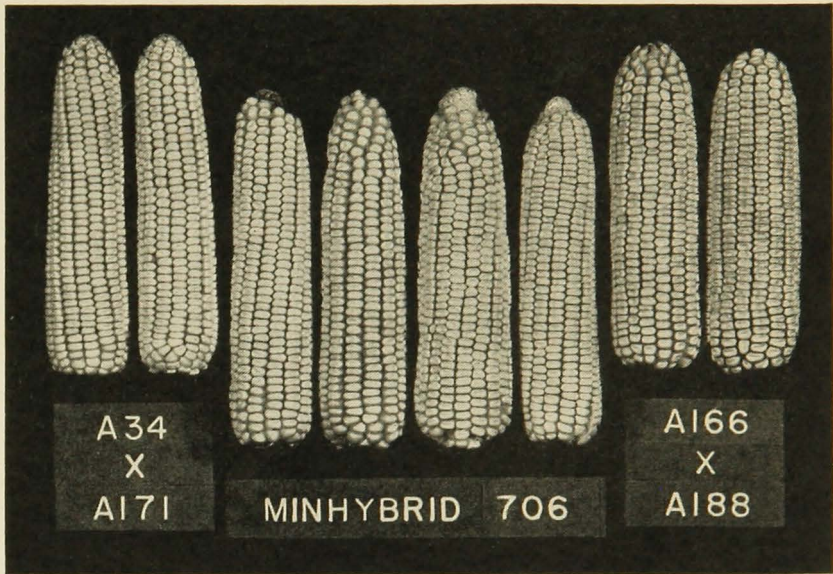


FIG. 6. Ears of single cross parents and Minhybrid 706

Minhybrid 702, 88-92 days maturity classification, has had about the same moisture content at husking as Minhybrid 703 and is earlier than the other 700 series Minhybrids. It has yielded about the same as Minhybrids 700 and 701. Minhybrid 702 has a tendency to give stalk breaking when grown under unfavorable conditions. All other agronomic characteristics are relatively desirable.

Minhybrid 703, 88-92 days maturity classification, is a white hybrid of about the same maturity as Minhybrids 702 and 402. It is earlier than the rest of the hybrids in the 700 zone series. Minhybrid 703 has yielded somewhat more than the yellow endosperm Minhybrids, although except for Minhybrid 700, the differences have been slightly less than required to give odds of 19:1 that such differences are not due to experimental error. Under unfavorable conditions this hybrid has some root lodging, a tendency to deviate more than an angle of  $30^\circ$  from an upright position.

Minhybrids 705 and 706 are white hybrids of about the same maturity as Minhybrids 700 and 701. These hybrids have yielded significantly more than 700, 701, and 702 and slightly, although not significantly, more than Minhybrid 703. Under unfavorable conditions these hybrids, like Minhybrid 703, have a tendency to give root lodging. These hybrids were described in Extension Folder 22, revised in 1943, as Minhybrids 605 and 606. They have

been placed in the 700 series because they have proven earlier in maturity than hybrids adapted to the Central Zone.

Wisconsin 275 is of about the same period of maturity as Minhybrid 702 and has yielded less than any of the other hybrids recommended for the North Central Zone. There has been a tendency for some stalk breaking under unfavorable conditions.

Minhybrid 800 is slightly earlier than Minhybrid 702 and is recommended for the Northern Zone. However, when Minhybrid 800 has been grown in the North Central Zone it has yielded as well as Minhybrid 702.

Minhybrids 602, 603, and 604 have been tested in the North Central Zone. They are later in maturity than the Haney's strain of Minnesota No. 13 and in rather limited trials have given rather marked increases in yield over Haney's No. 13. Minhybrid 602 has appeared somewhat more desirable than 603 and 604 in these trials, although the number of tests are too few to make it possible to draw definite conclusions.

**Central Zone—600 Series of Minhybrids**—The Morris strain of Minnesota No. 13 is an open-pollinated variety that has been selected for many years at the Morris Branch Experiment Station. It is an excellent strain of corn and very well adapted to this section. The per cent moisture at time of harvest and yield in bushels per acre of Minhybrids grown in the Central Zone yield trials are presented in table 5. Yields and moisture content at husking are given also in percentage of the Morris strain of Minnesota No. 13.

The five Minhybrids recommended for the Central Zone are

Table 5. Performance of Minhybrids in the Central Zone in Comparison with Morris No. 13

Hybrid	Years tested	Number trials	Stand	Moisture at husking	Yield per acre	Per cent of Morris No. 13 as 100	
						Moisture	Yield
			Per cent	Per cent	Bushels	Per cent	Bushels
Minhybrid 600 .....	4	9	89	29.8	51.2	90.6	99.2
Minhybrid 601 .....	4	9	91	30.2	53.3	91.8	103.3
Minhybrid 401 .....	4	9	91	31.1	55.0	94.5	106.6
Minhybrid 301 .....	4	9	90	35.6	58.9	108.2	114.1
Morris No. 13 .....	4	9	91	32.9	51.6	100	100
Level of significance at 5 per cent point .....	...	.....	.....	1.0	3.1	.....	.....
Minhybrid 602 .....	3	9	86	33.5	55.7	96.3	112.5
Minhybrid 603 .....	3	9	87	34.3	53.7	99.1	108.5
Morris No. 13 .....	3	9	91	34.6	49.5	100	100
Level of significance at 5 per cent point .....	...	.....	.....	0.7	2.8	.....	.....

Table 5. Performance of Minhybrids in the Central Zone (Continued)

Hybrid	Years tested	Number trials	Stand	Moisture at husking	Yield per acre	Per cent of Morris No. 13 as 100	
						Moisture	Yield
			Per cent	Per cent	Bushels	Per cent	Bushels
Minhybrid 602 .....	3	7	82	31.8	52.3	95.5	112.5
Minhybrid 607 .....	3	7	88	30.6	56.2	91.9	120.9
Minhybrid 401 .....	3	7	90	31.5	52.7	94.6	113.3
Morris No. 13 .....	3	7	89	33.3	46.5	100	100
Level of significance at 5 per cent point .....	..	.....	.....	1.0	3.7	.....	.....
Minhybrid 602 .....	2	8	86	33.3	57.1	96.2	113.5
Minhybrid 604 .....	2	8	93	34.9	56.1	100.9	111.5
Morris No. 13 .....	2	8	91	34.6	50.3	100	100
Level of significance at 5 per cent point .....	..	.....	.....	0.7	3.0	.....	.....
Minhybrid 603 .....	3	7	89	35.3	55.4	104.4	99.1
Minhybrid 604 .....	3	7	94	34.1	58.3	100.9	104.3
Minhybrid 401 .....	3	7	93	31.4	59.0	92.9	105.5
Minhybrid 301 .....	3	7	93	35.7	62.0	105.6	110.9
Minhybrid 500 .....	3	7	89	35.2	60.0	104.1	107.3
Morris No. 13 .....	3	7	93	33.8	55.9	100	100
Level of significance at 5 per cent point .....	..	.....	.....	1.2	3.4	.....	.....
Minhybrid 602 .....	2	4	77	30.3	49.0	95.3	107.0
Minhybrid 608 .....	2	4	84	32.0	50.5	100.6	110.3
Morris No. 13 .....	2	4	86	31.8	45.8	100	100
Level of significance at 5 per cent point .....	..	.....	.....	1.3	4.7	.....	.....
Minhybrid 700 .....	3	6	92	28.2	52.4	83.2	96.9
Minhybrid 702 .....	3	6	92	27.0	52.8	79.6	97.6
Morris No. 13 .....	3	6	93	33.9	54.1	100	100
Level of significance at 5 per cent point .....	..	.....	.....	1.3	3.7	.....	.....
Minhybrid 700 .....	2	4	85	29.8	42.3	91.7	100.0
Minhybrid 701 .....	2	4	89	28.8	45.0	88.6	106.4
Morris No. 13 .....	2	4	88	32.5	42.3	100	100
Level of significance at 5 per cent point .....	..	.....	.....	1.2	4.2	.....	.....
Minhybrid 705 .....	2	4	95	27.4	63.2	83.8	101.6
Minhybrid 706 .....	2	4	90	28.2	63.8	86.2	102.6
Morris No. 13 .....	2	4	93	32.7	62.2	100	100
Level of significance at 5 per cent point .....	..	.....	.....	1.9	4.9	.....	.....
Minhybrid 800 .....	3	4	93	22.8	47.1	71.7	106.8
Morris No. 13 .....	3	4	91	31.8	44.1	100	100
Level of significance at 5 per cent point .....	..	.....	.....	1.3	3.8	.....	.....

numbered Minhybrids 602, 603, 604, 607, and 608. The average increase in yield for this series of Minhybrids over the Morris strain of Minnesota No. 13 is 13 per cent. Their average moisture content is 98 per cent of Morris No. 13.

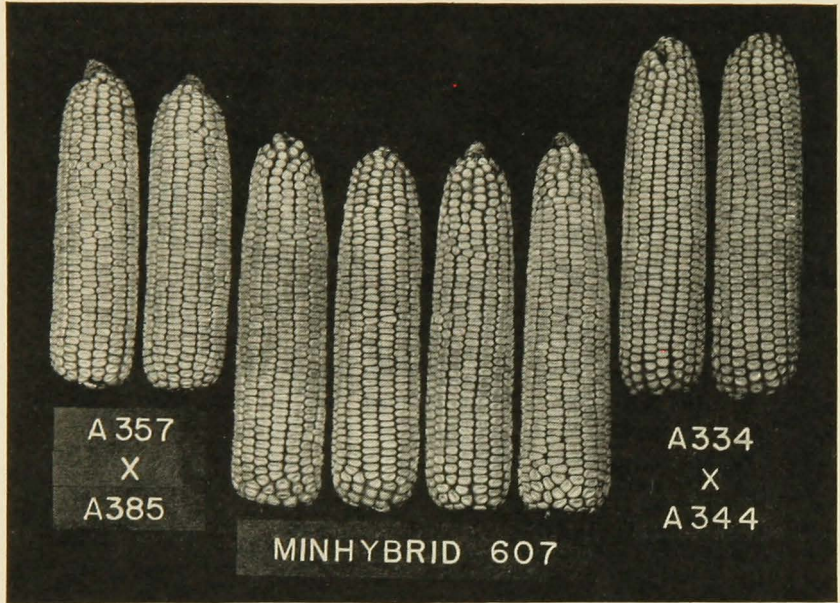


FIG. 7. Single cross parents and Minhybrid 607

Minhybrid 602, 95-99 days maturity classification, had somewhat higher moisture content at husking than Minhybrid 607 and was earlier in maturity than Minhybrids 603, 604, and 608. It has yielded slightly less than Minhybrid 607 but not significantly different from Minhybrids 603, 604, and 608. Under unfavorable conditions Minhybrid 602 has given some stalk breaking.

Minhybrid 603, 99-103 days maturity classification, and 604, 97-101 days maturity classification, are later in maturity than Minhybrids 602 and 607, and in comparable trials 603 has had slightly higher moisture content at husking than 604. Both hybrids have yielded slightly less than Minhybrid 607 and slightly less, although not significantly less, than Minhybrid 602. These hybrids seem best adapted to the southern half of the Central Zone and, as will be shown later, give relatively good yields in the South Central and Southern Zones.

Minhybrid 607, 95-99 days maturity classification, has had a slightly lower moisture content at husking than Minhybrid 602 and is earlier than Minhybrids 603, 604, and 608. In comparable trials it has yielded slightly more, although not significantly more, than Minhybrid 602.

Minhybrid 608, 97-101 days maturity classification, has about the same maturity as Minhybrids 603 and 604 and is later than

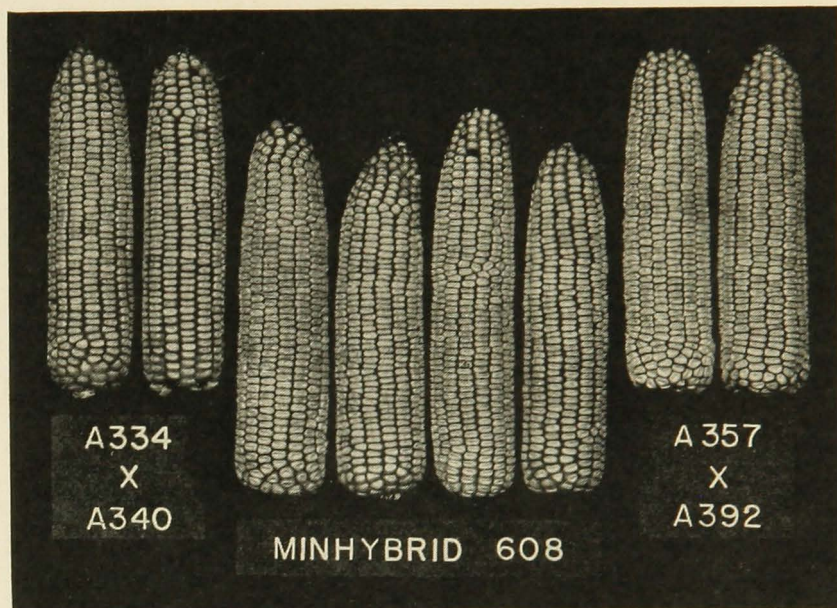


FIG. 8. Ears of single cross parents and Minhybrid 608

Minhybrids 602 and 607. In comparable trials it has yielded about the same as Minhybrid 602. It seems probable that it will be found best adapted in the southern half of the Central Zone.

Minhybrids 800, 700, 701, and 702 when grown in the Central Zone have yielded about as well as and are much earlier than the open-pollinated strain of Morris No. 13. They have not yielded as well as the Minhybrids recommended for the Central Zone. Minhybrids 705 and 706 were numbered 605 and 606 in Extension Folder 22. They have had about the same moisture content at husking, when grown in the Central Zone, as Minhybrids in the 700 series although their moisture content has been somewhat higher than that of Minhybrid 800. They have yielded about the same as Morris No. 13.

Minhybrids 301 and 500 are later than Morris No. 13 and in comparable trials when grown in the Central Zone have yielded more than Minhybrid 604. In normal growing seasons Minhybrids 301 and 500 are too late in maturity for the Central Zone.

**South Central Zone—500 Series of Minhybrids**—The University Farm strain of Minnesota No. 13 is an open-pollinated variety which is adapted to the South Central maturity zone. It was increased, and has been further selected for yielding ability, from

a selection made several years ago by Charles Lien at St. Cloud and in rather extensive trials it proved to be one of the more desirable strains of open-pollinated corn for this region. The per cent moisture at time of harvest and yields in bushels per acre of Minhybrids grown in the South Central Zone are presented in table 6. Yields and moisture content at husking are given also in percentage of the University Farm strain of Minn. No. 13 as 100.

The six Minhybrids recommended for the South Central Zone are Minhybrids 301, 500, 502, 503, 504, and 505. The average increase in yield for this series of Minhybrids over the University Farm strain of Minnesota No. 13 is 22 per cent, whereas their average moisture content is the same as Minnesota No. 13.

Minhybrid 301, 105-109 days maturity classification, is slightly later than the University Farm strain of Minnesota No. 13 and Minhybrids 500 and 502, and has about the same moisture content at husking as 503, 504, and 505. It is earlier than Minhybrid 403, although the differences in maturity are not very great. Minhybrid 301 has yielded about the same as 503, 504, and 505. It has yielded somewhat more than 500, 502, and 403. Minhybrid 301 is very susceptible to smut and the ear has a long shank.

Minhybrid 500, 104-108 days maturity classification, in com-

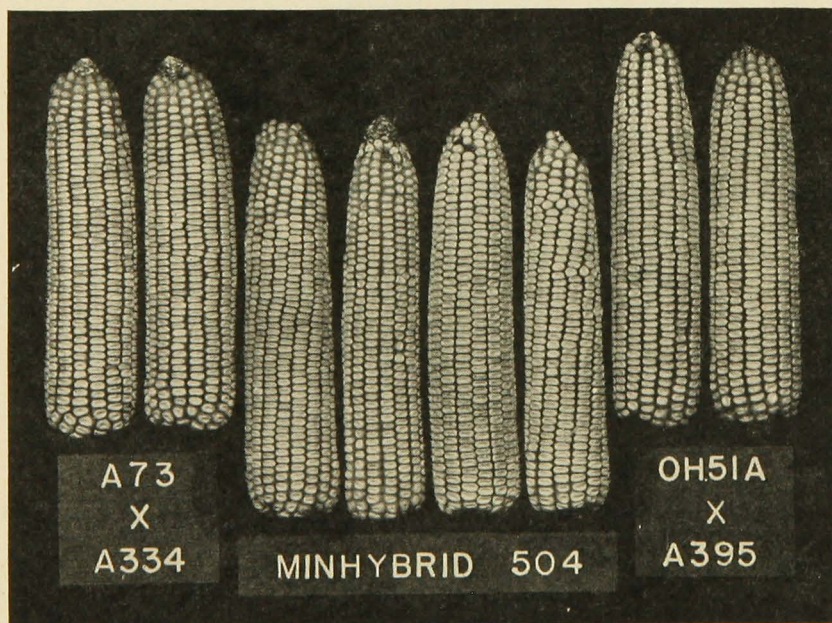


FIG. 9. Single cross parents and Minhybrid 504

Table 6. Performance of Minhybrids in the South Central Zone in Comparison with University Farm Minnesota No. 13

Hybrid	Years tested	Number trials	Stand	Moisture at husking	Yield per acre	Per cent of U. Farm No. 13 as 100	
						Moisture	Yield
			Per cent	Per cent	Bushels	Per cent	Bushels
Minhybrid 403 .....	7	25	85	28.3	62.1	104.4	117.8
Minhybrid 301 .....	7	25	87	27.5	65.7	101.5	124.7
U. Farm No. 13 .....	7	25	78	27.1	52.7	100	100
Level of significance at 5 per cent point .....	..	.....	.....	0.5	1.9	.....	.....
Minhybrid 502 .....	4	15	87	26.3	67.0	100.8	118.4
Minhybrid 301 .....	4	15	89	26.8	69.5	102.7	122.8
U. Farm No. 13 .....	4	15	81	26.1	56.6	100	100
Level of significance at 5 per cent point .....	..	.....	.....	0.7	2.5	.....	.....
Minhybrid 500 .....	3	14	86	26.3	65.2	99.2	115.2
Minhybrid 301 .....	3	14	89	27.2	69.8	102.6	123.3
U. Farm No. 13 .....	3	14	91	26.5	56.6	100	100
Level of significance at 5 per cent point .....	..	.....	.....	0.7	2.6	.....	.....
Minhybrid 500 .....	3	10	88	27.4	68.0	100.4	115.8
Minhybrid 502 .....	3	10	87	27.3	70.2	100.0	119.6
Minhybrid 301 .....	3	10	90	28.2	73.5	103.3	125.2
Minhybrid 403 .....	3	10	90	28.9	68.9	105.9	117.4
U. Farm No. 13 .....	3	10	82	27.3	58.7	100	100
Level of significance at 5 per cent point .....	..	.....	.....	0.9	3.3	.....	.....
Minhybrid 500 .....	2	6	90	26.4	72.1	100.4	117.0
Minhybrid 503 .....	2	6	92	27.7	75.8	105.3	123.1
Minhybrid 504 .....	2	6	91	26.5	78.5	100.8	127.4
Minhybrid 505 .....	2	6	94	25.7	77.3	97.7	125.5
Minhybrid 301 .....	2	6	94	26.6	76.6	101.1	124.4
Minhybrid 403 .....	2	6	91	27.8	70.3	105.7	114.1
U. Farm No. 13 .....	2	6	83	26.3	61.6	100	100
Level of significance at 5 per cent point .....	..	.....	.....	1.3	4.7	.....	.....
Minhybrid 603 .....	5	19	82	24.5	64.0	96.8	119.2
Minhybrid 301 .....	5	19	89	25.9	67.8	102.4	126.3
U. Farm No. 13 .....	5	19	78	25.3	53.7	100	100
Level of significance at 5 per cent point .....	..	.....	.....	0.7	2.2	.....	.....
Minhybrid 604 .....	3	13	88	24.9	62.4	95.4	116.6
Minhybrid 301 .....	3	13	87	27.0	66.1	103.4	123.6
U. Farm No. 13 .....	3	13	79	26.1	53.5	100	100
Level of significance at 5 per cent point .....	..	.....	.....	0.8	2.6	.....	.....
Minhybrid 602 .....	3	12	79	25.4	62.8	95.8	118.0
Minhybrid 301 .....	3	12	86	27.6	66.2	104.2	124.4
U. Farm No. 13 .....	3	12	78	26.5	53.2	100	100
Level of significance at 5 per cent point .....	..	.....	.....	0.9	3.2	.....	.....

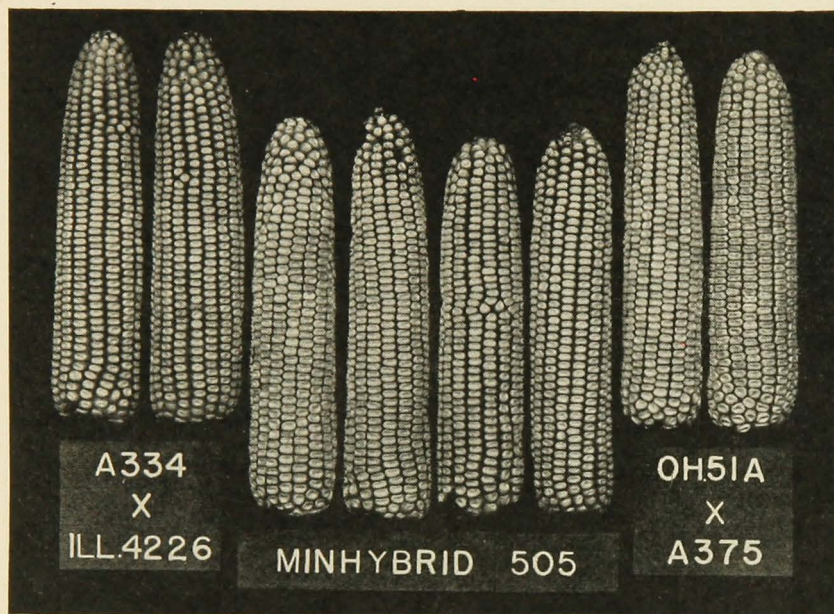


FIG. 10. Single cross parents and Minhybrid 505

parable trials has had slightly lower moisture content at husking than Minhybrids 301, 503, and 403. It is about the same in maturity as 502, 504, and 505. It has yielded about the same as Minhybrids 502 and 403, and somewhat less than Minhybrids 301, 503, 504, and 505.

Minhybrid 502, 103-107 days maturity classification, is a few days earlier than Minhybrids 301 and 403 and about the same in maturity as Minhybrid 500. It has yielded about the same as Minhybrids 500 and 403 in comparable trials and less than Minhybrid 301. Under adverse conditions Minhybrid 502 has given some stalk breaking.

Minhybrids 503, 504, and 505, 104-108 days maturity classification, are about the same in maturity as Minhybrid 301, although Minhybrid 503 has had slightly higher moisture content at husking than 504 and 505. In comparable trials Minhybrid 503 had about the same maturity as 403. They outyielded Minhybrids 500 and 403 but have not differed significantly in yield from each other or Minhybrid 301. In all trials to date these hybrids have exhibited very desirable agronomic characteristics.

Minhybrids 602, 603, and 604 are earlier in maturity than the Minhybrids of the 500 series and when grown in the South Central Zone have yielded as well as Minhybrids 500 and 502. Min-



hybrids 602, 603, and 604 apparently may be grown very satisfactorily in the northern portion of the South Central Zone.

Minhybrid 403 has been on the recommended list for the Southern Zone as it is later in maturity, although in all cases not significantly so, than the Minhybrids recommended for the 500 zone. As mentioned previously, Minhybrid 503 had about the same maturity as 403. Minhybrid 403 has yielded about the same as Minhybrids 500 and 502 and has not yielded as well as Minhybrids 301, 503, 504, and 505.

**Southern Zone—400 Series of Minhybrids**—The open-pollinated variety Murdock has been grown extensively in the Southern Zone for a considerable period of years. The per cent moisture at time of harvest and yield in bushels per acre for the Minhybrids grown in the Southern Zone yield trials are presented in table 7. Yield and moisture content are given also in percentage of the open-pollinated variety Murdock.

The six Minhybrids recommended for the Southern Zone are Minhybrids 403, 404, 405, 406, 407, and 408. The average increase in yield for this series of hybrids over the open-pollinated variety, Murdock, is 39 per cent, whereas their average increase in moisture content is only 2 per cent greater than Murdock.

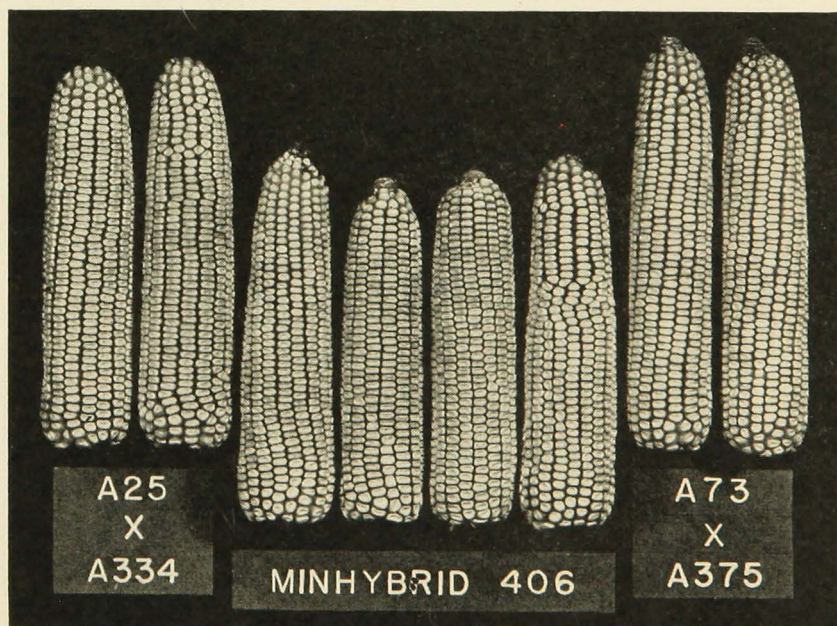


FIG. 11. Single cross parents and Minhybrid 406

Table 7. Performance of Minhybrids in the Southern Zone in Comparison with Murdock

Hybrid	Years tested	Number trials	Stand	Moisture at husking	Yield per acre	Per cent of Murdock as 100	
						Moisture	Yield
Minhybrid 403	7	36	85	25.4	68.2	98.4	125.6
Minhybrid 301	7	36	86	25.0	68.0	96.9	125.2
Murdock	7	36	79	25.8	54.3	100	100
Level of significance at 5 per cent point	..	.....	.....	0.4	1.6	.....	.....
Minhybrid 404	6	23	87	26.2	71.4*	101.9	140.0
Minhybrid 405	6	23	87	26.4	73.0*	102.7	143.1
Minhybrid 403	6	23	87	25.3	65.7	98.4	128.8
Murdock	6	23	77	25.7	51.0	100	100
Level of significance at 5 per cent point	..	.....	.....	0.5	1.9	.....	.....
Minhybrid 406	4	13	90	24.8	75.0†	103.3	144.8
Minhybrid 407	4	13	94	25.4	76.5†	105.8	147.7
Minhybrid 408	4	13	92	25.6	78.7†	106.7	151.9
Minhybrid 505	4	13	93	22.2	73.6†	92.5	142.1
Minhybrid 301	4	13	96	22.3	70.6	92.9	136.3
Minhybrid 403	4	13	91	24.0	64.7	100.0	124.9
Murdock	4	13	65	24.0	51.8	100.0	100
Level of significance at 5 per cent point	..	.....	.....	0.8	2.9	.....	.....
Minhybrid 502	6	20	87	24.5	66.9	94.6	135.2
Minhybrid 301	6	20	89	24.0	66.4	92.7	134.1
Murdock	6	20	73	25.9	49.5	100	100
Level of significance at 5 per cent point	..	.....	.....	0.6	2.1	.....	.....
Minhybrid 500	4	11	90	22.8	67.4	91.2	140.1
Minhybrid 403	4	11	92	24.5	66.0	98.0	137.2
Murdock	4	11	65	25.0	48.1	100	100
Level of significance at 5 per cent point	..	.....	.....	0.8	3.1	.....	.....
Minhybrid 503	3	10	96	22.4	73.9†	97.4	143.7
Minhybrid 504	3	10	92	22.2	72.4†	96.5	142.0
Minhybrid 403	3	10	97	23.4	62.6	101.7	122.7
Minhybrid 301	3	10	98	22.0	66.4	95.7	130.2
Murdock	3	10	65	23.0	51.0	100	100
Level of significance at 5 per cent point	..	.....	.....	0.8	3.2	.....	.....
Minhybrid 603	4	13	83	21.6	64.1*	84.0	126.7
Minhybrid 604	4	13	89	20.8	68.4*	80.9	135.2
Minhybrid 301	4	13	91	23.1	67.2	89.9	132.8
Minhybrid 403	4	13	89	24.5	63.7	95.3	125.9
Murdock	4	13	73	25.7	50.6	100	100
Level of significance at 5 per cent point	..	.....	.....	0.7	2.9	.....	.....
Minhybrid 602	3	6	80	25.4	76.4*	83.6	124.8
Minhybrid 301	3	6	91	27.8	78.9	91.4	128.9
Murdock	3	6	61	30.4	61.2	100	100
Level of significance at 5 per cent point	..	.....	.....	1.1	4.5	.....	.....

\* Yields of Minhybrids 404, 405, 602, 603, and 604 were predicted in 1938 from single crosses.

† Yields of Minhybrids 503, 504, 505, 506, 406, 407, and 408 were predicted in 1940 and 1941 from single crosses.

The yields of standard varieties and hybrids were determined on a perfect stand basis in trials where predicted yields were used.

Minhybrid 403, 108-112 days maturity classification, has had about the same moisture content at husking as Murdock and is slightly earlier than Minhybrid 404 and distinctly earlier than 405, 406, 407, and 408. It is the lowest yielding of all the Minhybrids recommended for the Southern Zone although it has given large increases in yield over Murdock and in this zone has yielded as well as 301.

Minhybrid 404, 108-112 days maturity classification, is somewhat later in maturity than 403 in these trials, not greatly different from Minhybrid 405, and earlier than 406, 407, and 408. It has yielded about the same as Minhybrid 405 in comparable trials and more than Minhybrid 403. It has not been tested extensively in comparable trials with 406, 407, and 408.

Minhybrid 405, 110-114 days maturity classification, in these trials has had about the same maturity as 404. It has yielded about 10 per cent more than Minhybrid 403 and about the same as 404.

Minhybrid 406, 112-116 days maturity classification, is somewhat later in maturity than Minhybrid 403 and has not been compared extensively with 404 and 405. In these trials it has been slightly earlier than 407 and 408. It has yielded significantly more than Minhybrid 403. It has yielded about the same as Minhybrid 407 and somewhat less than 408. This hybrid is probably best adapted to the southern half of the Southern Zone.

Minhybrids 407 and 408, 114-118 days maturity classification, are later in maturity than any other Minhybrids and also are the highest yielding Minhybrids recommended for the Southern Zone. Because of their lateness, Minhybrids 407 and 408 should be grown in the more favorable regions for maturity of the Southern Zone.

All of the 500 series Minhybrids have had lower moisture content than Minhybrid 403 when grown in the Southern Zone, and the differences appear statistically significant. Minhybrids 301, 500, and 502 have yielded about the same as 403. Minhybrids 503, 504, and 505 have given significant increases in yield over 403 and 301 when grown in the Southern Zone. Minhybrids 503, 504, and 505 seem well adapted to the Southern Zone and may prove to be excellent hybrids in the northern half of the Southern Zone as well as in the South Central Zone.

Minhybrids 602, 603, and 604 are earlier than 301 and 403 when grown in the Southern Zone and have yielded about the same in comparable trials as 403 and 301. These hybrids apparently are desirable for hogging off in southern Minnesota.

## SINGLE CROSS PARENTS OF MINHYBRID VARIETIES

The seed grower learns the characteristics of the single cross parents of the hybrids that he produces. As particular crosses react differently under varying conditions the information obtained locally by the grower is of greatest value to him. For hybrids that have not been grown previously, and as a guide to new seed producers, it is desirable to present data obtained in field trials for the parents of all Minhybrids. In addition to these data each seed grower is furnished mimeographed directions for each hybrid that he grows. These outlines carry the statement that the pollen-shedding period may be lengthened by applying a phosphate fertilizer on every other row of the male parent. This result is obtained only on those fields where there is a response to phosphate fertilizers.

Table 8 summarizes the data on agronomic characters and grading percentages of the single cross parents of Minhybrids belonging to the 600, 700, and 800 series. Data on double crosses that have been grown in the trials with the single cross parents are included also in the table. This information will be of use in an evaluation of the plant characters and yielding ability of the single crosses. Most of the plant characters except date of silking were taken in each trial. Each entry in the table except for date of silking and grading percentages represents an average of the data taken at several locations.

The grading percentages of all single crosses were obtained by separating the percentages of flat grades from the total marketable seed and then subdividing the flats into three groups, large, medium, and small flats, as follows:

- #21=kernels passing through a 13/64 slotted screen and over a 21/64 round hole screen.
- #19=kernels passing through a 13/64 slotted screen, through a 21/64 round hole screen, and over a 19/64 round hole screen.
- #17=kernels passing through a 12/64 slotted screen, through a 19/64 round hole screen, and over a 17/64 round hole screen.

**Yellow Minhybrids in the 800 and 700 Series**—The parents of the recently introduced Minhybrid 801 appear first in the table. They have been grown for two different years and in 12 different locations with three replications at each location, three of the trials being made at University Farm, St. Paul, two each in Otter

Table 8. Agronomic Characters and Grading Percentages of Single Cross Parents of 800, 700, and 600 Series Minhybrids

Parent of Min-hybrid	Cross	Years tested	Number trials	Date silk	Smut Broken		Plant height	Ear height	Ear length	Row number	Good ears per plant	Shell-ing	Moisture	Bushels per acre	Flat grades			
					Per cent	.....									No. 21	No. 19	No. 17	Total
801	A15 x A165	2	12	8-2	5	.....	74	26	7.2	18	.92	.....	29.7	47.2	48	32	3	83
801	A21 x A116	2	12	8-2	4	.....	75	28	7.5	14	.92	.....	25.8	40.1	20	41	9	70
—	Min. 402	2	12	8-3	7	.....	79	29	8.0	14	.95	.....	29.9	46.2	.....	.....	.....	.....
800	A96 x A148	4	10	7-26	6	.....	81	27	7.0	16	.93	78	22.0	61.8	25	35	10	70
800 and 702	A116 x A131	4	10	7-29	0	.....	82	29	6.3	15	.96	85	18.5	49.9	22	38	13	73
—	702	4	10	7-27	4	.....	75	28	7.1	14	.87	80	22.4	58.5	30	39	9	78
—	Min. 401	4	10	7-28	3	.....	.....	.....	7.9	14	.95	.....	24.7	62.1	.....	.....	.....	.....
700	A140 x A155	4	9	7-28	4	.....	80	30	7.1	16	.92	81	21.5	53.5	27	42	13	82
700 and 701	A7 x A12	4	9	7-28	9	.....	81	28	6.7	16	.86	83	20.4	57.1	43	37	7	87
—	701	4	9	7-28	5	.....	79	27	7.5	17	1.00	82	21.0	54.8	33	45	10	88
—	Min. 401	4	9	7-28	7	.....	.....	.....	7.5	14	.83	.....	26.3	55.8	.....	.....	.....	.....
703	A34 x A172	3	14	7-25	4	.....	76	25	7.4	13	.97	86	21.5	59.3	71	7	1	79
703	A39 x A166	3	14	7-28	4	.....	67	22	7.2	14	.85	80	28.6	48.3	20	38	10	68
705	A39 x A188	3	14	7-26	8	.....	64	23	7.7	13	.99	83	27.4	59.7	42	2	0	44
705 and 706	A34 x A171	3	14	7-26	1	.....	76	22	7.7	14	.88	85	24.0	47.4	21	42	11	74
—	706	3	14	7-26	4	.....	78	27	7.4	16	.99	85	29.0	68.1	59	21	3	83
—	Min. 401	3	14	7-25	8	.....	79	27	7.9	14	.88	.....	27.9	56.4	.....	.....	.....	.....
607	A357 x A385	4	10	7-28	11	0	81	34	7.0	14	.98	85	22.5	65.3	64	11	2	77
602 and 607	A334 x A344	4	10	7-27	11	17	85	36	8.1	16	.90	82	27.5	72.6	46	29	6	81
602 and 608	A357 x A392	4	10	7-29	2	0	91	41	7.7	16	.97	84	22.6	70.4	42	33	8	83
—	608	4	10	7-27	5	0	84	33	7.8	16	.97	82	26.2	69.8	51	28	5	84
603	A322 x A334	4	10	7-31	3	2	92	41	8.3	17	.89	81	30.0	78.9	18	47	17	82
603	A344 x A357	4	10	7-28	11	0	86	32	7.8	16	.98	82	25.9	73.5	68	10	3	81
604	A322 x A340	4	10	8-2	11	0	99	41	7.9	16	.83	82	29.5	61.7	47	28	6	81
604	A344 x A347	4	10	7-26	4	11	85	35	8.0	15	.96	82	25.6	71.1	58	15	3	76
—	Min. 301	4	10	7-29	13	3	95	42	8.8	16	.98	.....	29.1	70.5	.....	.....	.....	.....

Tail and Clay counties, and one each at Crookston, Grand Rapids, Morris, and in Wilkin County. Dates of silking were taken only at University Farm in 1940 and the grading studies were made only at University Farm in 1943. It is not necessary to call attention to each of the plant characters in detail. As both single cross parents of Minhybrid 801 silk on the same date they may be planted at the same time. The single cross A15 x A165 yields better than A21 x A116, being equal in yield in these trials to Minhybrid 402, and appears to be the more desirable female parent. The application of a phosphate fertilizer to the female parent would appear to be desirable as a means of hastening its silking date. In the northern zone it may be desirable to use A21 x A116 as the female parent as it has a much lower moisture at husking than A15 x A165.

Minhybrid 800 is produced from crossing A96 x A148 with A116 x A131. Six of the yield trials for the parents of Minhybrids 800 and 702 were made in the South Central and four in the Central Zone. The single cross A96 x A148 has high yielding ability and has proven to be the more satisfactory female parent. The silking data were taken at University Farm for four years and at Morris for a single season. Grading percentages were taken at University Farm for three years and at Morris for two years. Both parents may be planted at the same time.

Minhybrid 702 differs from 800 in that A158 is substituted for A148 in the female parent. In previous mimeographed directions it has been suggested that A96 x A158 should be planted several days before the male parent A116 x A131. It seems probable that satisfactory pollination can be obtained by planting both parents of Minhybrid 702 on the same date because A96 x A158 silks two days earlier, on the average, than A116 x A131. The application of phosphate to the female rows may be desirable as a means of speeding up the silking date of the female parent at those locations where there is a response to phosphate fertilizers.

Minhybrids 700 and 701 are yellow hybrids that have been grown previously for several years and their characteristics are well known. Five yield trials were grown in the Central, three in the South Central, and one in the Southern Zone. In nearly all cases A140 x A155 has been used as the female parent of Minhybrid 700 and A145 x A155 as the female parent of Minhybrid 701. Both of these single crosses have yielded about the same as Minhybrid 401 and are considerably lower in moisture content at husking than Minhybrid 401. Under unfavorable conditions there is a tendency to produce chaffy ears. The male parent A7 x A12

is more difficult to produce as a single cross and for this reason advanced generation A7 x A12 has usually been used as the male parent. Average dates of silking are the same for the single cross parents, A140 x A155, A145 x A155, and A7 x A12, from data taken at Morris and University Farm for two years each and at Waseca for a single season. Therefore, for Minhybrids 700 and 701 both parents are usually planted at the same time. The grading percentages are averages obtained from three years' studies at University Farm and a single year each at Morris and Waseca. Both female parents A140 x A155 and A145 x A155 give good percentages of flat kernels.

**White Hybrids in the 700 Series**—The single cross parents of the recently introduced white Minhybrids 703, 705, and 706 have been tested in 14 different trials during a three-year period. Nine trials were grown in the Central and five in the South Central Zone. The dates of silking are based on two years of study each at University Farm and one at Waseca, while grading percentages are averages of 1943 results at University Farm, Morris, and Waseca.

For Minhybrid 703 the single cross A34 x A172 has yielded somewhat more than Minhybrid 401 and is a desirable female parent as it averaged 71 per cent of large flats. The other parent, A39 x A166, has yielded much less than Minhybrid 401 and should be used as the male parent. A34 x A172 silked three days earlier than A39 x A166; therefore, satisfactory pollination should be obtained by planting both parents at the same time. The pedigree of Minhybrid 705 is (A39 x A188) (A34 x A171). Both single cross parents silked on the same date. The yield of A39 x A188 was 3.3 bushels higher than Minhybrid 401 while A34 x A171 yielded 9.0 bushels less, on the average, than Minhybrid 401. The percentage of flat grades in A39 x A188 was only 44 while there were 74 per cent of flats in A34 x A171. For these reasons A34 x A171 has been used as the female parent although it is not outstanding in yielding ability and has shown 6 per cent root lodging as an average of eight trials. Both parents may be planted at the same date.

Minhybrid 706 may be produced by using A166 x A188 as the female parent and A34 x A171, used as one of the parents in Minhybrid 705, as the male. A166 x A188 has produced 83 per cent of flat grades and in these trials has yielded 11.7 bushels more than Minhybrid 401. Both parents may be planted at the same date.

**Yellow Minhybrids in the 600 Series**—The single cross parents have been tested for four years in 10 different locations. One trial

was grown in the Central, five in the South Central, and three in the Southern Zone. Dates of silking have been taken for three years at University Farm and Waseca and for one year at Morris. Grading percentages are based on three years of study at University Farm, two at Morris, and one at Waseca. The Minhybrids 602, 603, and 604 have been grown for several years and are well known to seed producers. Minhybrids 607 and 608 have been introduced recently and are available to seed producers for the first time in 1944.

Minhybrid 602 (A334 x A344) (A357 x A392) may be produced by using either parent as the female. Yields of both parents have been about the same, slightly over 70 bushels in these trials, and as good as Minhybrid 301. The percentages of flat grades have been slightly over 80. The single cross parent A334 x A344 had 17 per cent of broken stalks which is an undesirable characteristic. A357 x A392 silked two days later than A334 x A344 and when A357 x A392 is used as the male parent satisfactory pollination has been obtained by planting both parents on the same date. When A357 x A392 is used as the female parent it may be desirable to plant it two to four days earlier than A334 x A344.

Minhybrid 603 (A322 x A334) (A344 x A357) also may be produced by using either parent as the female. Yields of both single crosses are excellent and the percentages of flat grades are satisfactory. A322 x A334 is an outstanding single cross and when seed is available it is preferred as a female parent by many producers. A322 x A334, on the average, silked three days later than A344 x A357. When A322 x A334 is used as a female in Minhybrid 603 it should be planted about four days earlier than A344 x A357. When A344 x A357 is used as the female both parents may be planted at the same time.

Minhybrid 604 (A344 x A347) (A322 x A340) may be produced by using either parent as the female although the date of silking of A322 x A340 was seven days later than for A344 x A347. A344 x A347 has yielded more than Minhybrid 301 and nearly 12 bushels more per acre than A322 x A340. It also gives a high percentage of flat grades. When A344 x A347 is used as the female it seems probable that both parents may be planted on the same date.

The single cross parent A334 x A344 of Minhybrid 607 yielded slightly over 7 bushels more than the other parent, A357 x A385, and also has excelled A357 x A385 in percentage of flat grades. A334 x A344 had 17 per cent broken stalks which is an undesirable characteristic. As A334 x A344 had an average silking date



of one day earlier than A357 x A385 both parents of Minhybrid 607 may be planted on the same date when A334 x A344 is used as the female parent.

Minhybrid 608 (A334 x A340) (A357 x A392) is produced by crossing two single crosses both of which have excellent yielding ability and excel in percentages of flat grades. A334 x A340 averaged two days earlier at silking than A357 x A392 and when A334 x A340 is used as the female parent both parents may be planted on the same date.

**Minhybrids in the 500 and 400 Series**—Table 9 presents data regarding the single cross parents for Minhybrids recommended for the Southern and South Central Zones. The plant characters and yield except for dates of silking usually are an average of the results for all trials.

The single cross parents of Minhybrid 500, A7 x A12 and A71 x A73, as well as the female parent, C11 x C14, of Minhybrid 403, have been grown in seven comparable tests with Minhybrid 301 for four years. Three of these tests were located at University Farm, two at Morris, and two at Waseca. Date of silking, per cent moisture, and bushels per acre are averages of all seven tests. Grading percentages are averages of three tests at University Farm, two at Morris, and one at Waseca. The yield of A7 x A12 in these trials was rather low in comparison with Minhybrid 301 and about the same as C11 x C14. A71 x A73 was six days later in silking than A7 x A12 and yielded 3.7 bushels more than Minhybrid 301. Its percentage of flat grades was 73, being about the same as that of C11 x C14. A71 x A73 usually is used as the female parent of Minhybrid 500 and should be planted about 12 to 14 days earlier than the male parent. Because of its late maturity the use of A71 x A73 as a female parent is somewhat of a risk in maturity zones other than the Southern Zone.

The single cross parents of Minhybrid 502 are A322 x A334 and A344 x A347. These single crosses have been grown in replicated trials for five years in 18 tests. Twelve of these tests were in the Southern, five in the South Central, and one in the Central Zone. Date silked is an average of five tests at Waseca, three at University Farm, and one at Morris. Grading percentages are averages of three trials at University Farm, two at Morris, and one at Waseca. A322 x A334 silks a few days later, yields slightly more, and gives a higher percentage of flat grades than does A344 x A347. Both single crosses have yielded about as well as Minhybrid 301. Either one of these single crosses makes a de-

Table 9. Agronomic Characters and Grading Percentages of Single Cross Parents of 500 and 400 Series Minhybrids

Parent of Min-hybrid	Cross	Years tested	Number trials	Date silk	Smut Broken		Plant height	Ear height	Ear length	Row number	Good ears per plant	Shell-ing	Moisture	Bushels per acre	Flat grades			
					Per cent	Per cent									No. 21	No. 19	No. 17	Total
500	A7 x A12	4	7	7-29	10	.....	77	28	6.8	16	.83	83	23.4	47.6	34	38	9	81
500	A71 x A73	4	7	8-4	3	.....	84	35	8.2	16	.94	84	35.0	68.9	18	39	16	73
403	C11 x C14	4	7	7-28	13	.....	74	28	7.6	16	.87	84	30.0	46.5	29	33	8	70
—	Min. 301	4	7	8-1	18	.....	87	39	8.5	17	1.02	.....	31.3	65.2	.....	.....	.....	.....
502	A322 x A334	5	18	7-30	1	2	91	41	8.1	17	.85	81	27.9	73.9	18	47	17	82
502	A344 x A347	5	18	7-27	4	10	85	35	8.0	15	.96	82	23.4	69.1	58	15	3	76
—	Min. 301	5	18	7-28	11	4	94	44	8.3	17	.96	.....	26.2	71.5	.....	.....	.....	.....
504	Oh51A x A395	3	11	8-2	2	6	97	43	7.9	15	1.06	87	26.0	72.5	23	48	11	82
503 and 504	A73 x A334	3	11	7-31	9	3	83	37	7.8	17	.92	84	26.3	76.3	25	46	13	84
503 and 505	Oh51A x A375	3	11	8-1	0	2	94	42	7.9	17	.99	85	24.5	72.8	6	39	29	74
505	A334 x Ill.4226	3	11	7-31	7	10	92	42	8.5	16	.96	82	26.2	72.0	12	55	15	82
—	Min. 301	3	11	7-30	8	5	92	40	8.0	16	.96	.....	24.0	66.7	.....	.....	.....	.....
404	A322 x A334	6	16	7-30	1	1	92	40	7.9	17	.84	81	26.6	71.1	19	46	17	82
403, 404, 405	A374 x A375	6	16	8-2	4	4	84	35	7.0	19	.86	79	28.3	52.4	1	11	27	39
405	A311 x A334	6	16	7-31	1	.....	93	42	7.5	17	.92	81	27.7	80.0	34	42	10	86
—	Min. 301	6	16	7-28	11	6	93	43	8.0	17	.91	.....	24.4	70.0	.....	.....	.....	.....
406	A25 x A334	3	10	7-31	1	1	94	40	7.6	18	.87	85	27.0	72.9	16	52	16	84
407	Os420																	
	x Ill. 4226	3	10	7-31	2	11	98	40	8.7	17	.93	85	27.9	75.0	20	42	7	69
408	Oh51A x Os420	3	10	7-31	0	4	100	42	8.0	16	.92	87	27.6	79.4	55	24	3	82
406, 407, 408	A73 x A375	3	10	7-31	1	0	84	32	7.3	19	.92	86	25.2	72.0	2	25	35	62
—	Min. 301	3	10	7-29	5	4	93	40	7.7	17	.92	.....	23.4	66.8	.....	.....	.....	.....

sirable seed parent although A344 x A347 may show some stalk breaking under unfavorable conditions. When A344 x A347 is used as the female parent both parents may be planted on the same date. If A322 x A334 is used as the female it should be planted approximately seven days earlier than the male parent, A344 x A347.

The single cross parents of Minhybrids 503 (A375 x Oh51A) (A73 x A334), 504 (A73 x A334) (A395 x Oh51A), and 505 (A375 x Oh51A) (A334 x Ill. 4226) have been grown in comparable trials for three years in 11 tests. Nine of these tests have been in the Southern, one in the South Central, and one in the Central Zone. Bushels per acre and per cent moisture are averages of these 11 tests. Date silked is an average of three tests at Waseca, one at University Farm, and one at Morris. Grading percentages are averages of tests conducted at Waseca, University Farm, and Morris in 1943.

All of the single crosses have silked within two days of each other, and have high yielding ability. Adjustments to assure pollination may have to be made by separate dates of planting or by the application of a phosphate fertilizer depending upon which single cross is used as the female parent. A334 x Ill. 4226 has shown 10 per cent stalk breaking as a two-year average.

The female parents of Minhybrids 404 and 405 as well as the male parent of Minhybrids 403, 404, and 405 have been grown in comparable yield trials for six years in 16 locations. Fourteen of these tests have been grown in the Southern and two in the South Central Zone. Bushels per acre and per cent moisture are averages of these 14 tests. Date silked is an average of five tests at Waseca and one at University Farm. Grading percentages are an average of three tests at University Farm and one at Waseca. A322 x A334 and A311 x A334 are always used as the female parents of Minhybrids 404 and 405, respectively, because of their superior yielding and grading ability. The female parents are two to three days earlier at date of silking than the male. On this basis both parents may be planted at the same time. Some growers have concluded that it is desirable to plant the male parent several days before the female.

The single cross parents of Minhybrids 406 (A25 x A334) (A73 x A375), 407 (Os420 x Ill. 4226) (A73 x A375), and 408 (Oh51A x Os420) (A73 x A375) have been grown in comparable trials for three years in 10 tests. Nine of these tests have been in the Southern and one in the South Central Zone. Bushels per acre and per cent moisture at harvest are averages of these 10

tests. Date silked is an average of three tests at Waseca and one at University Farm. Grading percentages are averages of one test at Waseca and one at University Farm. A73 x A375 is one of the parents in each of Minhybrids 406, 407, and 408. It will usually be used as a male parent as it did not give as high a percentage of flat grades as A25 x A334, Os420 x Ill. 4226, or Oh51A x Os420. All of these crosses have excellent yielding ability and have silked at the same time. The male and female parents may be planted at the same time. The time of silking of the female parents may be speeded up by applying a phosphate fertilizer to the female parents in those localities where there is a response to a phosphate fertilizer. Os420 x Ill. 4226 has shown some stalk breaking under unfavorable conditions. All of these crosses are rather late in maturity and should be produced only in the Southern Zone and the southern half of the South Central Zone.

### SUMMARY

Definitions of terms used in describing hybrid corn and an explanation of the methods of breeding that have been used with Minhybrids are presented.

The corn-growing regions of Minnesota are divided into five maturity zones. Hybrids bred by the Minnesota Agricultural Experiment Station that are adapted to each of these zones are available. There are 25 Minhybrids and two Wisconsin hybrids that are recommended for growing in particular maturity zones. Twelve of these Minhybrids have not been available previously for seed producers.

The bulletin presents the latest available information on Minhybrid varieties. Results are summarized from the yield trials made in the zones for which the hybrids are recommended. Data are given also for the performance of particular hybrids in zones other than those for which they primarily are adapted.

The performance of the single cross seed parents is discussed, particular attention being given to dates of silking and grading percentages as this information is valuable to seed producers.

Seed of the single crosses used as parents of Minhybrids is released only by the Minnesota Agricultural Experiment Station. Seed of the inbreds used in single crossing plots is produced chiefly by hand pollination to insure purity. The single cross parents are increased by the Minnesota Agricultural Experiment Station in cooperation with members of the Minnesota Crop Improvement Association and sold to seed producers.