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[45] Date of Patent: Sep. 13, 1994**[54] INBRED CORN LINE PHK56****[75] Inventor: Philip R. Martin, Alburnett, Iowa****[73] Assignee: Pioneer Hi-Bred International, Inc.,
Des Moines, Iowa****[21] Appl. No.: 6,193****[22] Filed: Jan. 19, 1993****Related U.S. Application Data****[63]** Continuation of Ser. No. 542,352, Jun. 20, 1990, abandoned.**[51] Int. Cl.⁵ A01H 5/00; A01H 4/00;
C12N 5/04****[52] U.S. Cl. 800/200; 800/250;
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435/240.5****[58] Field of Search 800/200, 205, 250, DIG. 56;
435/240.4, 240.49, 240.5****[56] References Cited
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[57] ABSTRACT

According to the invention, there is provided an inbred corn line, designated PHK56. This invention thus relates to the plants and seeds of inbred corn line PHK56 and to methods for producing a corn plant produced by crossing the inbred line PHK56 with itself or with another corn plant. This invention further relates to hybrid corn seeds and plants produced by crossing the inbred line PHK56 with another corn line or plant and to crosses with related species.

7 Claims, No Drawings

INBRED CORN LINE PHK56

This is a continuation of copending application Ser. No. 07,542,352 filed on Jun. 20, 1990, now abandoned.

FIELD OF THE INVENTION

This invention is in the field of corn breeding, specifically relating to an inbred corn line designated PHK56.

BACKGROUND OF THE INVENTION

The goal of plant breeding is to combine in a single variety/hybrid various desirable traits. For field crops, these traits may include resistance to diseases and insects, tolerance to heat and drought, reducing the time to crop maturity, greater yield, and better agronomic quality. With mechanical harvesting of many crops, uniformity of plant characteristics such as germination and stand establishment, growth rate, maturity, and fruit size, is important.

Field crops are bred through techniques that take advantage of the plant's method of pollination. A plant is self-pollinated if pollen from one flower is transferred to the same or another flower of the same plant. A plant is cross-pollinated if the pollen comes from a flower on a different plant.

Plants that have been self-pollinated and selected for type for many generations become homozygous at almost all gene loci and produce a uniform population of true breeding progeny. A cross between two homozygous lines produce a uniform population of hybrid plants that may be heterozygous for many gene loci. A cross of two plants each heterozygous at a number of gene loci will produce a population of hybrid plants that differ genetically and will not be uniform.

Corn plants (*Zea mays* L.) can be bred by both self-pollination and cross-pollination techniques. Corn has separate male and female flowers on the same plant, located on the tassel and the ear, respectively. Natural pollination occurs in corn when wind blows pollen from the tassels to the silks that protrude from the tops of the incipient ears.

The development of corn hybrids requires the development of homozygous inbred lines, the crossing of these lines, and the evaluation of the crosses. Pedigree breeding and recurrent selection breeding methods are used to develop inbred lines from breeding populations. Breeding programs combine the genetic backgrounds from two or more inbred lines or various other broad-based sources into breeding pools from which new inbred lines are developed by selfing and selection of desired phenotypes. The new inbreds are crossed with other inbred lines and the hybrids from these crosses are evaluated to determine which of those have commercial potential.

Pedigree breeding starts with the crossing of two genotypes, each of which may have one or more desirable characteristics that is lacking in the other or which complement the other. If the two original parents do not provide all of the desired characteristics, other sources can be included in the breeding population. In the pedigree method, superior plants are selfed and selected in successive generations. In the succeeding generations the heterozygous condition gives way to homogeneous lines as a result of self-pollination and selection. Typically in the pedigree method of breeding five or more generations of selfing and selection is practiced: $F_1 \rightarrow F_2$; $F_2 \rightarrow F_3$; $F_3 \rightarrow F_4$; $F_4 \rightarrow F_5$, etc.

Backcrossing can be used to improve an inbred line. Backcrossing transfers a specific desirable trait from one inbred or source to an inbred that lacks that trait. This can be accomplished for example by first crossing a superior inbred (A) (recurrent parent) to a donor inbred (non-recurrent parent), which carries the appropriate gene(s) for the trait in question. The progeny of this cross is then mated back to the superior recurrent parent (A) followed by selection in the resultant progeny for the desired trait to be transferred from the non-recurrent parent. After five or more backcross generations with selection for the desired trait, the progeny will be heterozygous for loci controlling the characteristic being transferred, but will be like the superior parent for most or almost all other genes. The last backcross generation would be selfed to give pure breeding progeny for the gene(s) being transferred.

A single cross hybrid corn variety is the cross of two inbred lines, each of which has a genotype which complements the genotype of the other. The hybrid progeny of the first generation is designated F_1 . In the development of hybrids only the F_1 hybrid plants are sought. Preferred F_1 hybrids are more vigorous than their inbred parents. This hybrid vigor, or heterosis, can be manifested in many polygenic traits, including increased vegetative growth and increased yield.

The development of a hybrid corn variety involves three steps: (1) the selection of plants from various germplasm pools; (2) the selfing of the selected plants for several generations to produce a series of inbred lines, which, although different from each other, each breed true and are highly uniform; and (3) crossing the selected inbred lines with unrelated inbred lines to produce the hybrid progeny (F_1). During the inbreeding process in corn, the vigor of the lines decreases. Vigor is restored when two unrelated inbred lines are crossed to produce the hybrid progeny (F_1). An important consequence of the homozygosity and homogeneity of the inbred lines is that the hybrid between any two inbreds will always be the same. Once the inbreds that give a superior hybrid have been identified, the hybrid seed can be reproduced indefinitely as long as the homogeneity of the inbred parents is maintained.

A single cross hybrid is produced when two inbred lines are crossed to produce the F_1 progeny. A double cross hybrid is produced from four inbred lines crossed in pairs ($A \times B$ and $C \times D$) and then the two F_1 hybrids are crossed again $(A \times B) \times (C \times D)$. Much of the hybrid vigor exhibited by F_1 hybrids is lost in the next generation (F_2). Consequently, seed from hybrid varieties is not used for planting stock.

Corn is an important and valuable field crop. Thus, a continuing goal of plant breeders is to develop high-yielding corn hybrids that are agronomically sound based on stable inbred lines. The reasons for this goal are obvious: to maximize the amount of grain produced with the inputs used and minimize susceptibility to environmental stresses. To accomplish this goal, the corn breeder must select and develop superior inbred parental lines for producing hybrids. This requires identification and selection of genetically unique individuals which in a segregating population occur as the result of a combination of crossover events plus the independent assortment of specific combinations of alleles at many gene loci which results in specific genotypes. Based on the number of segregating genes, the frequency of occurrence of an individual with a specific genotype is less than 1 in 10,000. Thus, even if the entire genotype of the

parents has been characterized and the desired genotype is known, only a few if any individuals having the desired genotype may be found in a large F₂ or S₀ population. Typically, however, the genotype of neither the parents nor the desired genotype is known in any detail.

SUMMARY OF THE INVENTION

According to the invention, there is provided a novel inbred corn line, designated PHK56. This invention thus relates to the seeds of inbred corn line PHK56, to the plants of inbred corn line PHK56, and to methods for producing a corn plant produced by crossing the inbred line PHK56 with itself or another corn line. This invention further relates to hybrid corn seeds and plants produced by crossing the inbred line PHK56 with another corn line or a related species.

DEFINITIONS

In the description and examples that follow, a number of terms are used herein. In order to provide a clear and consistent understanding of the specification and claims, including the scope to be given such terms, the following definitions are provided:

ABS=absolute measurement and % MN is percentage of mean of the experiments in which inbred or hybrid was grown unless otherwise defined.

BAR PLT=BARREN PLANTS. This is the percent of plants per plot that were not barren (lack ears).

BRT STK=BRITTLE STALKS. This is a measure of the stalk breakage near the time of pollination, and is an indication of whether a hybrid or inbred would snap or break near the time of flowering under severe winds. Data are presented as percentage of plants that did not snap.

BU ACR=YIELD (BUSHEL/ACRE). Actual yield of the grain at harvest adjusted to 15.5% moisture.

CLD TST=COLD TEST. This is the percentage of kernels that germinate under cold soil conditions. ABS=absolute measurement and % MN is percentage of mean of the experiments in which inbred or hybrid was grown.

COB SC=COB SCORE. The cob score is a rating of how well the grain is shelled off the cob and how badly the cob is broken up going through the combine. This is given as a 1 to 9 score with 9 being very good. A high score indicates that the grain shells off of the cob well, and the cob does not break.

DRP EAR=DROPPED EARS. This is a measure of the number of dropped ears per plot and represents the percentage of plants that did not drop ears prior to harvest.

EAR HT=EAR HEIGHT. The ear height is a measure from the ground to the top developed ear node attachment and is measured in inches.

EAR SZ=EAR SIZE. A 1 to 9 visual rating of ear size. The higher the rating the larger the ear size.

EST CNT=EARLY STAND COUNT. This is a measure of the stand establishment in the spring and represents the number of plants that emerge on a per plot basis for the inbred or hybrid.

GDU SHD=GDU TO SHED. The number of growing degree units (GDUs) or heat units required for an inbred line or hybrid to have approximately 50 percent of the plants shedding pollen and is measured from the time of planting. Growing degree units are calculated by the Barger Method, where the heat units for a 24-hour period are:

$$GDU = \frac{(\text{Max. temp.} + \text{Min. temp.})}{2} - 50$$

The highest maximum temperature used is 86° F. and the lowest minimum temperature used is 50° F. For each inbred or hybrid it takes a certain number of GDUs to reach various stages of plant development.

GDU SLK=GDU TO SILK. The number of growing degree units required for an inbred line or hybrid to have approximately 50 percent of the plants with silk emergence from time of planting. Growing degree units are calculated by the Barger Method as given in GDU SHD definition.

GRN QUL=GRAIN QUALITY. This is a 1 to 9 rating for the general quality of the shelled grain as it is harvested based on such factors as the color of the harvested grain, any mold on the grain, and any cracked grain. High scores indicate good grain quality.

MST=HARVEST MOISTURE. The moisture is the actual percentage moisture of the grain at harvest.

PLT HT=PLANT HEIGHT. This is a measure of the height of the plant from the ground to the tip of the tassel in inches.

POL SC=POLLEN SCORE. A 1 to 9 visual rating indicating the amount of pollen shed. The higher the score the more pollen shed.

PRM=PREDICTED RM. This trait, predicted relative maturity (RM), is based on the harvest moisture of the grain. The relative maturity rating is based on a known set of checks and utilizes standard linear regression analyses and is referred to as the Minnesota Relative Maturity Rating System.

RT LDG=ROOT LODGING. Root lodging is the percentage of plants that do not root lodge; plants that lean from the vertical axis at an approximately 30° angle or greater would be counted as root lodged.

SCT GRN=SCATTER GRAIN. A 1 to 9 visual rating indicating the amount of scatter grain (lack of pollination or kernel abortion) on the ear. The higher the score the less scatter grain.

SDG VGR=SEEDLING VIGOR. This is the visual rating (1 to 9) of the amount of vegetative growth after emergence at the seedling stage (approximately five leaves). A higher score indicates better vigor.

SEL IND=SELECTION INDEX. The selection index gives a single measure of the hybrid's worth based on information for up to five traits. A corn breeder may utilize his or her own set of traits for the selection index. One of the traits that is almost always included is yield. The selection index data presented in the tables represent the mean value averaged across testing stations.

STA GRN=STAY GREEN. Stay green is the measure of plant health near the time of black layer formation (physiological maturity). A high score indicates better late-season plant health.

STK CNT=NUMBER OF PLANTS. This is the final stand or number of plants per plot.

STK LDG=STALK LODGING. This is the percentage of plants that did not stalk lodge (stalk breakage) as measured by either natural lodging or pushing the stalks and determining the percentage of plants that break below the ear.

TAS BLS=TASSEL BLAST. A 1 to 9 visual rating was used to measure the degree of blasting (necrosis due to heat stress) of the tassel at time of flowering. A 1 would indicate a very high level of blasting at time of flowering, while a 9 would have no tassel blasting.

TAS SZ=TASSEL SIZE. A 1 to 9 visual rating was used to indicate the relative size of the tassel. The higher the rating the larger the tassel.

TAS WT=TASSEL WEIGHT. This is the average weight of a tassel (grams) just prior to pollen shed.

TEX EAR=EAR TEXTURE. A 1 to 9 visual rating was used to indicate the relative hardness (smoothness of crown) of mature grain. A 1 would be very soft (extreme dent) while a 9 would be very hard (flinty or very smooth crown).

TILLER=TILLERS. A count of the number of tillers per plot that could possibly shed pollen was taken. Data is given as percentage of tillers: number of tillers per plot divided by number of plants per plot.

TST WT=TEST WEIGHT UNADJUSTED. The measure of the weight of the grain in pounds for a given volume (bushel).

TST WTA=TEST WEIGHT ADJUSTED. The measure of the weight of the grain in pounds for a given volume (bushel) adjusted for percent moisture.

YLD=YIELD. It is the same as BU ACR ABS.

YLD SC=YIELD SCORE. A 1 to 9 visual rating was used to give a relative rating for yield based on plot ear piles. The higher the rating the greater visual yield appearance.

MDM CPX=Maize Dwarf Mosaic Complex (MDMV=Maize Dwarf Mosaic Virus & MCDV=Maize Chlorotic Dwarf Virus): Visual rating (1-9 score) where a "1" is very susceptible and a "9" is very resistant.

COM SMT=Common Smut (*Ustilago maydis*): Percentage of plants that did not have infection.

SLF BLT=Southern Leaf Blight (*Bipolaris maydis*, *Helminthosporium maydis*): Visual rating (1-9 score) where a "1" is very susceptible and a "9" is very resistant.

NLF BLT=Northern Leaf Blight (*Exserohilum turcicum*, *H. turcicum*): Visual rating (1-9 score) where a "1" is very susceptible and a "9" is very resistant.

COM RST=Common Rust (*Puccinia sorghi*): Visual rating 1-9 score) where a "1" is very susceptible and a "9" is very resistant.

EYE SPT=Eyespot (*Kabatiella zeae*): Visual rating (1-9 score) where a "1" is very susceptible and a "9" is very resistant.

GLF SPT=Gray Leaf Spot (*Cercospora zeae-maydis*): Visual rating (1-9 score) where a 1 is very susceptible and a "9" is very resistant.

STW WLT=Stewart's Wilt (*Erwinia stewartii*): Visual rating (1-9 score) where a "1" is very susceptible and a "9" is very resistant.

HD SMT=Head Smut (*reiliana*): Percentage of plants that did not have infection.

EAR MLD=General Ear Mold: Visual rating (1-9 score) where a "1" is very susceptible and a "9" is very resistant. This is based on overall rating for ear mold of mature ears without determining specific mold organism, and may not be predictive for a specific ear mold.

ECB DPE=Dropped ears due to European Corn Borer (*Ostrinia nubilalis*): Percentage of plants that did not drop ears under second brood corn borer infestation.

ECB 2SC=European Corn Borer Second Brood (*Ostrinia nubilalis*): Visual rating (1-9 score) of post flowering damage due to infestation by European Corn Borer. A "1" is very susceptible and a "9" is very resistant.

ECB 1LF=European Corn Borer First Brood (*Ostrinia nubilalis*): Visual rating (1-9 score) of pre-flowering leaf feeding by European Corn Borer. A "1" is very susceptible and a "9" is very resistant.

DETAILED DESCRIPTION OF THE INVENTION

Inbred corn line PHK56 is a yellow, dent corn inbred that provides an acceptable male parental line in crosses for producing first generation F1 corn hybrids. PHK56 is best adapted to the Central Corn Belt of the United States. The inbred can be used to produce hybrids from approximately 106-118 relative maturity based on the Minnesota Relative Maturity Rating System for harvest moisture of grain. PHK56 would make a good male because it is a good pollinator with good pollen yield. In hybrid combinations PHK56 provides high yields, has low grain moisture at maturity and performs under stress as well as good conditions. It also has good roots, low ear placement, and gray leaf spot tolerance.

The inbred has shown uniformity and stability within the limits of environmental influence for all the traits as described in the Variety Description Information (Table 1) that follows. Most of the data in the Variety Description Information was collected at Johnston, Iowa. The inbred has been self-pollinated and ear-rowed a sufficient number of generations with careful attention paid to uniformity of plant type to ensure and phenotypic stability. The line has been increased both by hand and in isolated fields with continued observation for uniformity. No variant traits have been observed or are expected in PHK56.

Inbred corn line PHK56, being substantially homozygous, can be reproduced by planting seeds of the line, growing the resulting corn plants under self-pollinating or sib-pollinating conditions with adequate isolations, and harvesting the resulting seed, using techniques familiar to the agricultural arts.

TABLE 1

VARIETY DESCRIPTION INFORMATION INBRED = PHK56	
Type: DENT	Region Best Adapted: Central Corn Belt

A. Maturity: Average across maturity zones. Zone : 0
Heat Unit Shed: 1420
Heat Unit Silk: 1460
No. Reps: 59

$$\text{HEAT UNITS} = \frac{[\text{Max. Temp.}(\geq 86^{\circ} \text{ F.}) + \text{Min. Temp.}(\geq 50^{\circ} \text{ F.})] *}{2} - 50$$

*If maximum is greater than 86 degrees fahrenheit, then 86 is used and if minimum is less than 50, then 50 is used. Heat units accumulated daily and can not be less than 0.

B. Plant Characteristics:

Plant height (to tassel tip): 216 cm
Length of top ear internode: 12 cm
Number of ears per stalk: Single
Ear height (to base of top ear): 82 cm
Number of tillers: None

Cytoplasm type: Normal

C. Leaf:

Color: (WF9) Medium Green
Angle from Stalk: 30-60 degrees

Marginal Waves: (OH7L) Many
 Number of Leaves (mature plants): 18
 Sheath Pubescence: (WF9) Medium
 Longitudinal Creases: (PA11) Many
 Length (Ear node leaf): 72 cm
 Width (widest point, ear node leaf): 10 cm
 D. Tassel:
 Number lateral branches: 6
 Branch Angle from central spike: 30–40 degrees
 Pollen Shed: Heavy based on Pollen Yield Test (107% of experiment means)
 Peduncle Length (top leaf to basal branches): 25 cm
 Anther Color: Yellow
 Glume Color: Green
 E. Ear (Husked Ear Data Except When Stated Otherwise):
 Length: 17 cm
 Weight: 142 gm
 Mid-point Diameter: 42 mm
 Silk Color: Pink
 Husk Extension (Harvest stage): Medium (Barely Covering Ears)
 Husk Leaf: Short (<8 cm)
 Taper of Ear: Average
 Position of Shank (dry husks): Horizontal
 Kernel Rows: Slightly Curved, Distinct Number=16
 Husk Color (fresh): Light Green
 Husk Color (dry): Buff
 Shank Length: 16 cm
 Shank (No. of internodes): 8
 F. Kernel (Dried):
 Size (from ear mid-point)
 Length: 11 mm
 Width: 8 mm
 Thick: 4 mm
 Shape Grade (% rounds): 20–40 (30% medium round based on Parent Test Data)
 Pericarp Color: Colorless
 Aleurone Color: Homozygous Yellow
 Endosperm Color: Yellow
 Endosperm Type: Normal Starch
 Gm Wt/100 Seeds (unsized): 25 gm
 G. Cob:
 Diameter at mid-point: 25 mm
 Strength: Strong
 Color: Red
 H. Diseases:
 Corn Lethal Necrosis (MCMV=Maize Chlorotic Mottle Virus and MDMV=Maize Dwarf Mosaic Virus): Intermediate
 Anthracnose Stalk Rot (*C. Graminicola*): Intermediate
 N. Leaf Blight (*H. turcicum*): Intermediate
 Carbonum Leaf Blight (*H. carbonum*): Susceptible
 Eye Spot (*K. zea*): Intermediate
 Gray Leaf Spot (*C. zea*): Intermediate
 Goss's Wilt (*C. nebraskense*): Resistant
 Common Smut (*U. maydis*): Resistant
 Head Smut (*S. reiliana*): Highly Resistant
 Fusarium Ear Mold (*F. moniliforme*): Resistant
 I. Insects:
 European Corn Borer-1 Leaf Damage (Pre-flowering): Intermediate
 European Corn Borer-2 (Post-flowering): Susceptible
 The above descriptions are based on a scale of 1–9, 1 being highly susceptible, 9 being highly resistant.
 S (Susceptible): Would generally represent a score of 1–3.

I (Intermediate): Would generally represent a score of 4–5.
 R (Resistant): Would generally represent a score of 6–7.
 H (Highly Resistant): Would generally represent a score of 8–9. Highly resistant does not imply the inbred is immune.

J. Variety Most Closely Resembling:

Character	Inbred
Maturity	PHW43
Usage	PHW43

Data for Items B, C, D, E, F, and G is based primarily on a maximum of two reps from Johnston, Iowa grown in 1988, plus description information from the maintaining station.

ELECTROPHORESIS RESULTS

Isozyme Genotypes for PHK56

Isozyme data were generated for inbred corn line PHK56 according to the procedures described in Stuber, C. W., Wendel, J. F., Goodman, M. M., and Smith, J. S. C., "Techniques and Scoring Procedures for Starch Gel Electrophoresis of Enzymes from Maize (*Zea mays* L.)", Technical Bulletin No. 286, North Carolina Agricultural Research Service, North Carolina State University, Raleigh, N.C. (1988).

The data in Table 2 compares PHK56 with its parents, PHG47 and PHG35.

TABLE 2

ELECTROPHORESIS RESULTS FOR PHK56 AND ITS PARENTS PHG47 AND PHG35

Loci	PHK56	PARENTS	
		PHG47	PHG35
ACP1	4	4	4
ADH1	4	4	4
CAT3	9	9	9
DIA1	8	8	8
GOT1	4	4	4
GOT2	4	4	4
GOT3	4	4	4
IDH1	4	4	4
IDH2	4	4	6
MDH1	6	6	6
MDH2	3	3	6
MDH3	16	16	16
MDH4	12	12	12
MDH5	12	12	12
MMM	4	4	4
PGM1	9	9	9
PGM2	4	4	3
PGD1	3.8	2	3.8
PGD2	5	5	5
PHI1	4	4	4

INDUSTRIAL APPLICABILITY

This invention also is directed to methods for producing a corn plant by crossing a first parent corn plant with a second parent corn plant wherein the first or second parent corn plant is an inbred corn plant from the line PHK56. Further, both first and second parent corn plants can come from the inbred corn line PHK56. Thus, any such methods using the inbred corn line PHK56 are part of this invention: selfing, backcrosses, hybrid production, crosses to populations, and the like. All plants produced using inbred corn line PHK56 as a parent are within the scope of this invention. Advantageously, the inbred corn line is used in crosses with

other, different, corn inbreds to produce first generation (F₁) corn hybrid seeds and plants with superior characteristics.

As used herein, the terms "plant and plant parts" include plant cells, plant protoplasts, plant cell tissue culture from which corn plants can be regenerated, plant calli, plant clumps, and plant cells that are intact in plants or parts of plants, such as embryos, pollen, flowers, kernels, ears, cobs, leaves, husks, stalks, roots, root tips, anthers, silk and the like.

Tissue culture of corn is described in European Patent Application, publication 160,390, incorporated herein by reference. Corn tissue culture procedures are also described in Green and Rhodes, "Plant Regeneration in Tissue Culture of Maize," *Maize for Biological Research* (Plant Molecular Biology Association, Charlottesville, Va. (1982, at 367-372). Thus, another aspect of this invention is to provide cells which upon growth and differentiation produce the inbred line PHK56.

The utility of inbred line PHK56 also extends to crosses with other species. Commonly, suitable species will be of the family Gramineae, and especially of the genera *Zea*, *Tripsacum*, *Coix*, *Schlerachne*, *Polytoca*, *Chionachne*, and *Trilobachne*, of the tribe Maydeae. Of these, *Zea* and *Tripsacum*, are most preferred. Potentially suitable for crosses with PHK56 may be the various varieties of grain sorghum, *Sorghum bicolor* (L.) Moench.

Corn is used as human food, livestock feed, and as raw material in industry. The food uses of corn, in addition to human consumption of corn kernels, include both products of dry- and wet-milling industries. The principal products of corn dry milling are grits, meal and flour. The corn wet-milling industry can provide corn starch, corn syrups, and dextrose for food use. Corn oil is recovered from corn germ, which is a by-product of both dry- and wet-milling industries.

Corn, including both grain and non-grain portions of the plant, is also used extensively as livestock feed, primarily for beef cattle, dairy cattle, hogs, and poultry.

Industrial uses of corn are mainly from corn starch from the wet-milling industry and corn flour from the dry-milling industry. The industrial applications of corn starch and flour are based on functional properties, such as viscosity, film formation, adhesive properties, and ability to suspend particles. The corn starch and flour have application in the paper and textile industries. Other industrial uses include applications in adhesives, building materials, foundry binders, laundry starches, explosives, oil-well muds, and other mining applications.

Plant parts other than the grain of corn are also used in industry. Stalks and husks are made into paper and wallboard and cobs are used for fuel and to make charcoal.

The seed of inbred corn line PHK56, the plant produced from the inbred seed, the hybrid corn plant produced from the crossing of the inbred, hybrid seed, and various parts of the hybrid corn plant can be utilized for human food, livestock feed, and as a raw material in industry.

EXAMPLE

Inbred and Hybrid Performance of PHK56

In the examples that follow the traits and characteristics of inbred corn line PHK56 are given as a line and in hybrid combination. The data collected on inbred corn

line PHK56 is presented for the key characteristics and traits.

Table 3A compares inbred PHK56 to PHG47. PHG47 is a parent of PHK56. The results show that PHK56 has higher grain yield than PHG47. PHK56 is a taller inbred with higher ear placement and flowers (GDU SHD and GDU SLK) later than PHG47. PHK56 has better stay green, more resistance to ear mold, gray leaf spot, and first and second brood European corn borer, but is slightly more susceptible to common rust and northern corn leaf blight than PHG47.

The results in Table 3B compare PHK56 to its other parent, PHG35. PHK56 yields more, is taller with lower ear placement, and flowers (GDU SHD and GDU SLK) earlier than PHG35. PHK56 has better seedling vigor and slightly lower early stand count compared to PHG35. PHK56 shows slightly better resistance to ear mold and northern corn leaf blight, is similar in resistance to first brood European corn borer, and is more susceptible to second brood European corn borer compared to PHG35.

The data in Table 3C show that PHK56 has higher yield and test weight but lower grain moisture at maturity than PHN82. PHK56 is a taller inbred with higher ear placement and flowers (GDU SHD and GDU SLK) earlier than PHN82. PHK56 has better seedling vigor but lower early stand establishment than PHN82. The pollen yield is greater and tassel size larger for PHK56 than PHN82. PHK56 has better stalks but poorer roots, is more resistant to gray leaf spot, and more susceptible to common rust and northern corn leaf blight than PHN82.

Table 3D shows that PHK56 and PHV78 have similar yield. PHK56 is shorter with lower ear placement and flowers (GDU SHD and GDU SLK) earlier than PHV78. PHK56 has less pollen yield and a smaller tassel compared to PHV78. PHK56 is more resistant to stalk lodging and ear mold but more susceptible to northern corn leaf blight and first brood European corn borer than PHV78.

Table 3E results show that PHK56 and PHW43 have similar yield and plant and ear height. PHK56 has better seedling vigor and similar early stand establishment compared to PHW43. PHK56 flowers (GDU SHD and GDU SLK) earlier than PHW43. PHK56 has better ear mold resistance, similar first brood European corn borer resistance, but is slightly more susceptible to second brood European corn borer than PHW43.

The results in Table 4A compare PHK56 to PHN82 crossed to the same inbred testers. The results show that PHK56 hybrids yield less and have lower test weight and grain harvest moisture than PHN82 hybrids. The PHK56 and PHN82 hybrids have similar plant and ear height and flower at approximately the same time. PHK56 hybrids have average stay green and are more susceptible to stalk and root lodging compared to PHN82 hybrids.

Table 4B compares PHK56 to PHV78 crossed to the same inbred testers. The PHK56 hybrids have higher yield and test weight and lower grain moisture at maturity than the PHV78 hybrids. PHK56 hybrids are shorter with lower ear placement and flower (GDU SHD) earlier than PHV78 hybrids. The PHK56 hybrids have better stalk and root lodging resistance than the PHV78 hybrids.

The results in Table 4C compare PHK56 to PHW43 crossed to the same inbred testers. The hybrids are

similar for yield and test weight but the PHK56 hybrids have lower grain moisture at maturity than the PHW43 hybrids. The PHK56 hybrids have better early stand establishment than the PHW43 hybrids.

Tables 5-8 compare PHK56 hybrids to Pioneer Brand Hybrids 3362, 3180, 3344, and 3467, respectively. Each hybrid has a parent in common with the PHK56 hybrid other than PHK56. The hybrids are adapted to much of the same area as the PHK56 hybrids. Table 5 compares a PHK56 hybrid with 3362. The PHK56 hybrid is slightly lower yielding, has similar test weight, and has lower grain harvest moisture compared to 3362. The PHK56 hybrid is shorter with lower ear placement and flowers (GDU SHD) earlier than 3362. The PHK56 hybrid has better seedling vigor and early stand count than 3362. The PHK56 hybrid has better stalk lodging resistance but is more susceptible to root lodging than 3362.

The results in Table 6 show the PHK56 hybrid has lower yield, similar test weight, and less grain harvest

and flowers (GDU SHD) much earlier than 3180. The PHK56 hybrid has similar stalks, is more susceptible to root lodging, and has lower seedling vigor compared to 3180.

Table 7 compares a PHK56 hybrid with 3344. The PHK56 hybrid is lower yielding, has higher test weight, and has less grain moisture at maturity than 3344. The PHK56 hybrid is shorter with lower ear placement and flowers (GDU SHD) earlier than 3344. The PHK56 hybrid has better stalks and roots than 3344.

Table 8, comparing a PHK56 hybrid to 3467, shows the PHK56 hybrid has higher yield, lower test weight, and less grain harvest moisture than 3467. The PHK56 hybrid is shorter but has higher ear placement and flowers (GDU SHD) earlier than 3467. The PHK56 hybrid has better stalk lodging resistance but is more susceptible to root lodging than 3467.

These results show that PHK56 hybrids offer significant advantage over commercial products that are sold for yield and other important agronomic traits.

TABLE 3A

PAIRED INBRED COMPARISON DATA											
VARIETY #1 - PHK56											
VARIETY #2 - PHG47											
YEAR	REGION	VAR #	YLD SC ABS	EAR SZ ABS	BAR PLT ABS	PLT HT ABS	EAR HT ABS	SDG VGR ABS	EST CNT ABS	TIL LER ABS	
TOTAL SUM		1	6.5	6.5	95.0	78.8	29.2	4.8	24.3	3.5	
		2	4.0	3.6	88.9	62.9	19.6	4.2	26.5	6.9	
		LOCS	17	11	5	12	12	28	34	16	
		DIFF	2.5	2.8	6.0	15.8	9.6	0.7	2.2	3.4	
		PROB	.000#	.000#	.380	.000#	.000#	.034+	.007#	.213	
YEAR	REGION	VAR #	GDU SHD ABS	GDU SLK ABS	POL SC ABS	TAS BLS ABS	TAS SZ ABS	TEX EAR ABS	SCT GRN ABS	STA GRN ABS	
TOTAL SUM		1	140.5	145.0	5.4	3.0	5.8	4.5	6.6	3.9	
		2	135.7	137.4	6.4	8.0	5.9	6.2	6.9	2.0	
		LOCS	42	41	14	1	25	10	14	9	
		DIFF	4.8	7.7	1.0	5.0	0.1	1.7	0.2	1.9	
		PROB	.000#	.000#	.047+		.746	.002#	.736	.012+	
YEAR	REGION	VAR #	RT LDG ABS	COM RST ABS	EAR MLD ABS	GLF SPT ABS	NLF BLT ABS	ECB 1LF ABS	ECB 2SC ABS		
TOTAL SUM		1	98.2	6.0	7.0	4.0	4.0	5.0	4.5		
		2	100.0	7.0	4.9	2.0	6.0	3.3	2.3		
		LOCS	3	1	15	1	1	21	8		
		DIFF	1.8	1.0	2.1	2.0	2.0	1.8	2.3		
		PROB	.423		.001#			.001#	.001#		

*10% SIG

+ = 5% SIG

= 1% SIG

moisture compared to 3180. The PHK56 hybrid is taller

TABLE 3B

PAIRED INBRED COMPARISON DATA											
VARIETY #1 - PHK56											
VARIETY #2 - PHG35											
YEAR	REGION	VAR #	YLD SC ABS	EAR SZ ABS	BAR PLT ABS	PLT HT ABS	EAR HT ABS	SDG VGR ABS	EST CNT ABS	TIL LER ABS	GDU SHD ABS
TOTAL SUM		1	6.5	6.7	96.9	75.8	27.4	5.4	25.9	3.1	138.7
		2	5.9	6.1	97.7	69.6	28.0	4.6	27.3	6.4	155.1
		LOCS	14	9	6	9	9	19	23	11	33
		DIFF	0.6	0.6	0.8	6.2	0.6	0.8	1.5	3.3	16.4
		PROB	.156	.276	.750	.010+	.787	.025+	.131	.553	.000#
YEAR	REGION	VAR #	POL SC ABS	TAS BLS ABS	TAS SZ ABS	TEX EAR ABS	SCT GRN ABS	STA GRN ABS	EAR MLD ABS	NLF BLT ABS	ECB 1LF ABS
TOTAL SUM		1	5.7	3.0	5.7	4.3	6.9	3.5	7.1	4.0	5.5
		2	5.8	9.0	6.4	5.5	5.7	4.2	6.6	3.0	5.5
		LOCS	12	1	15	6	12	10	11	1	17
		DIFF	0.2	6.0	0.7	1.2	1.3	0.7	0.5	1.0	0.1

TABLE 3B-continued

PAIRED INBRED COMPARISON DATA								
VARIETY #1 - PHK56								
VARIETY #2 - PHG35								
PROB	.795	.036+	.013+	.021+	.333	.211	.916	.013+

*10% SIG
 + = 5% SIG
 # = 1% SIG

TABLE 3C

PAIRED INBRED COMPARISON DATA													
VARIETY #1 - PHK56													
VARIETY #2 - PHN82													
YEAR	REGION	VAR #	BU ACR ABS	BU ACR % MN	YLD SC ABS	MST ABS	EAR SZ ABS	EAR PLT ABS	PLT HT ABS	EAR HT ABS	SDG VGR ABS	EST CNT ABS	DRP EAR ABS
TOTAL SUM		1	110.0	131	6.3	18.7	6.3	97.9	79.7	28.8	5.0	27.5	99.5
		2	95.7	113	6.8	23.6	6.3	99.3	69.7	27.1	4.3	30.4	100.0
		LOCS	2	2	18	2	12	9	15	15	35	35	2
		DIFF	14.3	18	0.5	5.0	0.0	1.4	10.0	1.7	0.6	2.9	0.5
		PROB	.407	.418	.108	.092*	.870	.288	.000#	.207	.024+	.007#	.500
YEAR	REGION	VAR #	TIL LER ABS	GDU SHD ABS	GDU SLK ABS	POL SC ABS	TAS BLS ABS	TAS SZ ABS	TEX EAR ABS	TST WT ABS	GRN QUL ABS	SCT GRN ABS	STA GRN ABS
TOTAL SUM		1	2.4	139.5	143.2	5.9	3.0	5.8	4.7	56.3	5.0	6.9	4.2
		2	1.0	143.3	148.2	4.6	9.0	4.3	5.2	55.7	6.0	7.0	6.7
		LOCS	19	48	46	18	1	24	9	2	2	15	12
		DIFF	1.4	3.9	5.0	1.3	6.0	1.5	0.6	0.6	1.0	0.1	2.5
		PROB	.168	.000#	.000#	.026+	.000#	.325	.272	.295	.751	.001#	
YEAR	REGION	VAR #	STK LDG ABS	RT LDG ABS	BRT STK ABS	COM RST ABS	EAR MLD ABS	GLF SPT ABS	NLF BLT ABS	ECB 1LF ABS	ECB 2SC ABS	ECB ABS	
TOTAL SUM		1	98.4	97.4	100.0	6.0	7.4	3.3	4.0	5.0	4.1		
		2	91.5	100.0	100.0	9.0	7.0	1.0	6.0	5.0	4.1		
		LOCS	2	2	1	1	15	4	1	24	7		
		DIFF	7.0	2.6	0.0	3.0	0.4	2.3	2.0	0.1	0.1		
		PROB	.319	.500			.253	.003#	.857	.930			

*10% SIG
 + = 5% SIG
 # = 1% SIG

TABLE 3D

PAIRED INBRED COMPARISON DATA										
VARIETY #1 - PHK56										
VARIETY #2 - PHV78										
YEAR	REGION	VAR #	YLD SC ABS	EAR SZ ABS	BAR PLT ABS	PLT HT ABS	EAR HT ABS	SDG VGR ABS	EST CNT ABS	TIL LER ABS
TOTAL SUM		1	6.3	6.3	97.9	75.1	26.8	5.1	25.9	2.6
		2	6.7	7.0	93.9	82.1	28.5	5.0	24.9	2.3
		LOCS	18	12	9	11	11	26	26	15
		DIFF	0.4	0.7	4.1	7.0	1.7	0.1	1.0	0.3
		PROB	.361	.005#	.187	.011+	.286	.762	.339	.816
YEAR	REGION	VAR #	GDU SHD ABS	GDU SLK ABS	POL SC ABS	TAS BLS ABS	TAS SZ ABS	TEX EAR ABS	SCT GRN ABS	STA GRN ABS
TOTAL SUM		1	138.4	142.4	5.9	3.0	5.9	4.5	6.9	3.6
		2	153.8	157.6	7.5	9.0	7.5	3.9	5.9	6.1
		LOCS	41	38	17	1	21	8	14	10
		DIFF	15.4	15.3	1.5	6.0	1.6	0.6	0.9	2.5
		PROB	.000#	.000#	.000#	.000#	.370	.006#	.005#	
YEAR	REGION	VAR #	LDG RT ABS	BRT STK ABS	COM RST ABS	EAR MLD ABS	GLF SPT ABS	NLF BLT ABS	ECB 1LF ABS	ECB 2SC ABS
TOTAL SUM		1	100.0	100.0	6.0	7.2	4.0	4.0	4.9	4.0
		2	86.4	100.0	6.0	6.2	4.0	7.0	5.9	4.6
		LOCS	1	1	1	13	1	1	21	7
		DIFF	13.6	0.0	0.0	1.1	0.0	3.0	1.0	0.6
		PROB			.052*			.035+	.436	

*10% SIG
 + = 5% SIG
 # = 1% SIG

TABLE 3E

PAIRED INBRED COMPARISON DATA														
VARIETY #1 - PHK56														
VARIETY #2 - PHW43														
YEAR	REGION	VAR #	YLD SC ABS	EAR SZ ABS	BAR PLT ABS	PLT HT ABS	EAR HT ABS	SDG VGR ABS	EST CNT ABS	TIL LER ABS	GDU SHD ABS	GDU SLK ABS	POL SC ABS	
TOTAL SUM		1	6.2	6.7	97.9	73.8	28.7	5.5	27.4	1.9	139.0	142.8	5.8	
		2	6.2	6.6	97.5	73.3	26.2	4.8	27.4	0.8	144.0	146.3	5.9	
		LOCS	13	10	9	6	6	17	23	12	30	28	13	
		DIFF	0.0	0.1	0.5	0.5	2.5	0.7	0.0	1.1	5.0	3.5	0.2	
		PROB	.907	.758	.749	.809	.185	.013+	.964	.407	.000#	.002#	.801	
YEAR	REGION	VAR #	TAS BLS ABS	TAS SZ ABS	TEX EAR ABS	SCT GRN ABS	STA GRN ABS	BRT STK ABS	EAR MLD ABS	NLF BLT ABS	ECB 1LF ABS	ECB 2SC ABS		
TOTAL SUM		1	3.0	6.1	4.4	6.8	4.2	100.0	6.8	4.0	5.6	4.7		
		2	9.0	6.6	6.1	5.7	5.0	100.0	5.0	3.0	5.6	5.5		
		LOCS	1	13	7	11	6	1	12	1	14	6		
		DIFF	6.0	0.5	1.6	1.1	0.8	0.0	1.8	1.0	0.0	0.8		
		PROB		.025+	.035+	.003#	.317		.016+		.000	.185		

*10% SIG
 + = 5% SIG
 # = 1% SIG

TABLE 4A

AVERAGE INBRED BY TESTER PERFORMANCE COMPARING PHK56 TO PHN82 CROSSED TO THE SAME INBRED TESTERS AND GROWN IN THE SAME EXPERIMENTS. ALL VALUES ARE EXPRESSED AS PERCENT OF THE EXPERIMENT MEAN EXCEPT PREDICTED RM, SELECTION INDEX, AND YIELD (BU/AC).												
	INBRED	PRM	SEL IND	BU ACR	YLD	MST	GDU SHD	PRM SHD	STK LDG	RT LDG	BAR PLT	STA GRN
TOTAL	REPLIC.	66	73	73	73	73	22	69	63	30	12	28
MEAN WTS	PHK56	115	101	143	100	99	99	117	99	103	99	96
MEAN WTS	PHN82	120	105	149	104	109	100	117	101	106	101	110
	DIFF.	5	5	7	5	10	1	0	2	3	2	15
	INBRED		TST WTA	COB SC	GRN QUL	SDG VGR	EST CNT	STK CNT	PLT HT	EAR HT	DRP EAR	BRT STK
TOTAL	REPLIC.		73	2	38	33	38	77	28	28	45	10
MEAN WTS	PHK56		99	103	102	85	98	100	98	94	100	101
MEAN WTS	PHN82		101	121	98	99	103	101	97	95	100	101
	DIFF.		2	17	3	14	4	1	2	1	0	1

TABLE 4B

AVERAGE INBRED BY TESTER PERFORMANCE COMPARING PHK56 TO PHV78											
CROSSED TO THE SAME INBRED TESTERS AND GROWN IN THE SAME EXPERIMENTS.											
ALL VALUES ARE EXPRESSED AS PERCENT OF THE EXPERIMENT MEAN EXCEPT PREDICTED RM, SELECTION INDEX, AND YIELD (BU/AC).											
	INBRED	PRM	SEL IND	BU ACR	YLD	MST	GDU SHD	PRM SHD	STK LDG	RT LDG	BAR PLT
TOTAL	REPLIC.	56	63	63	63	63	18	63	51	26	4
MEAN WTS	PHK56	118	108	155	103	95	97	118	100	105	99
MEAN WTS	PHV78	121	93	148	99	102	102	124	99	95	102
	DIFF.	3	14	7	5	7	5	6	1	10	2
	INBRED	STA GRN	TST WTA	GRN QUL	SDG VGR	EST CNT	STK CNT	PLT HT	EAR HT	DRP EAR	BRT STK
TOTAL	REPLIC.	26	63	16	13	10	63	34	34	37	10
MEAN WTS	PHK56	80	100	91	105	106	101	97	90	100	101
MEAN WTS	PHV78	85	97	94	105	106	100	103	104	100	94
	DIFF.	5	3	4	0	0	1	6	13	0	7

TABLE 4C

AVERAGE INBRED BY TESTER PERFORMANCE COMPARING PHK56 TO PHW43													
CROSSED TO THE SAME INBRED TESTERS AND GROWN IN THE SAME EXPERIMENTS.													
ALL VALUES ARE EXPRESSED AS PERCENT OF THE EXPERIMENT MEAN EXCEPT PREDICTED RM, SELECTION INDEX, AND YIELD (BU/AC).													
	INBRED	PRM	SEL IND	BU ACR	YLD	MST	PRM SHD	STK LDG	TST WTA	EST CNT	STK CNT	PLT HT	DRP EAR
TOTAL	REPLIC.	10	10	10	10	10	10	10	10	2	10	2	2
MEAN WTS	PHK56	110	100	143	100	101	112	101	101	105	100	101	99
MEAN WTS	PHW43	112	96	142	100	111	113	102	100	100	102	100	101

TABLE 7-continued

PHK56 HYBRID COMPARED TO PIONEER HYBRID 3344						
VARIETY #1 - PHK56 HYBRID						
VARIETY #2 - 3344						
PROB	.285	.215	.000#	.000#	.070*	.861

*10% SIG
 + = 5% SIG
 # = 1% SIG

TABLE 8

PHK56 HYBRID COMPARED TO PIONEER HYBRID 3467									
VARIETY #1 - PHK56 HYBRID									
VARIETY #2 - 3467									
YEAR	REGION	VAR #	PRM	SEL IND	BU ACR ABS	BU ACR % MN	MST ABS	GDU SHD ABS	STK LDG ABS
TOTAL SUM		1	113	108	152.5	103	17.9	130.3	97.6
		2	116	97	144.6	98	18.8	134.0	95.8
		LOCS	2	2	8	8	8	3	6
		DIFF	2	12	7.9	5	0.9	3.7	1.8
		PROB	.397	.332	.131	.160	.037+	.311	.403
YEAR	REGION	VAR #	RT LDG ABS	STA GRN ABS	TST WTA ABS	PLT HT ABS	EAR HT ABS	DRP EAR ABS	BRT STK ABS
TOTAL SUM		1	92.4	4.8	58.1	111.0	49.5	95.7	90.5
		2	99.2	6.0	59.0	113.3	44.3	100.0	88.0
		LOCS	5	3	8	2	2	5	2
		DIFF	6.8	1.2	0.9	2.3	5.3	4.3	2.6
		PROB	.287	.020+	.011+	.500	.579	.012+	.306

*10% SIG
 + = 5% SIG
 # = 1% SIG

Applicant has made available to the public without restriction a deposit of at least 2500 seeds of inbred PHK56 with the American Type Culture Collection (ATCC), Rockville, Md. 20852 USA, ATCC Deposit No. 75677, on Mar. 4, 1994. The seeds deposited with the ATCC are taken from the same deposit maintained by Pioneer Hi-Bred International Inc. 700 Capital Square, 400 Locust Street, Des Moines, Iowa 50309 since prior to the filing date of this application. This deposit of the Inbred Corn Line PHK56 will be maintained without restriction in the ATCC depository, which is a public depository, for a period of 30 years, or 5 years after the most recent request, or for the effective life of the patent, whichever is longer, and will be replaced if it becomes nonviable during that period.

What is claimed is:

1. Inbred corn seed designated PHK56, having the ATCC Accession No. 75677.

2. A corn plant produced by the seed of claim 1.
3. An inbred corn plant having all the physiological and morphological characteristics of the plant of claim 2.
4. A tissue culture of regenerable cells of the plant PHK56.
5. A tissue culture according to claim 4 comprising regenerable cells selected from meristematic tissue, anthers, leaves, embryos, and pollen protoplasts therefrom.
6. A corn plant regenerated from the regenerable cells of a tissue culture of claim 5 having all the physiological and morphological characteristics of inbred corn plant PHK56.
7. An F₁ hybrid corn plant and seed thereof produced by crossing an inbred corn plant produced from seed identified as PHK56 and having ATCC accession number 75677, with another, different corn plant.

* * * * *

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