# 2001

# NORTH CENTRAL CORN BREEDING RESEARCH COMMITTEE (NCR-167)

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| NCR-167 | NCR-167 |
| 2001 Meetings | 2002 Meetings |
| February 5-6, 2001 | June 17-19, 2002 |
| Ames, Iowa | Urbana, IL |

Report of the

North Central Corn Breeding
Research Committee

NCR-167

Ames, Iowa
February 5-6, 2001

2002 Meetings
June 17-19, 2002
Urbana, IL

Reported by
Arnel R. Hallauer

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Minutes of the
North Central Corn Breeding Research Committee
NCR-167

February 5-6, 2001
Holiday Inn Gateway Center
U.S. 30 & Elwood Drive
Ames, Iowa 50014

Annual meeting of NCR-167 was held February 5-6, 2001 at the Holiday Inn Gateway Center, Ames, Iowa. Elizabeth Lee from the University of Guelph, Guelph, Canada, chaired the 2001 meetings and called the meetings to order at 8:00 AM on February 5, 2001. Elizabeth Lee worked with Kendall Lamkey, who was in charge of local arrangements, to develop the program for the 2001 annual meeting. Elizabeth Lee presented the agenda for the schedule of activities during the 1.5-day meetings. The meetings were organized into three half-day sessions of voluntary reports by members of NCR-167 and invited reports by Pat Schnable and Jean-Luc Jannink. Each half-day session included 4 to 6 reports. The quality of the reports were generally excellent, of interest to those in attendance, and attendance was very good throughout the 1.5-day meeting. Abstracts for most of the reports for each of the three sessions are included herein. The annual NCR-167 Business Meeting was conducted following the afternoon session of February 5, 2001 with the minutes of the annual meeting following the research report abstracts.

Registered attendance for the 1.5-day meeting was 57. Attendees included official representatives to NCR-167, corn researchers from public and private corn breeding programs located primarily in the North Central Area, and graduate students from the corn research programs. There were 16 graduate students who attended the meetings.

Dr. Gary Heichel, Head, Department of Plant Science, University of Illinois, Urbana, serves as the Administrative Adviser for NCR-167. He attended the 1.5-day meeting and the NCR-167 Business Meeting. He offers experienced advise to NCR-167 in matters related to goals, mission, and direction for NCR-167. He announced at the Business Meeting that the NCR-167 project had been approved for 5-year period of renewal rather than 4-year renewal. The renewal for continuance of NCR-167 is until 2006.

NCR-167 will depart from its normal schedule for conducting its annual meeting in 2002. Because 100 years of selection will have been completed for the long-term Illinois selection studies, the University of Illinois will hold a symposium that reviews long-term selection programs. NCR-167 will be a co-sponsor with the University of Illinois in conducting the symposium. Dates for the symposium are June 17, 18, and 19, 2002. John Dudley (Chair), James Coors, and Kendall Lamkey are the planners and coordinators for the symposium. More details of the symposium are included in the minutes of the NCR-167 business meeting.

# Texas A&M Corn Breeding & Genetics Program

Javier Betran
Department of Soil and Crop Sciences
Texas A & M University

The goal of the Texas A&M Corn Breeding Program is the improvement of corn for sustainable productivity value-added profitability and food safety. Our activities focus on aflatoxin resistance, high lysine corn, introgression of germplasm, food corn, and abiotic stresses (drought and heat). During the 2000 season we have continued the evaluation, characterization and selection of corn germplasm with different origins and genetic backgrounds to develop inbred lines with superior grain quality, aflatoxin resistance, adaptation to Texas, and tolerance to abiotic stresses. We have conducted multilocation testing across the major corn production regions of Texas and evaluated germplasm under controlled drought stress and under artificial inoculation of the *Aspergillus flavus*, fungi responsible of aflatoxin production in corn. Approximately 700 experimental hybrids were tested across Texas to identify the most adapted germplasm to the local conditions. Different traits (yield, maturity, moisture, test weight, lodging, ear and plant height, cob and grain color, texture, disease resistance, etc.) were recorded. The 2000 season has been good with timely rainfall, low stress at flowering time, and low incidence of aflatoxin. We will select the best material in these trials considering its overall performance, local adaptation, and quality. In these evaluations we have collaborated with other public programs and agencies, international centers, and private seed companies. Also, we have continued as a cooperator of The U.S. Germplasm Enhancement of Corn (GEM) project. Aflatoxin resistant candidate inbred lines and hybrids were tested under artificial inoculation in three Texas locations. We have identified white and yellow inbreds with consistent low AF content in hybrid combinations. The most promising inbreds for the Texas growing conditions are CML322, CML269, CML176 among the whites and CML326, Tx772, CML285 and Mp715 among the yellows. We will characterize further these genotypes, initiate the transfer of AF resistance to elite inbreds, and combine different types of aflatoxin resistance. Quality Protein Maize (QPM) hybrids were evaluated in Texas environments. QPM in general had longer maturities, bigger tassels, higher ear placements, higher lodging, and lower grain yields than commercial checks. White QPM hybrids performed better in Texas than the yellow QPM hybrids. During 2000 we had two nurseries. One during the regular season (summer) at College Station, TX and one off-season (winter) at Weslaco, TX. Unfortunately a hailstorm before flowering severely damaged our summer nursery and trials at College Station. An approximate of 1000 inbred lines and 50 populations representing a wide range of maturities (early, intermediate and late), adaptation (tropical, subtropical and temperate), color (white, yellow, orange), quality (lysine content), and kernel characteristics (flint, dent) were screened in these nurseries. Traits such as early vigor, maturity, adaptation, plant and ear height, grain color, cob color, texture, disease resistance (aflatoxin, head smut), and ear characteristics were recorded and ultimately used to classify and select the most promising germplasm for our program objectives.

# Breeding for Quality and Yield in Silage Corn

James G. Coors
Department of Agronomy
University of Wisconsin – Madison
http://UWsilagebreeding.agronomy.wisc.edu

The UW corn (*Zea mays* L.) breeding program initiated studies on the relationship between plant cell wall composition and resistance to the European corn borer (ECB) in the mid-1980s. The divergent germplasms used for these studies, WFISIHI and WFISILP, were created by three cycles of $S_1$ recurrent selection for high and low values of neutral detergent fiber (NDF) and lignin in the stalk, leaf sheath, and leaf blade. It was apparent from these selection studies that selection for plant composition was straightforward and successful. Furthermore, the same fiber components influencing ECB resistance were probably important nutritional components for corn fed as silage to ruminants.

Based on nutritional evaluations of historically important inbred lines used by the seed industry, inbred lines H99 and Mo17 were crossed to WFISILO C3 to create the Wisconsin Quality Synthetic (WQS), a source germplasm for improved corn silage. Inbreds Mo17 and H99 both had relatively low NDF, high in vitro true digestibility (IVTD), and high in vitro NDF digestibility (IVNDFD). Furthermore, they were both from the Lancaster background and would likely enhance this heterotic characteristic for WQS. Several resource allocation studies were performed in the early 1990s to determine the appropriate evaluation methods for silage yield and quality and the degree to which agronomic and quality characteristics were correlated. Repeatabilities for most quality traits were approximately equal to those for grain yield, so no changes in experimental design appeared necessary. There were few significant correlations between agronomic and quality characteristic with the exception of those involving maturity and ear-fill. As corn plants matured, stover NDF increased while IVTD decreased, but the whole plant composition was not affected to the same extent due to compensatory increase in the ear fraction. However, starch also became less digestible as plants matured. This was due, in part, to the increasing hardness of the seed, but there may have been other factors involved. There also appeared to be significant genetic differences in starch degradability among corn genotypes.

An $S_2$-topcross recurrent selection protocol was adopted for improving WQS for silage yield and quality. Two cycles of this program have been completed. The current selection method involves evaluation of topcross forage yield and dry matter, NDF, IVTD, IVNDFD, protein, and starch. Based on these traits, milk production ton$^{-1}$ and milk production acre$^{-1}$ are calculated using the spreadsheet program MILK2000 developed by R. D. Shaver and collaborators in the UW Dairy Science and Agronomy departments. Milk production acre$^{-1}$ is used as a selection index combining both yield and quality.

Impact of Recombination and Biomass Selection on Inbred Line Development**.**

Elizabeth Lee
Department of Plant Agriculture
University of Guelph

Homozygosity is rapidly achieved by self-pollination; each generation of selfing reduces the heterozygous regions available for recombination by 50 percent. Compared to selfing, full-sib mating reduces the rate of approach to homozygosity, thus retaining more heterozygous regions and in turn permitting greater opportunities for recombination. Two methods of inbreeding were examined in this study, selfing (S) and full-sibbing (FS) to examine if superior performing inbred lines result when greater opportunities for recombination are permitted. The other aspect of inbred line development that this study examined is the impact that selecting for biomass (B) rather than grain yield per se (G) has on the testcross performance of inbreds. A F2 population formed by self pollinating the hybrid Pioneer 3902 served as the starting material for this study. Through generations of selfing (S) or full sibbing (FS) followed by selection based on either grain yield (G) or biomass (B) 100 inbreds were developed for each method: BFS, BS, GFS, and GS. The 100 S5 lines were testcrossed to 2 inbred testers (LH61 and LH145) and evaluated for grain yield. Based on testcross performance the top 6 S5 lines on LH61 and the top 6 S5 lines on LH145 from each method were chosen. The S5 lines selected on LH61 were testcrossed to LH162 and the S5 lines selected on LH145 were testcrossed to LH223. The testcrosses were then evaluated in six environments and the inbred lines per se were evaluated in three environments. On a per se basis biomass selection resulted in inbred lines with significantly higher grain yields. While, grain moisture, test weight and percentage broken stalks were not affected by method of selection. Full-sibbing resulted in inbred lines with significantly higher grain yields and lower grain moistures however selfing produced inbred lines with significantly fewer broken stalks. Test weight on a per se basis was not affected by method of inbreeding. We found that both method of inbreeding and method of selection impacts the testcross performance. Inbreds developed through biomass selection resulted in significantly higher yielding hybrids, while inbreds developed through grain yield selection resulted in hybrids with significantly higher test weights and significantly lower grain moistures. Inbreds developed by full-sibbing produced hybrids that were significantly higher yielding and had significantly lower grain moistures. While inbreds developed by selfing produced hybrids that had significantly higher test weights and fewer broken stalks.

Development of the Wisconsin Quality Synthetic:
A Breeding Population for Silage Corn

T. J. Frey and J. G. Coors
Department of Agronomy
University of Wisconsin – Madison
http://UWsilagebreeding.agronomy.wisc.edu

Over the past 15 years a population of corn (*Zea mays* L.) designated the Wisconsin Quality Synthetic (WQS) has been developed at the University of Wisconsin to have improved forage yield and nutritional quality. The impetus for developing WQS came for studies involving the WFISIHI and WFISILO populations that were divergently selected for $S_1$ per se fiber and lignin concentrations in order to study the effects of fiber and silica levels on insect resistance. Based on these selection studies and also the growing interest in silage corn, the Wisconsin Quality Synthetic was developed. Its source was a cross of cycle 3 of WFISILO (Mo17 x H99). WQS was then further improved by recurrent selection for $S_2$ topcross silage yield and nutritional quality.

Cycles C0 to C3 of WFISIHI and WFISILO, cycles C0 and C1 of WQS as well as WQS population crosses to LH119, LH198, and LH200, and several experimental and hybrid check materials were evaluated for their agronomic traits and nutritional quality in Madison and Arlington, WI in 2000. Both whole plant and stover fractions were evaluated for forage yield, dry matter (DM), neutral detergent fiber (NDF), acid detergent fiber (ADL), in vitro true digestibility (IVTD), in vitro NDF digestibility (IVNDFD), and crude protein. The whole plant material was evaluated additionally for ear percentage, milk production ton$^{-1}$ of forage, and milk production acre$^{-1}$. Whole plant and stover composition was analyzed using near infrared reflectance spectrophotometry (NIRS). Milk production estimates were calculated using the spreadsheet program MILK2000 developed by R. D. Shaver and collaborators in the UW Dairy Science and Agronomy departments.

The results of the first year of a two-year study indicated very few changes among cycles within each population. The exceptions involved the WFISILO population where forage yield decreased by 1.8 t acre$^{-1}$ cycle$^{-1}$, DM increased by 3.6% cycle$^{-1}$, and whole plant IVTD increased by 0.9% cycle$^{-1}$. Over all the populations several significant change were observed for whole plant composition. NDF decreased from 57% to 51% for WFISILO C0 to WQS C1, respectively. IVTD increased from 71% to 74% for WFISILO C0 to WQS C1, respectively. Milk ton$^{-1}$ of forage increased from 2664 lb ton$^{-1}$ to 2905 lb ton$^{-1}$ for WFISILO C0 to WQS C1, respectively. Selection improved the nutritional quality of WQS C1 to the extent that this population was equivalent to the brown midrib (*bm3*) check, F657.

# The impact of recurrent selection on GCA and SCA

Trevor Doerksen and Elizabeth Lee
Department of Plant Agriculture, University of Guelph

Twelve maize populations (either RRS, $S_2$ progeny RS, or combined), were evaluated in their original and advanced cycles, for change in their *per se* performance and their populations cross. The three traits evaluated were: grain yield (adjusted to 15.5% moisture), grain moisture and % of broken stalks. A significant improvement was found in all but 3 *per se* populations, for grain yield and for reduction of broken stalks. Moisture did not show a consistent trend. In a diallel of original and advanced cycles, the GCA and SCA effects for each trait were found to be significant, with the exception of the SCA effect for broken stalks in the advanced cycle. No significant SCA effects were found between RRS pairs in the original cycle. Only two significant SCA effects were found in the advanced cycle between RRS pairs. The GCA effects of the populations were not negatively affected by recurrent selection. For most of the populations, selection either caused no significant change in the GCA of the population, or was significantly improved.

# Changes In RFLP Allele And Genotypic Frequencies Following Half-Sib And S2 Selection In BSSS

Paulo E. O. Guimarães and Kendall R. Lamkey
USDA-ARS
Department of Agronomy
Iowa State University
Ames, IA 50011

Evaluating progress from Recurrent Selection (RS) programs can lead to increased knowledge of selection methods, populations, traits, undergoing selection, and lead to better management of selection programs. Iowa Stiff Stalk Synthetic (BSSS) has been undergoing intrapopulation RS since 1939. The objective of our research was to evaluate the effects of 7 cycles of half-sib selection followed by 7 cycles of S2 selection on the molecular genetic structure of BSSS. The BSSSP (16 progenitor lines), BS13(S)C0 (90 individuals of original S2 selection), and BS13(S)C7 (102 individuals of $7^{th}$ S2 cycle) populations were genotyped with 105 RFLP loci. Results from different population genetic statistics indicated C0 and C7 had reduced genetic variation in comparison to P. For P, C0, and C7 populations the proportion of polymorphic loci was 98, 79, and 66%; number of alleles was 439, 251, and 231; and expected heterozygosity was 0.58, 0.34, and 0.26, respectively. The average frequency of the most common allele increased from 0.56 (P) to 0.75 (C0) and 0.82 (C7). Principal Component Analysis and Nei's genetic distance (N) revealed P distant from C0 and C7 (N = 0.26 and 0.33, respectively), and a close distance (N=0.08) between C0 and C7. The Illinois inbred line Hy had a significantly greater contribution to C7 than others progenitor lines. Results from Waples' neutrality test suggested that changes in allele frequencies for about 30% of the loci could not be explained by genetic drift alone. Other studies indicated reduced genetic gain for S2 selection in BSSS and our study revealed a relatively narrow genetic basis in C7 based on a sample of RFLP loci. Based on this limited knowledge, one may raise the question if there is enough genetic variability in C7 to sustain long-term genetic gains for yield.

# US and Yugoslavian Sources of Favorable Alleles for Maize Hybrids Improvement

Slobodan Trifunovic
Maize Research Institute
Belgrade, Yugoslavia

Choice of an appropriate donor of alleles for use in re-selection programs of existing inbred lines of maize (*Zea mays* L.) is crucial to the success of such programs. Well-adapted local populations or exotic improved populations might be used as donors in order to improve a target genotype. The objectives of this study were to: 1) evaluate USA and Yugoslav maize populations as donors of favorable alleles for improvement of two single cross hybrids, 2) estimate Dudley's relationship values to determine which inbred parent should be improved and 3) compare four estimators of the value of populations: Dudley's minimally biased estimators (Lplµ*), minimum upper bound (UBND), predicted three-way cross (PTC), and net improvement (NI). Lplµ*, UBND, PTC and NI showed significant differences among donors for heritability index. The highest values of favorable alleles were detected in populations, which had already undergone some type of family-based recurrent selection for grain yield. The improvement of both hybrids should be done with populations BS12C8, BS26, ZPSyn1, and EP1. Rank correlations among applied estimators were positive and generally highly significant, while Lplµ* and PTC identically ranked all studied populations for both target hybrids. One target hybrid is adequate to evaluate populations as donors of favorable alleles for improvement of a heterotic pattern.

Think Out Loud About Plant Breeding,
Quantitative Genetics, and Genomics

Rex Bernardo
Department of Agronomy and Plant Genetics
University of Minnesota

Genomics can potentially enhance breeding progress for quantitative traits. My objectives are to: (i) stimulate thinking and discussion of the interrelationships among plant breeding, quantitative genetics, and genomics; (ii) review the basic approaches used in quantitative genetics and genomics; and (iii) and speculate on the future impacts of genomics in applied plant breeding programs. Plant breeders have successfully improved crops for quantitative traits such as yield without knowing the number, location, effects, and interactions of the underlying genes. Quantitative genetics aims to model the phenotype that results from the joint action of many genes that are largely unknown. This black-box approach focuses on how well the phenotype is modeled, with little regard for whether the model depicts how genes act. In contrast, genomics aims to describe how a phenotype actually arises from the joint action of many known genes. The least-squares models in quantitative genetics force most of the genetic variation to be additive. Even loci with strong physiological epistasis contribute relatively little to the epistatic variance. This property diminishes the usefulness of knowing, through genomics, the interactions among genes. I speculate that genomics will be most useful for something quantitative genetics cannot accomplish: the creation of new genetic variation. Genomics could enhance our undersanding of genotype-environment interaction only if testing environments are characterized more accurately. Plant breeding programs, both public and private, need to maintain a sufficient return on investment regardless of how the cost and benefit of breeding programs is measured. Will genomics increase the return on investment in plant breeding in the long run?

# Variation in Maize Protein Content

Richard Pratt and Peter Thomison
Dept. of Horticulture and Crop Science
Ohio Agricultural Research and Development Center
The Ohio State University

Germplasm and specialty hybrids with enhanced kernel protein content are being developed and evaluated in the private and public sectors. Artifacts may arise in the measurement of grain compositional traits due to the manner in which pollination occurred. Cross-fertilization is known to result in xenia effects on kernel weight and oil content (Bulant and Gallais, 1998; Seka and Cross, 1995) and differences in protein content have resulted from controlled pollination ("bagging") vs. open-pollination (Letchworth and Lambert, 1998). Xenia, a direct influence of pollen on tissues other than the embryonic ones (Sinnot and Dunn, 1939), apparently has minor effects on protein content (East and Jones, 1920) or affects protein content only in specific reciprocal crosses such as that between low oil and high oil hybrids, but not between high x low protein hybrids (Letchworth and Lambert, 1998). Pixley and Bjarnason (1994) found no differences in protein content of QPM hybrids pollinated by different QPM males, and concluded random cross-pollination of entries in QPM trials would not confound differences among females. Additional studies would be useful with normal endosperm maize because some xenia effects appear to be genotype specific, vary with environmental conditions (Bulant and Gallais, 1998), or may have indirect effects through alteration of source-sink relationships (Bulant and Gallais, 1998; Tsai and Tsai, 1990).

The objectives of our studies were to: 1) examine the extent to which cross-pollination occurs in conventional four-row plots and 2) to examine the influence of uncontrolled vs. controlled pollination treatments on kernel protein values of distinctly different hybrids.

A white food-grade hybrid was entered in the state corn performance evaluation at Hoytville, Ohio in 1991 and 1992. Ears were harvested individually within each of the four rows of each replicate plot. Individual ears were hand-shelled and light yellow (cross-pollinated) kernels were manually separated and counted. The rate of outcrossing, averaged across years, was 9% in the inner two rows and 12% in the outer two rows. The rate in the center rows appeared to be slightly higher in 1992 (11 vs. 7 %). These results suggest the potential impact of xenia on grain compositional values would be fairly restricted in the inner rows of four-row plots for the observed hybrid under the conditions experienced.

We also examined the grain protein content of two diverse hybrids grown in nurseries in Columbus (1991) and Wooster (1992) using near-infrared transmittance spectroscopy. Kernel samples obtained from controlled cross- or self-pollination, or through natural open-pollination, of a high protein hybrid (Wilson Hybrids Demand 110) and a low protein hybrid (B73 x Mo17) were compared. Open-pollinated samples showed less protein than controlled, self-pollinated samples in both hybrids. Controlled cross-pollination also resulted in elevated grain protein values that were not significantly different than those obtained through self-pollination. We concluded these results were consistent with earlier reports (Letchworth and Lambert, 1998) that also demonstrated elevated protein content attributable to a "bag effect." (Table 1) We conducted a similar experiment in 1994, this time adding an additional high-protein hybrid. Protein content of samples obtained through controlled self-pollination was again higher than that of the open-pollinated samples, further demonstrating the "bag effect." (Table 2) Interestingly, cross-pollination resulted in no change when P52 was the female parent, but as the male, it appeared to reduce the protein content in the other hybrids. B73 x Mo17 also appeared to reduce protein content in Demand 110. (Table 3) These results could be interpreted as xenia effects on protein content, perhaps resulting through stimulation of kernel filling.

We also tested the effect of self-pollination vs. cross-pollination in an experiment conducted at S. Charleston, Ohio. The study involved high and low protein and high oil hybrids selected based on previous variety trials conducted in southwestern Ohio. Plots were planted in a split-plot version of a random complete block (RCB) design with four replications. Treatments were assigned as main-plots and genotypes as sub-plots for ANOVA. Treatments consisted of 1) allowing tassels to remain in place or 2) removal of the emerging tassels. These treatments should have approximated self-pollination (>90%) and cross-pollination (>90%). The latter treatment would emulate a "worst case" scenario in a variety trial, without the need for "bagging" to control pollination. During each year there were several hybrids that showed significant differences between treatments. These differences were not consistent in increasing or decreasing protein content, and only one hybrid showed the same directional effect during both seasons. (Table 4) We concluded that there is no general xenia effect on protein content in normal maize, but the potential for confounding results in trials containing highly diverse normal maize genotypes may be more serious than for QPM trials.

**Acknowledgements:** We thank Allen Geyer, Dave Jordan, Mark Casey, Jim Hacker, and Judy Smith for valuable assistance.

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Table1. Mean grain protein composition of two maize hybrids pollinated three ways during 1991-92 in Ohio

| Entry | Open-pollinated (natural) | Self-pollinated (artificial) | Cross-pollinated (to other hyb.) |
|---|---|---|---|
| B73 x Mo17 | 9.8c | 11.3b | 11.1b |
| Wilson Hyb. Demand 110 | 11.2b | 11.8a | 11.5ab |

Table 2. Grain protein composition of three maize hybrids pollinated two ways during 1994 in Ohio

| Entry | Open-pollinated | Self-pollinated (artificial) |
|---|---|---|
| B73 x Mo17 | 9.2 f | 10.6 de |
| Wilson Hyb. Demand 110 | 11.4 c | 12.0 a |
| Bird P52 | 10.8 d | 12.0 a |

Table 3. Grain protein composition of three maize hybrids cross-pollinated during 1994 in Ohio

| Male ><br>Female | B73 x Mo17 | WH Demand 110 | Bird P52 |
|---|---|---|---|
| B73 x Mo17 | 10.6 de | 10.3 ef | 10.0 f |
| WH Demand 110 | 11.5 bc | 12.0 a | 11.3 c |
| Bird P52 | 11.8 ab | 11.8 ab | 12.0 a |

Table 4 Grain protein composition of hybrids self- vs. cross-pollinated at S. Charleston, OH - 1994-95

| Maize Hybrid Entry | Phenotype Represented | Protein (%) 1994 -Pollination trt.- | | | Protein (%) 1995 - Pollination trt.- | | |
|---|---|---|---|---|---|---|---|
| | | SP | OP | Mean | SP | OP | Mean |
| Wilson Demand 110 | High Protein | 10.6 | 10.3 | 10.5 | 10.1 | 9.9 | 10.0 |
| Campbell Hy646y | High Protein | 11.0 | 10.5* | 10.8 | 8.6 | 9.4* | 9.0 |
| Bird B66 | High Protein | 10.5 | 10.1* | 10.3 | 9.8 | 9.8 | 9.8 |
| Dairyland 1111 | High Protein | 10.4 | 10.3 | 10.4 | 10.1 | 9.8* | 10.0 |
| Pfister Kernoil-4 | High Oil | 9.7 | 10.1* | 9.9 | 8.6 | 8.5 | 8.6 |
| Pfister Kernoil-11 | High Oil | 9.5 | 9.5 | 9.5 | 8.6 | 8.5 | 8.6 |
| Countrymark H.O. 772 | High Oil | 10.1 | 10.0 | 10.1 | 9.2 | 9.2 | 9.2 |
| Countrymark H.O. 792 | High Oil | 10.2 | 9.6* | 9.9 | 8.9 | 8.5* | 8.7 |
| B73 x Mo17 | Low Protein | 9.1 | 8.8 | 9.0 | 8.4 | 8.0 | 8.2 |
| Bird B84 | Low Protein | 9.7 | 9.5 | 9.6 | 8.4 | 8.4 | 8.4 |
| Dairyland 1118 | Low Protein | 9.7 | 9.5 | 9.6 | 8.6 | 8.8 | 8.7 |
| IFS FG white | Food grade | 10.9 | 10.7 | 10.8 | 9.4 | 9.7 | 9.6 |
| LSD (0.05) | | | | 0.35 | | | 0.34 |

# Senescence in Maize: A Visual and Functional Comparison Between Old and New Hybrids

Oscar Valentinuz and M. Tollenaar
Department of Plant Agriculture
University of Guelph

Delayed leaf senescence has been credited to improved grain yield in maize (*Zea mays* L) in temperate regions. Loss of chlorophyll and decline of photosynthesis are the most common symptoms of visual and functional senescence, respectively. We carried out two field experiments where an old (Pride 5) and two more recent (Pioneer 3902 and Pioneer 3893) maize hybrids were compared according to their visual and functional symptoms of senescence. In Experiment 1, maize was grown at 1, 3.5 and 12 plants $m^{-2}$ and visual senescence of each leaf, i.e. the proportion of leaf turned yellow, was estimated each 10 d interval starting at silking. In Experiment 2, maize was grown in a field hydroponic system and functional senescence, i.e. carbon gas exchange (CER) on the first leaf above the leaf subtending the topmost ear, was measured 2 wk interval starting at silking. Visual senescence started approximately at silking in the old hybrid and four weeks after silking in more recent hybrids. After leaf area was normalized with respect to leaf area at silking, the rates of visual senescence for each density were similar in the old hybrid and differed in more recent hybrids. At maturity, visual senescence was less for leaves at the central portion of the plant. For all hybrids, functional senescence started after silking but progressed faster in the old hybrid. At six weeks after silking, CER had declined 70% in the old hybrid and 30% in more recent hybrids, although the measured leaves did have not visual symptoms of senescence. In conclusion, both visual and functional senescence contribute to the decline in rate of dry matter accumulation of maize during the grain filling period.

Mechanisms of Heterosis and Inbreeding Depression

Jode W. Edwards and Kendall R. Lamkey
Monsanto and Iowa State University

Single-locus quantitative genetic models of heterosis attribute the phenomenon to divergence in allele frequencies at loci exhibiting directional dominance. Likewise, inbreeding depression can be attributed to an increase in homozygosity at loci exhibiting directional dominance. However, these models are parameterized in terms of allele frequencies and specific types of gene action. We have examined heterosis in terms of general least-squares gene effects, with reference to a general reference population. Assuming two inbred parents derived from a common reference population, expected single-locus midparent heterosis was found to be $\delta_{ij} - \frac{1}{2}\left(\delta_{ii} + \delta_{jj}\right)$, where $\delta_{ii}$ and $\delta_{jj}$ are dominance deviations of randomly sampled inbred (F=1) genotypes and $\delta_{ij}$ is the noninbred dominance deviation of their offspring. By analogy, specific combining ability is a function of noninbred dominance deviations, (i.e., $\delta_{ij}$) and inbreeding depression is a function of inbred dominance deviations (i.e., $\delta_{ii}$ and $\delta_{jj}$). The model suggests heterosis can be partitioned into two components: specific combining ability and inbreeding depression. However, it was also found that the components are completely confounded without estimates of the general combining ability of the parents. On the basis of this model, general combining ability does not contribute to heterosis, and hence any improvement in grain yields of U.S. maize hybrids due to improved general combining ability is unrelated to heterosis in a population context. Only the specific combining ability component of heterosis contributes to $F_1$ performance. The model further highlights the importance of defining heterosis in the context of an appropriately defined reference population because components due to specific combining ability and inbreeding depression are completely confounded for individual crosses, but can be separated if the general combining abilities of the parents, in context of the reference population, are known.

# Breeding And Evaluating Open Pollinated Varieties Of Corn

Kendall R. Lamkey
USDA-ARS
Department of Agronomy
Iowa State University
Ames, IA 50011

There has been increasing interest among farmers in growing open-pollinated varieties (OPVs) of corn. At face value, this seems somewhat of a surprise, given the enormous success of hybrid breeders at improving yield and agronomics. The reasons that farmers want to switch from hybrids to OPVs are as varied as the farmers themselves. The reasons I hear most frequently are: 1) some farmers simply want to unplug from the agro-industrial complex; this can mean many things but typically farmers are looking for ways to reduce inputs and maximize profits; 2) many organic corn growers switch to OPVs as their only source of GMO free seed; 3) both organic and nonorganic farmers perceive and in some cases have data to suggest that overall feed value of OPVs is greater than for conventional hybrids. The term OPV has typically been reserved for referring to land races developed and maintained by farmers. I now use the term to refer to synthetics, composites and any other populations that have a random mating structure.

I have begun interacting with these farmers for several reasons. 1) The bulk of our applied breeding program is dedicated to population improvement. 2) It serves as a direct outlet for our germplasm and increases the visibility of the public breeding programs with the public. 3) The interactions with farmers fits well with our research objective of improving the grain quality of corn. And 4) it provides a opportunity to intereact with farmer breeders and collect germplasm.

Targeting farmers with the products of our recurrent selection programs requires little redirection of resources other than time. One of the biggest differences is that we need to pay more attention to population per se performance rather than the performance of the hybrids of these populations. So as I start new breeding programs, I focus on breeding methods that will improve the population per se. One of the frequent justifications given for maintaining public population improvement programs has been the maintenance of genetic diversity. The various recurrent selection populations provide a backup of improved diverse germplasm and the inbreds released from these programs are “novel” in the sense that they are not technically recycled from other inbreds thus increasing diversity as they are used by commercial breeders. However, it has been difficult to document public germplasm usage by commercial breeders. Documenting usage by farmers may also prove to be a challenge, but if farmers find something they like and know that public breeders are actively improving the germplasm, they may return to get new seed. In this way it may be possible to build a database of farmers who are growing OPVs and to increase support for public breeding programs in corn.

The most frequently cited traits that farmers want in an OPV are yield, standability, and grain quality. Similar to what they want in hybrids. The big difference is that these farmers are not yield maximizers. There goal is to maximize profits within the constraints of their farm system and life style. Some are willing to sacrifice yield and standability to get reduced input costs and improved grain quality.

There are several research challenges raised when working with farmers and OPVs. One is providing and collecting good reliable performance data. There has been little data available to compare the performance of hybrids with OPVs. These kinds of data are important because there are some misunderstandings about the differences in performance between OPVs and hybrids. There is also surprisingly little data on protein content and quality for OPVs and hybrids. This is primarily a function of the difficulty in collecting this type of data.

We have been conducting statewide trials evaluating our germplasm with both public and commercial hybrids for comparison purposes. The trials are grown in four row plots to minimize inter-plot competition. We grow three reps at each location and use a different plant density for each rep (16,000, 24,000, and 32,000 plants/acre). We have also increased seed of some of the more promising germplasm so that farmers who are interested can conduct on-farm experiments.

# Quantitative trait locus analysis of rind penetrometer resistance in four maize populations

S. A. Flint-Garcia, L. L. Darrah,
M. D. McMullen, and C. Jampatong

Plant Genetics Research Unit, ARS, USDA
and University of Missouri, Columbia, MO

Stalk lodging in maize (*Zea mays* L.) causes losses estimated to range from 5 to 20% annually in the United States. Selection for rind penetrometer resistance has proven useful in enhancing germplasm for stalk strength, and therefore improving stalk lodging resistance. We conducted quantitative trait locus (QTL) analyses for rind penetrometer resistance in four $F_{2:3}$ populations. The populations were constructed using MoSCSSS-High (selection for high rind penetrometer resistance), MoSCSSS-Low (selection for low rind penetrometer resistance), MoSQB-Low (selection for low stalk crushing strength), Mo47, and B73. Simple sequence repeat and restriction fragment length polymorphism markers were used to genotype individuals in each population and data was collected for rind penetrometer resistance, plant height, and ear height. Means combined over locations were used to conduct composite interval mapping using QTL Cartographer. Eight, nine, ten, and ten QTL were detected for rind penetrometer resistance in the four populations. Multilocus models of flanking markers determined by stepwise regression accounted for 35.7, 46,4, 48.7, and 52.6% of the phenotypic variance in the four populations. No QTL was in common across all four populations, one QTL was in common across three populations, and six were in common for two of the four populations. Differences in the QTL detected among the populations may be explained by lack of variation at a QTL between parents of a population, epistasis, or a lack of power to detect QTL with smaller effects. Possible candidate genes include *bm1* and *bm3* involved in lignin content, and *gl15* which has been implicated in timing of vegetative phase change.

# Inheritance of Gray Leaf Spot Resistance in Corn

Jason Cromley, Arnel R. Hallauer, and C. A. Martinson
Iowa State University

Gray leaf spot of corn, a disease caused by the fungus, *Cerecospora Zea-maydis* (Tehon and Daniels, 1925), has become prevalent throughout the U.S. Corn Belt. The increased frequency and severity of gray leaf spots have been related to the increase of conservation tillage practices, particularly no-till. Specific objectives of our research were (1) to estimate genetic effects for six generations (2 parents, $F_1$, $F_2$, and reciprocal backcrosses, BC1 and BC2) of five crosses by use of generation means analysis, and (2) to estimate the heritability and genetic gain from evaluation of 100 $S_1$ progenies of the cross B79 x B98. Six inbred lines that had not been studied for genetic effects that contribute resistance to gray leaf spot were included: B98, B99, and B100 were classified as resistant lines, and B79, N192, and MS1334 were classified as susceptible, based on data in Illinois. Our data, however, suggested that B79 was as resistant as B98, B99, and B100. The generation means portion of study was conducted at two central Iowa locations with artificial infection of gray leaf spot inoculum June 23, June 30, July 7, and July 14. All $S_1$ progenies at central Iowa location were inoculated on same dates as generation mean study, but infection at Crawfordsville was by natural inoculum. Disease assessments for percentage of leaf area affected were taken on August 5-6, 12-13, 19-20, and 27 for the two central Iowa locations for generation mean study. For variation among $S_1$ progenies, disease assessments were August 4, 11, 18, and 25 at Ames and August 14, 21, and 28 and September 3 and 10 for Crawfordsville.

Genetic effect estimates were calculated for each cross (B79 x N192, B98 x B79, B98 x B99, B99 x N192, and B100 x MS1334) for the six generations ($P_1$, $P_2$, $F_1$, $F_2$, BC1, and BC2) for each cross in a least squares regression analysis. Additive and dominance genetic effects were important for controlling gray leaf spot resistance from the generation mean analysis. Additive effects were of primary importance in the B79 x N192, B100 x MS1334, and B99 x N192 crosses with dominance effects important in all crosses. Genetic effects estimates were primarily negative for both additive and dominance effects, but dominance effects had greater negative values in all crosses. Based on percentages of gray leaf spot infection of parents and their $F_1$, it seems good level of resistance to gray leaf spot infection in one parent confers resistance in the $F_1$. For the three resistant by susceptible, the percentage of leaf area affected in the $F_1$ was less than for the more resistant parent. Broad-sense heritability estimate of 0.78 was obtained for $S_1$ progeny means from the (B79 x B98) $F_2$ population suggested additive effects being of primary importance. A predicted genetic gain estimate of 5.1 per cycle suggests that selection should be effective to increase the level of gray leaf spot resistance. B79 and B98 have similar levels of resistance, but they must have different combinations of alleles and genes that contribute to resistance. Heritability (0.78) and predicted genetic gain (5.1) of the (B79 x B98) $F_2$ population suggests that the level of gray leaf spot resistance can be increased within crosses of lines that have above average resistance.

Minutes of NCR-167

**Ames, Iowa State University**

**February 5-6, 2001**


**Administrative Advisor**:
Dr. Gary Heichel
University of Illinois
Turner Hall
1102 S. Goodwin Ave.
Urbana, IL 61801

**Chair**:
Dr. E. A. Lee
University of Guelph
Dept. of Crop Science
Guelph, Ontario
Canada N1G 2W1

**Secretary**:
Dr. Arnel Hallauer
Iowa State University
1505 Agronomy Hall
Ames, IA 50011-1010


**Members in Attendance**:
John E. Ayers – Pennsylvania; Rex Bernardo – Minnesota; Javier Betran – Texas; Marcelo Carena – North Dakota; James Coors – Wisconsin; Larry Darrah – USDA/ARS, Missouri; James Dodd – Industrial Representative; Arnel Hallauer – Iowa; Robert Lambert – Illinois; Kendall Lamkey – USDA/ARS, Iowa; Elizabeth Lee – Ontario; Richard Pratt – Ohio; Zeno Wicks III – South Dakota (Appendix A).

**Members Absent**:
James Holland – USDA/ARS, North Carolina; M. Kang – Louisiana.

**Guests**:
Forty-four others were in attendance, including 16 graduate students.

The annual meeting of the NCR-167 was held at the Gateway-Holiday Inn, Ames, IA on February 5-6, 2001. The meeting site and date were determined at the 2000 annual business meeting, based on location and facilities available. Elizabeth Lee, Chair of NCR-167, and Kendall Lamkey, Chair of local arrangements for NCR-167, planned and coordinated the 2001 annual meeting of NCR-167.

Dr. Lee called the meeting to order at 8:00 AM, February 5, 2001. There were a few opening remarks and a slight revision of the printed program. Generally, 30 minutes were allowed for each presentation and discussion. Three one-half day sessions were scheduled for the research reports (Appendix B).

Dr. Lee called the business meeting to order at 5:15 PM, February 5, 2001.

The agenda was reviewed.

- Approve agenda
- Approve minutes of 2000 NCR-167 meeting
- NCR-167 Administrative Advisor Report
- Treasurer's Report by Kendall Lamkey

- Meeting Place Committee report by Kendall Lamkey
- Nominating subcommittee report by Larry Darrah
- Germplasm Release subcommittee report by James Coors
- Subcommittee report for uniform tests for 100-300 maturity group by Elizabeth Lee
- Subcommittee report for uniform tests for 400-600 maturity group by Zeno Wicks
- Subcommittee report for uniform tests for 700-800 maturity group by Rex Bernardo
- Other business
- Adjourn

A motion was made and seconded to approve the agenda. Motion was passed unanimously.

Dr. Gary Heichel, Administrative Advisor, presented a report on the status of NCR-167 for renewal. He indicated the requisition for extension of NCR-167 was approved by NCA-1. Continuation of NCR-167 received a high rating, and final action on the extension for NCR-167 will be at the NCR Directors meeting in March 2001. The extension was for 5 years (October 2001-September 2006) rather than 4 years. He reported that method of reporting, annual reports, web-sites, etc. are very important to NCA-1 committee. NCA-1 desired greater uniformity in reporting the meetings and structure of the minutes. NCR Directors wish to have minutes of the meetings within 30 days.

Dr. Heichel made the observation that the NCR-167 program focuses around voluntary reports. NCR Directors emphasized that all official representatives should present an oral report, or at least, a written report to include in the minutes of the meeting. It would be helpful in future years if the minutes included reports from each of the official representatives. He emphasized that linkages and synergism were very important goals, and that multi-state and industry participation were desirable to enhance the goals. Linkages are important because of the Government Performance and Results Act. In closing, he indicated the website for NCR-167 <http://corn2.agron.iastate.edu/ncr167/> is excellent, viewed as a model for other NCR committees, and communicates what NCR-167 is doing internationally. Minutes should be sent to Gary Heichel, Administrative Advisor, within 30 days.

Kendall Lamkey presented treasurer's report. Registration fees were $40 for all participants and $20 for graduate students. He was not sure if registration fees would cover all costs incurred for the meetings. An amount of $1,425.82 was reimbursed to Iowa State University for the balance of monies left over from the 8th Interregional Corn Conference held in Baltimore, 2000. The check of $1,425.82 was deposited in account designated for NCR-167. Funds for NCR-167 can be either deposited or expended from this account. Zeno Wicks moved to accept treasurer's report; James Coors seconded the motion; motion was passed unanimously.

Meeting place subcommittee report was presented by Kendall Lamkey. He reported that 2002 annual meeting of NCR-167 will be held in conjunction with a symposium to be held at Urbana, IL in June 2002. Meetings for 2003 are scheduled for February 17-18 in Madison, WI. Greater details of the 2002 annual meetings are included in other business. A motion was made and seconded to approve the report of meeting place subcommittee. The motion was approved unanimously.

Nominating subcommittee report was presented by Larry Darrah. Several changes were proposed: Zeno Wicks and Elizabeth Lee become chair and past chair, respectively, of Executive Committee; R. Bernardo leaves Executive Committee and David Willmot added to Executive Committee for 2001-2004 term; Kendall Lamkey will replace Arnel Hallauer as Recording Secretary; James Coors replaces Kendall Lamkey as chair of meeting place subcommittee; David Willmot replaces Arnel Hallauer on Germplasm Release subcommittee; Rex Bernardo was added to the 100-300 maturity group subcommittee; John Ayers replaced Arnel Hallauer on 400-600 matjurity group subcommittee; and Javier Betran replaced Rex Bernardo on the 700-800 maturity group subcommittee. There were no further nominations from the floor. Motion was made and seconded to approve nominations. Motion was passed unanimously.

The Germplasm Release subcommittee report was given by James Coors. A complete report was not available because of either late submissions or new submissions will be submitted. A final report was prepared when complete information was available (Appendix F).

Elizabeth Lee, chair 100-300 maturity group subcommittee, presented the report (Appendix C). Trials were conducted at six locations; data were obtained at four locations (two, Ontario; one New York; and one South Dakota) in 2000. Testcross seed for 24 lines was produced in 2001 for testing at 5 or 6 locations in 2002. There was some discussion that each cooperator produce testcross seed for own specific lines. After discussion, it was decided that may not be feasible because of differences that may occur for seed quality and proper nick with testers. Testcross seed will be produced at one location.

James Coors presented report for the 400-600 maturity group subcommittee (Appendix D). A trial was not conducted in 2000. Testcross seed for 13 lines were produced in Madison, WI in 2000 for testing in 2001.

Rex Bernardo presented report for the 700-800 group subcommittee (Appendix E). Testcross seed of 22 experimental lines was produced at Ames, IA in 1999 for test in 2000. Lines testcrossed were from five states. The trials conducted in 2000 included trials in Nebraska, Ohio, Pennsylvania, Indiana, Kentucky, Missouri, Illinois, Iowa, and Delaware. IL6254 (testcrossed to LH185) had the best yield and superior agronomic performance across locations. Testcross seed for 21 lines (Iowa, Ohio, Pennsylvania, and Delaware) was produced in 2000 at Ames, Iowa for test in 2001.

Other Business:
John Dudley announced plans for a symposium to be held at Urbana, IL, June 16-18, 2002. One-hundred years of selection will have been completed in the Illinois protein and oil selection experiments and it was proposed that a symposium be held to report the results of selection for the long-term selection studies at Illinois and other long-term selection studies in plants. It was suggested that the focus of the 2002 NCR-167 meetings should be with the planned symposium on long-term selection studies. Some preliminary planning has been done and the tentative dates for the symposium are June 16-18, 2002. Members of the steering committee to plan the symposium include Rex Bernardo, James Coors, Kendall Lamkey, and John Dudley (Chair).

Larry Darrah moved and Bob Lambert seconded that the 2002 NCR-167 annual meeting be held at the time of the planned symposium at the University of Illinois. There was further discussion that a good idea for NCR-167 because of synergism. Discussion relative to potential speakers, registration fees, publicity, sources for possible publication of proceedings, facilities, etc. were items that will need to be resolved in the near future. Motion was passed unanimously.

James Coors confirmed that the 2003 NCR-167 meetings would be held in Madison, WI February 17-18, 2003.

The business meeting was adjourned at 6:10 PM. These minutes and other committee information will be posted on the website <http://corn2.agron.iastate.edu/ncr167/>.

**Appendix A**
**NCR-167**
**North Central Regional Corn Breeding Meetings**

Administrative Advisor

Dr. Gary Heichel
University of Illinois

Executive Committee

| | |
|---|---|
| Zeno W. Wicks III, Chair | 1999-2002 |
| E. A. Lee, Past Chair | 1998-2001 |
| M. Carena | 2000-2003 |
| D. Willmot | 2001-2004 |
| J. Dodd, Industry Representative | |
| K. R. Lamkey, Recording Secretary | |

Subcommittees

1. Meeting Place:
   R. C. Pratt, W. K. Russell, J. G. Coors (Chair)

2. Nominating
   M. Carena, K. R. Lamkey, Z. W. Wicks III, L. L. Darrah (Chair)

3. Germplasm Release
   W. F. Tracy, L. L. Darrah, D. Willmot, J. G. Coors (Chair)

4. Uniform Tests for 100-300 Maturity Group
   R. Bernardo, M. Carena, Z. W. Wicks III, E. A. Lee (Chair)

5. Uniform Tests for 400-600 Maturity Group
   J. G. Coors, E. A. Lee, J. E. Ayers, Z. W. Wicks III (Chair)

6. Uniform Tests for 700-800 Maturity Group
   J. Betran, W. K. Russell, R. C. Pratt (Chair)

Official Representatives
NCR-167 Technical Committee

| Name | Organization | Address | Phone/Fax/Email |
|---|---|---|---|
| Heichel, Gary H. | University of Illinois | Dep. of Crop Science<br>AW-101<br>1102 S. Goodwin Ave.<br>Urbana, IL 61801 | PH: 217-333-3420<br>FAX: 217-333-9817<br>gheichel@uiuc.edu |
| Ayers, John E. | Pennsylvania State University | Dep. of Plant Pathology<br>308 Buckhout Laboratory<br>University Park, PA 16802 | PH: 814-865-7776<br>FAX: 814-863-7217<br>jea@psu.edu |
| Bernardo, Rex | University of Minnesota | Dep. of Agronomy & Plant Genetics<br>411 Borlaug Hall<br>1991 Upper Buford Circle<br>St. Paul, MN 55108-6026 | PH: 612-625-6282<br>FAX: 612-625-1268<br>berna022@umn.edu |
| Betran, Javier | Texas A&M University | Dep. of Soil & Crop Sciences<br>College Station, TX 77843-2474 | PH: 979-845-3469<br>FAX: 979-862-1931<br>Javier-betran@tamu.edu |
| Carena, Marcelo J. | North Dakota State University | Dep. of Plant Sciences<br>PO Box 5051<br>Fargo, ND 58105 | PH: 701-231-8138<br>FAX: 701-231-8474<br>marcelo_carena@ndsu.nodak.edu |
| Coors, James G. | University of Wisconsin | Department of Agronomy<br>1575 Linden Drive<br>Madison, WI 53706 | PH: 608-262-7959<br>FAX: 608-262-5217<br>jgcoors@facstaff.wisc.edu |
| Darrah, Larry L. | USDA-ARS | University of Missouri<br>110A Curtis Hall<br>Columbia, MO 65211 | PH: 573-882-2349<br>FAX: 573-884-7850<br>darrahl@missouri.edu |
| Dodd, James L. | Professional Seed Research, Inc. | 7 South 437 Dugan Road<br>Sugar Grove, IL 60554 | PH: 630-466-1060<br>FAX: 630-466-1068<br>psr@psrcorn.com |
| Hallauer, Arnel R. | Iowa State University | Department of Agronomy<br>1505 Agronomy Hall<br>Ames, IA 50011-1010 | PH: 515-294-7823<br>FAX: 515-294-3163<br>hallauer@iastate.edu |

| | | | |
|---|---|---|---|
| Holland, James B. | USDA-ARS | North Carolina State University<br>Dep of Crop Science<br>Box 7620<br>Raleigh, NC 27695-7620 | PH: 919-515-4087<br>FAX: 919-515-7959<br>James_Holland@ncsu.edu |
| Lambert, Robert J. | University of Illinois | Dep. of Crop Science<br>S-110 Turner Hall<br>1102 S. Goodwin Ave.<br>Urbana, IL 61801 | PH: 217-333-9642<br>FAX: 217-333-9817<br>rjlambert@uiuc.edu |
| Lamkey, Kendall R. | USDA-ARS | Iowa State University<br>Department of Agronomy<br>Ames, IA 50011-1010 | PH: 515-294-7826<br>FAX: 515-294-9359<br>krlamkey@iastate.edu |
| Lee, Elizabeth | University of Guelph | Dep. of Crop Science<br>Guelph, ON N1G 2W1<br>Canada | PH: 519-824-4120<br>ext. 3360<br>FAX: 519-763-8933<br>lizlee@uoguelph.ca |
| Pratt, Richard C. | OSU/OARDC | Dep. of Horticulture & Crop Sciences<br>1680 Madison Ave.<br>Wooster, OH 44691 | PH: 330-263-3972<br>FAX: 330-263-3887<br>pratt.3@osu.edu |
| Wick, III, Zeno W. | South Dakota State University | Dep. of Plant Science<br>NPB 247, Box 2140-C<br>Brookings, SD 57006-2141 | PH: 605-688-5542<br>FAX: 605-688-4452<br>wicksz@mg.sdstate.edu |

**Appendix B**

North Central Region Corn Breeding Meetings (NCR-167)
February 5-6, 2001
Gateway Holiday Inn, Ames, Iowa

AGENDA

**Monday, February 5**

| | | |
|---|---|---|
| 8:00-8:15 | | Opening remarks and general announcements |
| 8:15-8:45 | Javier Betran<br>Dept. of Soil & Crop Sciences<br>Texas A & M University | Texas A & M corn breeding and genetics program |
| 8:45-9:15 | James G. Coors<br>Department of Agronomy<br>University of Wisconsin | Breeding for improved nutritional value and forage yield in silage corn |
| 9:15-9:45 | Elizabeth Lee<br>Dept. of Plant Agriculture<br>University of Guelph | Impact of recombination and biomass selection on inbred line development |
| 9:45-10:15 | Break | |
| 10:15-10:45 | Travis Frey<br>Department of Agronomy<br>University of Wisconsin | Development of the Wisconsin quality synthetic, a breeding population for silage corn |
| 10:45-11:15 | Trevor Doerksen<br>Dept. of Plant Agriculture<br>University of Guelph | Impact of recurrent selection on GCA and SCA in Guelph populations |
| 11:15-11:45 | Paulo Guimaraes<br>Department of Agronomy<br>Iowa State University | Changes in RFLP allele and genotypic frequencies following half-sib and S2 selection in BSSS |
| 11:45-1:00 | Lunch | |
| 1:00-1:30 | Slobodan Trifunovic<br>Maize Research Institute<br>Belgrade, Yugoslavia | US and Yugoslavian sources of favorable alleles for maize hybrids improvement |
| 1:30-2:00 | Rex Bernardo<br>Department of Agronomy<br>University of Minnesota | North American Study on essential derivation in maize |
| 2:30-2:45 | Rich Pratt<br>Dept. of Horticulture & Crop Sci.<br>Ohio State University | Talk about something to do with corn |

| | | |
|---|---|---|
| 2:45-3:15 | Break | |
| 3:15-3:45 | Oscar Valentinuz<br>Dept. of Plant Agriculture<br>University of Guelph | Senescence in maize: a visual and functional comparison between old and new hybrids |
| 3:45-4:15 | Jode W. Edwards<br>Monsanto Company<br>Savoy, Illinois | Mechanisms of heterosis and inbreeding depression |
| 4:15-4:45 | Kendall Lamkey<br>USDA-ARS,<br>Iowa State University | Evaluation and breeding of open pollinated varieties for farmers |
| 5:00-5:30 | Business Meeting | |

**Tuesday, February 6**

| | | |
|---|---|---|
| 8:00-8:15 | | Opening remarks and general announcements |
| 8:15-8:45 | Patrick Schnable<br>Department of Agronomy<br>Iowa State University | Invited Talk:<br>Functional genomics in maize |
| 8:45-9:15 | Jean-Luc Jannink<br>Department of Agronomy<br>Iowa State University | Using interconnected populations to find quantitative trait loci |
| 9:15-9:45 | Sherry Flint-Garcia<br>Department of Agronomy<br>University of Missouri | Quantitative trait locus analysis of rind penetrometer resistance in four maize populations |
| 9:45-10:15 | Arnel R. Hallauer<br>Department of Agronomy<br>Iowa State University | Inheritance of gray leaf spot resistance in corn |

**Appendix C**

NCR-167 Uniform 100-300 Maturity Trials - 2000

Trials were conducted at six locations (Elora, Ontario; Ottawa, Ontario; Morrisville, NY; Brookings, SD; Watertown, SD; Fargo, ND) in 2000 from modified single-cross seed produced in 1999. The Ottawa location was unable to harvest their trial this year because of excessively high grain moistures (>35%) in late November. Two related-line testers were used: LH176 x LH177 and LH300 x LH301. Table 1 contains the combined results from five of the locations as well as individual location results for grain yield (bu/ac and mg/ha), % moisture, % stalk lodging, and performance index (bu/ac / % moisture). Included in the trial as checks were 6 commercial hybrids.

Testcross seed for 2001 trials was produced in Brookings SD for 5 inbred lines. Crosses and approximate seed supply for 2000 entries are listed below.

| Inbred | Tester | Amt. Seed |
|---|---|---|
| CG107 | LH176 x LH177 | 2530 |
| CG109 | LH176 x LH177 | 3193 |
| CO328 | LH176 x LH177 | 3400 |
| CO365 | LH176 x LH177 | 3472 |
| CO386 | LH176 x LH177 | 2529 |
| CO388 | LH176 x LH177 | 2675 |
| CO427 | LH176 x LH177 | 3944 |
| CO429 | LH176 x LH177 | 2839 |
| CO430 | LH176 x LH177 | 2494 |
| CO433 | LH176 x LH177 | 3776 |
| CO435 | LH176 x LH177 | 3055 |
| CO438 | LH176 x LH177 | 4895 |
| ND96_12 | LH176 x LH177 | 2065 |
| ND97_23 | LH176 x LH177 | 3610 |
| ND97_30 | LH176 x LH177 | 3598 |
| ND97_32 | LH176 x LH177 | 3344 |
| ND97_50 | LH176 x LH177 | 2709 |
| ND97_6W | LH176 x LH177 | 3081 |
| ND98_95 | LH176 x LH177 | 1489 |
| ND98_97 | LH176 x LH177 | 3311 |
| NY32311C | LH176 x LH177 | 2601 |
| NY73118 | LH176 x LH177 | 3313 |
| NYA665 | LH176 x LH177 | 2844 |
| CO429 | LH176 x LH177 | 4001 |

| Inbred | Tester | Amt. Seed |
|---|---|---|
| CG107 | LH300 x LH301 | 2351 |
| CG109 | LH300 x LH301 | 3133 |
| CO328 | LH300 x LH301 | 3197 |
| CO365 | LH300 x LH301 | 3167 |
| CO386 | LH300 x LH301 | 2279 |
| CO388 | LH300 x LH301 | 2115 |
| CO427 | LH300 x LH301 | 2993 |
| CO429 | LH300 x LH301 | 2174 |
| CO430 | LH300 x LH301 | 1771 |
| CO433 | LH300 x LH301 | 2682 |
| CO435 | LH300 x LH301 | 2995 |
| CO438 | LH300 x LH301 | 1701 |
| ND96_12 | LH300 x LH301 | 2650 |
| ND97_23 | LH300 x LH301 | 3314 |
| ND97_30 | LH300 x LH301 | 3423 |
| ND97_32 | LH300 x LH301 | 3003 |
| ND97_50 | LH300 x LH301 | 2993 |
| ND97_6W | LH300 x LH301 | 2409 |
| ND98_135 | LH300 x LH301 | 1632 |
| ND98_95 | LH300 x LH301 | 2522 |
| NY32311CA | LH300 x LH301 | 3641 |
| NY73118 | LH300 x LH301 | 2372 |
| NYA665ECB1 | LH300 x LH301 | 1867 |
| NY73118 | LH300 x LH301 | 3961 |
| CO429 | LH300 x LH301 | 3585 |
| CG108 | LH300 x LH301 | 1425 |

100-300 Maturity Group Sub-committee:

M. Carena<br>
Z. W. Wicks III<br>
E. A. Lee, chair

Table 1. NCR-167 Uniform 100-300 AES Maturity Trials.

| | Combined | | Elora, Ontario | | | | Morrisville, NY | | |
|---|---|---|---|---|---|---|---|---|---|
| Pedigree | Moisture | Grain yield | Moisture | Grain yield | Stalk lodging | Test wt. | Moisture | Grain yield | Stalk lodging |
| | (%) | (bu/ac) | (%) | (bu/ac) | (%) | (kg/hl) | (%) | (bu/ac) | (%) |
| CG104 x (LH176xLH177) | 17.8 | 93.4 | 22.0 | 96.3 | 1.0 | 49.1 | 22.5 | 120.6 | 0 |
| CG104 x (LH300xLH301) | 17.7 | 83.0 | 21.6 | 81.7 | 3.1 | 48.4 | 23.4 | 88.0 | 0 |
| CG105 x (LH176xLH177) | 18.1 | 106.6 | 22.8 | 101.8 | 1.0 | 50.4 | 24.2 | 133.8 | 0 |
| CG105 x (LH300xLH301) | 17.2 | 91.2 | 20.6 | 89.0 | 6.3 | 51.7 | 21.5 | 114.1 | 0 |
| CG106 x (LH176xLH177) | 19.6 | 100.8 | 26.6 | 104.1 | 2.6 | 49.2 | 26.0 | 117.3 | 2 |
| CH106 x (LH300xLH301) | 17.6 | 83.8 | 20.2 | 83.4 | 7.3 | 51.2 | 25.8 | 104.1 | 0 |
| SD 98:0211 x (LH300xLH301) | 26.2 | 100.8 | 37.0 | 93.1 | 2.1 | 48.8 | 33.6 | 111.2 | 0 |
| SD 98:0243 x (LH300xLH301) | 22.3 | 80.9 | 28.5 | 77.1 | 1.6 | 49.7 | 27.9 | 107.5 | 0 |
| Pride K115 | | | | | | | | | |
| Pickseed 2459 | | | | | | | | | |
| Cargill 1877 | 18.7 | 104.5 | 23.2 | 82.6 | 3.1 | 54.3 | 22.9 | 127.8 | 0 |
| Pioneer 39k38 | 19.5 | 111.6 | 27.9 | 106.8 | 4.2 | 49.4 | 22.8 | 135.2 | 0 |
| Pioneer 39D81 | | | 23.8 | 110.6 | 4.7 | 50.8 | 24.2 | 151.4 | 0 |
| N.K. N25-D7 | 19.8 | 115.1 | 24.3 | 100.2 | 0.0 | 49.2 | 24.1 | 132.0 | 0 |
| **GRAND MEAN** | **19.5** | **97.4** | **24.9** | **93.9** | **3.1** | **50.2** | **24.9** | **120.2** | **0** |
| **CV** | **10.0** | **8.3** | **4.1** | **7.9** | **93.4** | **1.5** | **8.0** | **14.5** | **357** |
| **LSD** | **2.1** | **8.7** | **1.4** | **10.4** | **4.0** | **1.0** | **3.4** | **29.6** | **1** |

Table 1. NCR0167 Uniform 100-300 AES Maturity Trials, continued.

| | Brookings, SD | | Watertown, SD | | Fargo, ND | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Grain | | Grain | | Grain | Lodging | | Dropped | Days to pollen | Days to | Height | | Test |
| Pedigree | Moisture | yield | Moisture | yield | Moisture | yield | Root | Stalk | ears | shed | silk | Plant | Ear | wt. |
| | (%) | (bu/ac) | (%) | (bu/ac) | (%) | (bu/ac) | (%) | (%) | (%) | (days) | (days) | (cm) | (cm) | (lb/bu) |
| CG104 x (LH176xLH177) | 15.7 | 74.9 | 13.3 | 73.4 | 15.6 | 102.0 | 2.6 | 2.6 | 0.0 | 68.3 | 70.3 | 185.7 | 90.2 | 54.3 |
| CG104 x (LH300xLH301) | 15.7 | 65.9 | 13.5 | 75.2 | 14.2 | 104.4 | 2.5 | 10.9 | 0.0 | 68.3 | 70.0 | 204.7 | 98.8 | 54.9 |
| CG105 x (LH176xLH177) | 15.2 | 78.7 | 13.6 | 94.9 | 14.7 | 123.9 | 7.7 | 0.0 | 0.0 | 68.3 | 70.0 | 192.3 | 92.5 | 55.0 |
| CG105 x (LH300xLH301) | 15.2 | 75.2 | 13.7 | 73.3 | 14.9 | 104.5 | 1.2 | 6.0 | 1.0 | 68.3 | 69.0 | 201.5 | 95.5 | 56.6 |
| CG106 x (LH176xLH177) | 14.3 | 89.2 | 13.7 | 90.6 | 17.2 | 102.8 | 27.8 | 1.1 | 1.1 | 68.3 | 70.7 | 197.0 | 92.0 | 54.4 |
| CG106 x (LH300xLH301) | 13.9 | 77.9 | 13.3 | 73.9 | 14.9 | 79.6 | 18.8 | 2.2 | 0.0 | 68.7 | 71.3 | 207.2 | 101.3 | 55.9 |
| SD 98:0211 x (LH300xLH301) | 20.4 | 91.8 | 15.4 | 96.2 | 24.6 | 111.5 | 2.3 | 2.3 | 0.0 | 70.0 | 72.3 | 205.0 | 91.3 | 54.2 |
| SD 98:0243 x (LH300xLH301) | 19.4 | 67.5 | 14.7 | 67.5 | 20.8 | 84.7 | 0.0 | 0.0 | 0.0 | 70.0 | 72.0 | 203.0 | 88.4 | 56.8 |
| Pride K115 | 16.5 | 110.2 | 14.2 | 113.9 | | | | | | | | | | |
| Pickseed 2459 | 16.2 | 107.8 | 13.6 | 97.1 | | | | | | | | | | |
| Cargill 1877 | 16.6 | 107.3 | 14.6 | 100.1 | 16.2 | 104.6 | 0.0 | 1.0 | 0.0 | 69.0 | 69.7 | 184.3 | 79.2 | 60.9 |
| Pioneer 39k38 | 16.6 | 100.4 | 14.1 | 91.7 | 16.2 | 123.7 | 2.1 | 4.1 | 0.0 | 68.3 | 69.3 | 199.8 | 99.5 | 55.0 |
| Pioneer 39D81 | | | | | 17.9 | 141.1 | 0.0 | 2.8 | 0.0 | 68.0 | 68.7 | 195.5 | 95.7 | 55.2 |
| N.K. N25-D7 | 19.1 | 108.3 | 14.3 | 104.1 | 17.2 | 130.7 | 1.0 | 1.0 | 0.0 | 71.7 | 72.7 | 211.8 | 104.7 | 55.6 |
| **GRAND MEAN** | **16.5** | **88.9** | **13.9** | **88.6** | **17.0** | **109.5** | **5.5** | **2.8** | **0.2** | **68.9** | **70.5** | **199.0** | **94.1** | **55.7** |
| **CV** | **3.2** | **13.7** | **3.1** | **10.8** | **4.10** | **14.80** | **235.5** | **177.4** | **434.2** | **1.3** | **1.8** | **2.60** | **4.30** | **1.2** |
| **LSD** | **2.1** | **20.45** | **0.7** | **16.2** | **1.20** | **27.40** | **21.9** | **8.5** | **1.3** | **1.5** | **2.1** | **8.70** | **6.80** | **1.1** |

**Appendix D**

NCR-167 Uniform 400-600 Maturity Trials

No grain yield trials were conducted in 2000 because of the limited number of testcrosses available. New testcrosses were made in the 2000 nursery in Madison, WI for testing in 2001. Seed quantities were low, particularly for LH185 topcrosses. The crosses and approximate seed supply are provided below.

| Inbred | Tester | Amount of seed |
|---|---|---|
| | | |
| BS21(R)C6-8-1-1-1-1 | LH185 | 500 |
| BS21(R)C6-59-1-2-1-2 | LH185 | 400 |
| BS22(R)C6-240-2-1-1 | LH185 | 0 |
| ND96-6 | LH185 | 1100 |
| ND98-7W | LH185 | 0 |
| ND98-95 | LH185 | 1100 |
| BS21(R)C6-8-1-1-1-1 | LH198 | 500 |
| BS21(R)C6-59-1-2-1-2 | LH198 | 1450 |
| BS22(R)C6-240-2-1-1 | LH198 | 1450 |
| ND96-6 | LH198 | 2000 |
| ND98-7W | LH198 | 0 |
| ND98-95 | LH198 | 2300 |
| W53090-1-1-6-1-1 | LH198 | 3000 |

J. G. Coors, E. A. Lee, A. R. Hallauer, Z. W. Wicks III (Chair)

**Appendix E**
Testcross Seed Produced at Ames, Iowa
2000 for Test in 2001 for 700-800 Maturity Group

| Inbred Line | Source | Tester |
|---|---|---|
| BS16(HI)C0-253-1-1-1-1-1-1-1-1 | 4879-80 | LH198 |
| BS11(S2)C4-198-1-1-1-2-1-1-1 | 4883-84 | " |
| BS26(S-H)C4-42-1-1-1 | 4887-88 | " |
| OhSyn3 E6-5-4-2-3 | 4864 or 4872 | " |
| OhSyn3 E6-5-1-3-5 | 4865 or 4873 | " |
| PA95-77 | 4867-4875 | " |
| PA95-82 | 4868-4876 | " |
| PA95-92 | 4869-4877 | " |
| B97/B95-001-1-1-1 | 5714-15 | " |
| B97/B95-094-1-1-1-1-1-1 | 5716-17 | " |
| B97/B95-107-1-1-1-1-1-1 | 5718-19 | " |
| B97/B99-047-1-1-1-1-1-2 | 5724-25 | " |
| | | |
| BS13(S)C7-226-1-1-1-1 | 5726-27 | LH185 |
| BS13(S)C7-032-1-1-1-1 | 5728-29 | " |
| BS10(FR)C12-3834-15-1-1 | 5730-31 | " |
| PA95-46 | 5687 or 5701 | " |
| PA95-60 | 5689 or 5702 | " |
| PA95-72 | 5690 or 5704 | " |
| DE(BSSS)C2-68-1-2-1-1 | 5691 or 5705 | " |
| DE(BSSS)C2-420-3-2-1-1 | 5695 or 5709 | " |
| DE(BSSS)C2-612-4-3-1-1 | 5751-5752 | " |

Adequate quantities of seed were produced for 12 lines crossed to LH198 and nine lines crossed to LH185 for testing at 6 to 8 locations in 2001.

J. Betran
W. K. Russell
R. C. Pratt, Chair

# 2000 Yield Trials, 700-800 Maturity Corn

A total of 22 experimental inbreds were testcrossed to either LH198 (Holden's Foundation Seeds inbred derived from Iowa Stiff Stalk Synthetic, BSSS) or LH185 (non-BSSS Holden's Foundation Seeds inbred) in 1999. Seven experiment inbreds were from Iowa State University, seven from Pennsylvania State University, four from the University of Illinois, two from The Ohio State University, and two from the University of Missouri-Columbia. Replicated yield trials were subsequently conducted in 2000 at participating experiment stations in Pennsylvania, Ohio, Indiana, Kentucky, Illinois, Iowa (two locations), Missouri, and Nebraska. Different check hybrids were grown and different sets of traits were measured at each location. The commercial check hybrids comprised LH198 x LH185, LH198 x LH82, and five Pioneer® brand hybrids.

On average, grain yield within a location was about 25% higher among the commercial check hybrids than among the testcrosses of the experimental inbreds. Grain moisture was about 1.6 percentage points lower among the commercial hybrids than among the testcrosses. Among the experimental inbreds, IL6254 (testcrossed to LH185) had the best yield along with superior agronomic performance across locations.

R. C. Pratt, Subcommittee Chair
R. Bernardo
W. K. Russell

## 2000 Yield Tests, 700-800 Maturity Corn

| Hybrid | | Grain yield (Mg/ha) | | | | | | | | | Grain moisture (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PA | OH | IN | KY | IL | IA-1 | IA-2 | NE | **Mean** | PA | OH | IN | KY | IL | IA-1 | IA-2 | NE | **Mean** |
| BS13(S)C6-7726-1 | x LH185 | 4.64 | 4.98 | 3.52 | 12.00 | 10.90 | 7.45 | 7.38 | 13.47 | **8.04** | 21.6 | 31.4 | 21.0 | 21.2 | 14.3 | 18.1 | 12.8 | 11.9 | **19.0** |
| BS13(S)C6-7693-1 | x LH185 | 4.57 | 2.64 | 3.14 | 9.30 | 6.30 | 6.63 | 6.19 | 7.58 | **5.79** | 21.4 | 32.3 | 23.7 | 20.2 | 18.3 | 19.1 | 13.7 | 13.6 | **20.3** |
| BS13(S)C6-7712-1 | x LH185 | 7.22 | 4.04 | 5.61 | 12.50 | 11.10 | 8.97 | 6.19 | 13.71 | **8.67** | 20.9 | 31.9 | 21.7 | 19.9 | 15.4 | 19.6 | 14.1 | 13.1 | **19.6** |
| BS10(FR)C10-3556-1 | x LH185 | 7.74 | 6.42 | 6.29 | 7.70 | 9.60 | 9.62 | 7.62 | 12.34 | **8.42** | 20.2 | 30.9 | 22.5 | 20.5 | 13.2 | 18.8 | 13.2 | 12.6 | **19.0** |
| IL3163 | x LH185 | 8.68 | 5.16 | 5.41 | 10.50 | 8.30 | 6.86 | 7.09 | 12.31 | **8.04** | 17.6 | 27.5 | 20.5 | 19.2 | 14.4 | 17.6 | 13.2 | 12.7 | **17.8** |
| IL3183 | x LH185 | 5.96 | 4.52 | 4.84 | 13.80 | 11.50 | 10.96 | 8.76 | 14.14 | **9.31** | 19.3 | 30.4 | 21.0 | 19.2 | 13.8 | 18.6 | 13.3 | 11.9 | **18.4** |
| IL6254 | x LH185 | 9.78 | 5.75 | 6.79 | 13.50 | 11.20 | 10.54 | 8.90 | 14.30 | **10.09** | 18.8 | 27.9 | 20.8 | 20.2 | 11.4 | 16.4 | 12.8 | 12.5 | **17.6** |
| IL6294 | x LH185 | 8.00 | 5.11 | 5.16 | 14.10 | 11.80 | 9.28 | 9.10 | 13.44 | **9.50** | 21.3 | 31.3 | 23.5 | 21.3 | 14.9 | 18.3 | 13.3 | 13.7 | **19.7** |
| MO97:953-72 | x LH185 | 6.60 | 5.43 | 5.85 | 12.40 | 10.90 | 9.11 | 8.09 | 12.45 | **8.85** | 19.7 | 28.4 | 21.1 | 19.7 | 13.9 | 17.2 | 13.3 | 12.5 | **18.2** |
| Oh512(C0)97-190 | x LH185 | 3.46 | 4.07 | 4.34 | 7.60 | 8.80 | 8.33 | 5.58 | 12.89 | **6.88** | 21.6 | 30.7 | 22.9 | 20.5 | 14.4 | 20.1 | 13.8 | 15.1 | **19.9** |
| PA95-1 | x LH185 | 6.26 | 5.38 | 4.28 | 11.20 | 10.10 | 8.54 | 9.15 | 12.43 | **8.42** | 19.4 | 26.1 | 21.4 | 19.3 | 14.6 | 16.2 | 13.0 | 12.3 | **17.8** |
| PA95-8 | x LH185 | 8.25 | 4.58 | 4.91 | 9.10 | 10.30 | 8.63 | 7.62 | 10.19 | **7.95** | 20.4 | 33.5 | 23.1 | 20.8 | 17.7 | 22.2 | 14.2 | 13.4 | **20.7** |
| PA95-40 | x LH185 | 7.29 | 4.65 | 4.65 | 12.30 | 11.40 | 10.10 | 8.15 | 13.32 | **8.98** | 21.1 | 33.3 | 24.5 | 22.0 | 16.9 | 19.9 | 13.8 | 13.4 | **20.6** |
| PA95-41 | x LH185 | 7.09 | 3.82 | 2.21 | 7.50 | 9.40 | 4.23 | 4.55 | 10.39 | **6.15** | 19.9 | 28.2 | 23.0 | 21.4 | 17.4 | 19.3 | 14.3 | 12.7 | **19.5** |
| BS11(FR)C9-3227-9 | x LH198 | 6.50 | 6.15 | 3.84 | 11.00 | 12.20 | 9.07 | 8.78 | 14.00 | **8.94** | 20.7 | 32.2 | 23.3 | 19.7 | 19.2 | 19.4 | 14.2 | 13.9 | **20.3** |
| BSCB1(R)C12-6826-1 | x LH198 | 7.77 | 8.25 | 5.85 | 10.40 | 10.80 | 10.96 | 9.33 | 12.42 | **9.47** | 22.0 | 31.9 | 25.3 | 20.2 | 15.7 | 19.6 | 14.2 | 12.8 | **20.2** |
| BSCB1(R)C12-7018-1 | x LH198 | 8.16 | 7.46 | 6.23 | 9.90 | 11.40 | 9.19 | 9.11 | 11.22 | **9.08** | 21.2 | 30.4 | 25.3 | 19.2 | 17.6 | 20.4 | 14.4 | 13.5 | **20.2** |
| MO97:974-993 | x LH198 | 7.72 | 5.15 | 4.53 | 10.10 | 7.20 | 8.62 | 7.21 | 11.92 | **7.81** | 20.1 | 31.5 | 22.2 | 19.2 | 16.0 | 18.8 | 14.1 | 12.8 | **19.3** |
| Oh512(C0)97-190 | x LH198 | 7.97 | 4.98 | 5.03 | 11.10 | 10.30 | 9.23 | 8.49 | 11.16 | **8.53** | 22.1 | 30.2 | 22.5 | 21.1 | 16.3 | 19.7 | 14.1 | 14.5 | **20.1** |
| PA95-23-B | x LH198 | 7.03 | 6.08 | 5.53 | 11.80 | 8.50 | 9.50 | 8.30 | 11.53 | **8.53** | 21.1 | 27.9 | 21.2 | 18.3 | 14.0 | 18.4 | 13.4 | 12.7 | **18.4** |
| PA95-28 | x LH198 | 7.72 | 6.67 | 5.03 | 12.00 | 10.80 | 9.32 | 8.40 | 11.19 | **8.89** | 21.1 | 32.8 | 29.0 | 20.2 | 19.7 | 21.5 | 15.2 | 14.7 | **21.8** |
| PA95-102 | x LH198 | 6.76 | 8.28 | 7.61 | 12.90 | 11.70 | 10.87 | 9.39 | 11.37 | **9.86** | 22.6 | 32.5 | 27.8 | 20.7 | 19.2 | 19.1 | 14.4 | 13.0 | **21.2** |
| B73 x Mo17 | | 7.08 | 4.38 | | | | | | | | 20.6 | 28.6 | | | | | | | |
| B73 x Pa762 | | 5.86 | | | | | | | | | 23.1 | | | | | | | | |
| B73 x Pa91 | | 5.24 | | | | | | | | | 21.7 | | | | | | | | |
| P3394 | | | 8.96 | | | | | | | | | 27.5 | | | | | | | |
| LH198 x LH185 | | | | 6.54 | | | 10.84 | 9.89 | | | | | 20.6 | | | 15.9 | 13.1 | | |
| P33G26 | | | | 6.92 | | | | | | | | | 22.9 | | | | | | |
| P33A14Bt | | | | | | 11.90 | | | | | | | | | 14.2 | | | | |
| P34W67 | | | | | | 11.30 | | | | | | | | | 15.0 | | | | |
| B84 x LH185 | | | | | | | 9.07 | 9.35 | | | | | | | | 17.6 | 12.8 | | |
| LH198 x B97 | | | | | | | 12.21 | 9.84 | | | | | | | | 17.0 | 13.8 | | |
| LH198 x LH82 | | | | | | | | | 12.12 | | | | | | | | | 12.6 | |
| P33K81 | | | | | | | | | 13.35 | | | | | | | | | 13.2 | |
| **Mean** | | 6.94 | 5.54 | 5.16 | 11.00 | 10.30 | 9.12 | 8.10 | 12.22 | | 20.8 | 30.4 | 22.9 | 20.2 | 15.4 | 18.7 | 13.7 | 13.1 | |
| **LSD (5%)** | | 1.56 | 2.31 | | 2.30 | 1.76 | 1.75 | 0.88 | 1.17 | **1.13** | 1.6 | 1.8 | | 1.3 | 2.8 | 1.2 | 0.8 | 0.6 | **1.1** |

## 2000 Yield Tests, 700-800 Maturity Corn

| Hybrid | | Stalk lodging (%) | | | | | | | | | Root lodging (%) | | | | Rind penet (kg) | Root pull resist (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PA | 0H | IN | KY | IL | IA-1 | IA-2 | NE | **Mean** | IA-1 | IA-2 | NE | **Mean** | MO | MO |
| BS13(S)C6-7726-1 | x LH185 | 4 | 41 | 14 | 1 | 6 | 3 | 0 | 1 | **8.8** | 5 | 0 | 5 | **3.2** | 4.6 | 361 |
| BS13(S)C6-7693-1 | x LH185 | 7 | 6 | 10 | 0 | 6 | 7 | 5 | 1 | **5.2** | 0 | 0 | 0 | **0.0** | 4.4 | 346 |
| BS13(S)C6-7712-1 | x LH185 | 6 | 31 | 5 | 0 | 3 | 5 | 7 | 0 | **7.0** | 0 | 2 | 1 | **0.8** | 4.2 | 275 |
| BS10(FR)C10-3556-1 | x LH185 | 9 | 24 | 13 | 0 | 11 | 18 | 11 | 0 | **10.7** | 0 | 4 | 3 | **2.2** | 4.9 | 341 |
| IL3163 | x LH185 | 4 | 15 | 8 | 3 | 18 | 76 | 33 | 12 | **21.0** | 0 | 3 | 0 | **0.9** | 4.6 | 325 |
| IL3183 | x LH185 | 5 | 39 | 11 | 1 | 13 | 23 | 13 | 1 | **13.2** | 1 | 0 | 0 | **0.3** | 4.6 | 351 |
| IL6254 | x LH185 | 4 | 16 | 3 | 1 | 3 | 14 | 3 | 1 | **5.6** | 0 | 0 | 0 | **0.0** | 4.6 | 356 |
| IL6294 | x LH185 | 4 | 18 | 5 | 0 | 3 | 5 | 5 | 3 | **5.3** | 0 | 1 | 0 | **0.4** | 4.7 | 358 |
| MO97:953-72 | x LH185 | 10 | 13 | 5 | 1 | 8 | 30 | 26 | 2 | **11.9** | 0 | 1 | 0 | **0.3** | 4.2 | 358 |
| Oh512(C0)97-190 | x LH185 | 5 | 34 | 7 | 1 | 10 | 12 | 8 | 2 | **10.0** | 0 | 2 | 2 | **1.4** | 4.6 | 301 |
| PA95-1 | x LH185 | 8 | 26 | 5 | 0 | 10 | 37 | 1 | 1 | **11.0** | 0 | 0 | 0 | **0.0** | 4.9 | 310 |
| PA95-8 | x LH185 | 9 | 28 | 13 | 0 | 5 | 6 | 9 | 0 | **8.6** | 0 | 0 | 2 | **0.6** | 5.0 | 317 |
| PA95-40 | x LH185 | 9 | 48 | 11 | 0 | 6 | 32 | 15 | 1 | **15.2** | 0 | 3 | 3 | **1.8** | 4.6 | 351 |
| PA95-41 | x LH185 | 15 | 62 | 16 | 3 | 2 | 9 | 9 | 2 | **14.6** | 0 | 0 | 0 | **0.0** | 4.3 | 297 |
| BS11(FR)C9-3227-9 | x LH198 | 5 | 38 | 16 | 1 | 3 | 20 | 10 | 0 | **11.6** | 0 | 0 | 0 | **0.0** | 4.1 | 392 |
| BSCB1(R)C12-6826-1 | x LH198 | 0 | 10 | 12 | 1 | 0 | 2 | 3 | 0 | **3.5** | 0 | 0 | 0 | **0.0** | 4.1 | 410 |
| BSCB1(R)C12-7018-1 | x LH198 | 1 | 48 | 9 | 0 | 3 | 4 | 7 | 1 | **9.1** | 0 | 0 | 0 | **0.0** | 4.7 | 394 |
| MO97:974-993 | x LH198 | 13 | 27 | 8 | 1 | 7 | 23 | 31 | 1 | **13.9** | 2 | 0 | 0 | **0.7** | 4.6 | 328 |
| Oh512(C0)97-190 | x LH198 | 14 | 67 | 13 | 0 | 6 | 14 | 26 | 1 | **17.7** | 0 | 1 | 1 | **0.5** | 4.3 | 323 |
| PA95-23-B | x LH198 | 3 | 9 | 14 | 1 | 8 | 28 | 3 | 1 | **8.4** | 0 | 0 | 1 | **0.4** | 4.0 | 339 |
| PA95-28 | x LH198 | 6 | 13 | 6 | 0 | 3 | 3 | 1 | 1 | **4.1** | 0 | 0 | 0 | **0.0** | 4.3 | 384 |
| PA95-102 | x LH198 | 12 | 12 | 12 | 1 | 6 | 12 | 11 | 1 | **8.4** | 1 | 0 | 0 | **0.3** | 4.0 | 404 |
| B73 x Mo17 | | 11 | 11 | | | | | | | | | | | | 4.1 | 361 |
| B73 x Pa762 | | 12 | | | | | | | | | | | | | | |
| B73 x Pa91 | | 14 | | | | | | | | | | | | | | |
| P3394 | | | 15 | | | | | | | | | | | | 4.1 | 362 |
| LH198 x LH185 | | | | 8 | | | 11 | 4 | | | 0 | 0 | | | | |
| P33G26 | | | | 11 | | | | | | | | | | | | |
| P33A14Bt | | | | | | 5 | | | | | | | | | | |
| P34W67 | | | | | | 5 | | | | | | | | | | |
| B84 x LH185 | | | | | | | 13 | 13 | | | 0 | 1 | | | | |
| LH198 x B97 | | | | | | | 6 | 16 | | | 0 | 0 | | | | |
| LH198 x LH82 | | | | | | | | | 1 | | | | 1 | | | |
| P33K81 | | | | | | | | | 0 | | | | 0 | | | |
| **Mean** | | 7.5 | 27.0 | 10.0 | 0.7 | 7.0 | 16.5 | 10.8 | 1.4 | | 0 | 1 | 1 | | 4.4 | 348 |
| **LSD (5%)** | | 5.9 | 55.0 | | 1.6 | ns | 14.3 | 9.6 | 2.5 | **9.0** | 3 | 3 | 5 | **2** | 0.5 | 37 |

## 2000 Yield Tests, 700-800 Maturity Corn

| Hybrid | | Ear height (cm) KY | Days to 50% silk KY | Dropped ears (%) IA-1 and IA-2 | Green snap (%) NE | Test weight NE |
|---|---|---|---|---|---|---|
| BS13(S)C6-7726-1 | x LH185 | 89 | 61 | 0 | 2.5 | 67.4 |
| BS13(S)C6-7693-1 | x LH185 | 71 | 65 | 1 | 0.6 | 68.1 |
| BS13(S)C6-7712-1 | x LH185 | 60 | 59 | 0 | 1.8 | 68.8 |
| BS10(FR)C10-3556-1 | x LH185 | 73 | 61 | 0 | 1.8 | 69.1 |
| IL3163 | x LH185 | 67 | 59 | 0 | 1.8 | 69.5 |
| IL3183 | x LH185 | 86 | 60 | 0 | 1.2 | 69.8 |
| IL6254 | x LH185 | 73 | 60 | 0 | 1.8 | 70.6 |
| IL6294 | x LH185 | 89 | 59 | 2 | 6.5 | 70.6 |
| MO97:953-72 | x LH185 | 81 | 60 | 0 | 4.3 | 70.8 |
| Oh512(C0)97-190 | x LH185 | 68 | 60 | 0 | 1.4 | 70.9 |
| PA95-1 | x LH185 | 75 | 59 | 1 | 5.5 | 70.6 |
| PA95-8 | x LH185 | 77 | 59 | 0 | 19.0 | 70.4 |
| PA95-40 | x LH185 | 90 | 61 | 0 | 2.4 | 70.2 |
| PA95-41 | x LH185 | 83 | 60 | 0 | 1.9 | 69.0 |
| BS11(FR)C9-3227-9 | x LH198 | 81 | 61 | 0 | 1.9 | 67.9 |
| BSCB1(R)C12-6826-1 | x LH198 | 83 | 62 | 0 | 0.0 | 68.0 |
| BSCB1(R)C12-7018-1 | x LH198 | 89 | 59 | 0 | 1.0 | 68.1 |
| MO97:974-993 | x LH198 | 77 | 62 | 0 | 9.3 | 68.0 |
| Oh512(C0)97-190 | x LH198 | 79 | 59 | 0 | 8.6 | 68.0 |
| PA95-23-B | x LH198 | 87 | 59 | 1 | 18.5 | 68.2 |
| PA95-28 | x LH198 | 107 | 61 | 0 | 12.2 | 68.5 |
| PA95-102 | x LH198 | 80 | 63 | 0 | 17.1 | 68.6 |
| B73 x Mo17 | | | | 0 | | |
| B73 x Pa762 | | | | 1 | | |
| B73 x Pa91 | | | | 0 | | |
| P3394 | | | | | | |
| LH198 x LH185 | | | | 0 | | |
| P33G26 | | | | | | |
| P33A14Bt | | | | | | |
| P34W67 | | | | | | |
| B84 x LH185 | | | | 0 | | |
| LH198 x B97 | | | | 1 | | |
| LH198 x LH82 | | | | | 1.2 | 68.5 |
| P33K81 | | | | | 6.8 | 68.5 |
| **Mean** | | 80 | 60 | 0.3 | 5.0 | 70.9 |
| **LSD (5%)** | | 17 | 2 | 0.6 | 6.5 | 0.9 |

**Appendix F**

Report of the Subcommittee for Germplasm Releases

The following germplasms were released since the 2000 report:

| Release | Source | Comments |
|---|---|---|
| **Inbreds:** | | |
| N547 | Multiple borer population from CIMMYT | $S_5$ inbred germplasm, yellow endosperm, semident, with sources of resistance to European corn borer stalk and shank tunneling damage (second generation ECB). AES maturity 800. |
| N548 | Multiple borer population from CIMMYT | $S_5$ inbred germplasm, yellow endosperm, semident,with sources of resistance to European corn borer stalk and shank tunneling damage (second generation ECB). AES maturity 900. |
| SD81 | Noble Bear 710W | Developed from a self in the hybrid Noble Bear 710W. Performs best on non-Stiff Stalk testers and probably belongs in the SSS breeding group. This line has large, dense round kernels with white endosperm. |
| SD82 | Sturdy Grow 744W | Tested as 980701. This white endosperm line was derived by pedigree selection from a self in the commercial hybrid Sturdy Grow 744W and selfed for nine generations. This line performed well on A654 and in single crosses with other developmental inbreds. It has good yield potential and probably has an Iowa Stiff-Stalk Synthetic background. This line has medium size, dented kernels. 90 DRM. |
| SD83 | Vineyard 418W x Noble Bear 710W | Developed from a self in the hybrid cross of Vineyard 418W x Noble Bear 710W. This line performs well on non-Stiff Stalk testers and belongs in the SSS breeding group. This line has medium, round, dense kernels with white endosperm. |
| SD84 | Vineyard 418W x Pioneer Brand 3336W | Developed from a self in the hybrid cross of Vineyard 418W x Pioneer Brand 3336W. Performs well on non-Stiff Stalk testers and belongs to the SSS breeding group. This line has large, round dense kernels with a small dent and white endosperm. |
| SD86 | Noble Bear 710W | Developed from a self in the hybrid Noble Bear 710W. This line performs exceptionally on non-Stiff Stalk testers and belongs to the SSS breeding group. This line has a large round kernel with a moderate dent and moderate density. This line is somewhat yellow, but the yellow color does not show in hybrid seed when using this line as the male. |
| SD87 | Vineyard 417W | Developed from a self in the hybrid Vineyard 417W. This line performs very well on non-Stiff Stalk testers and belongs to the SSS breeding group. This line has a medium, flat kernel with moderate dent and density and a white endosperm. |
| SD88 | Sturdy Grow 744W x Vineyard 418W | Developed from a self in the hybrid cross Sturdy Grow 744W x Vineyard 418W. This line performs very well on non-Stiff Stalk testers and belongs to the SSS breeding group. This line has a medium, round kernel with little dent and a dense, white endosperm. |
| SD203 | Oh43Ht x Mo17Ht | Tested as 980006. This line was derived by pedigree selection from a self in the hybrid Oh43Ht x Mo17Ht. It |

| | | |
|---|---|---|
| | | was selfed for nine generations and tested on inbred lines A654 and A632. Performance was best on A632. This line has a desirable Lancaster genetic background with good yield potential and resistance to northern corn leaf blight race 1. 100 DRM. |
| SD206 | BC10 x C123 | Tested as 980041. This line was derived by pedigree selection from a self in the hybrid BC10 x C123 and selfed for nine generations. It has a Lancaster genetic background and performed well when tested on A632. This line has good stalk strength and moderate yield potential. 90 DRM. |
| SD207 | A641 x A632 | Tested as 980051. This line was derived by pedigree selection from a self in the hybrid A641 x A632 and selfed for nine generations. It performed well when tested on A654. This line has an Iowa Stiff-Stalk Synthetic background and has good yield potential. 95 DRM. |
| SD208 | CM105 x B73 | Tested as 980056. This line was derived by pedigree selection from a self in the hybrid CM105 x B73 and selfed for nine generations. It has an Iowa Stiff-Stalk Synthetic background and has good yield potential. 90 DRM. |
| SD211 | A632Ht x B37Ht | Tested as 980086. This line was derived by pedigree selection from a self in the hybrid A632Ht x B37Ht and selfed for nine generations. This line has an Iowa Stiff-Stalk Synthetic background with resistance to northern corn leaf blight race 1. This line shows good yield potential. 95 DRM. |
| SD212 | AS-3Ht | Tested as 980096. This line was derived by pedigree selection from a self in the Minnesota synthetic population AS3-Ht and selfed for nine generations. This line performed well on A654 and appears to have an Iowa Stiff-Stalk Synthetic background. This line has good yield potential. 95 DRM. |
| SD82 | Sturdy Grow 744W | Tested as 980701. This white endosperm line was derived by pedigree selection from a self in the commercial hybrid Sturdy Grow 744W and selfed for nine generations. This line performed well on A654 and in single crosses with other developmental inbreds. It has good yield potential and probably has an Iowa Stiff-Stalk Synthetic background. This line has medium size, dented kernels. 90 DRM. |

**Populations and Synthetics:**

| | | |
|---|---|---|
| NECB549 | Three multiple borer sub-populations from CIMMYT crossed to Mo47 | Multiple generations of selection for resistance to European corn borer stalk and shank tunneling damage (second generation ECB). Yellow endosperm and semident. AES maturity 700. |

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L.L. Darrah
A.R. Hallauer
J.G. Coors, Chair

# 2001 Roster of Attendance

| | | |
|---|---|---|
| John Ayers | Penn State Univ.<br>308 Buckhout Lab.<br>University Park, PA 16802 | *Work Phone:* (848) 657-7776<br>*Fax Number*: (814) 863-7217<br>*email:* jea@psu.edu |
| Pat Beauzay | South Dakota State Univ.<br>Dept. of Plant Science<br>Box 2140 C NPB134<br>Brookings, SD 57007 | *Work Phone:* (605) 693-3810<br>*Fax Number*: (605) 688-4452<br>*email:* |
| Rex Bernardo | University of Minnesota<br>1991 Upper Buford Circle<br>411 Borlaug Hall<br>St Paul, MN 55108 | *Work Phone:* (612) 625-6282<br>*Fax Number*: (612) 625-1268<br>*email:* berna002@umn.edu |
| Javier Betran | Texas A&M University<br>Dept. of Soil & Crop Sciences<br>College Station, TX 77843 | *Work Phone:* (979) 845-3469<br>*Fax Number*: (979) 862-1931<br>*email:* javier-betran@tamu.edu |
| Marcelo Carena | North Dakota State University<br>Department of Plant Science<br>Loftsqard Hall 166<br>P.O. Box 58105<br>Fargo, ND 58105 | *Work Phone:* (701) 231-8138<br>*Fax Number*: (701) 231-8474<br>*email:* marcelo-carena@ndst.nodak.edu |
| Mario Carlone | Pioneer Hi-Bred International<br>19741 Illinois Hwy 26<br>P.O. Box 513<br>Princeton, IL 61356 | *Work Phone:* (815) 875-6523<br>Fax Number: (815) 872-0517<br>email: carlonemr@phibred.com |
| Michael Chapman | Pioneer Hi-Bred International<br>RR 8, Box 113A<br>Mankato, MN 56001 | *Work Phone:* (507) 625-3252<br>Fax *Number*: (507) 625-6446<br>e*mail:* |
| Steve Coates | University of Illinois<br>Dept. of Crop Science<br>S-112 Turner Hall<br>1102 S. Goodwin Ave.<br>Urbana, IL 51801 | *Work Phone:* (217) 244-5950<br>*Fax Number*: (217) 333-9817<br>*email:* s-coates@uiuc.edu |
| Mark Cooper | Pioneer Hi-Bred International<br>7300 N.W. 62nd Avenue<br>P.O. Box 1004<br>Johnston, IA 50131 | *Work Phone:* (515) 334-4690<br>*Fax Number*: (515) 270-4312<br>*email:* coopermark@phibred.com |
| James Coors | University of Wisconsin<br>1575 Linden Drive<br>Madison, WI 53706 | *Work Phone:* (608) 262-7959<br>*Fax Number:* (608) 262-5217<br>*email:* jgcoors@facstaff.wisc.edu |
| Larry Darrah | USDA/ARS<br>110 Curtis Hall<br>University of Missouri<br>Columbia, MO 65211 | *Work Phone:* (573) 882-2349<br>*Fax Number*: (573) 884-7850<br>*email:* agrolld1@showme.missouri.edu |

## 2001 Roster of Attendance

| | | |
|---|---|---|
| Jessie Daub | Iowa State University<br>1492 Agronomy Hall<br>Ames, IA 50011 | *Work Phone:* (515) 294-8665<br>*Fax Number*:<br>*email:* jdaub@iastate.edu |
| Jim Dodd | Professional Seed Research, Inc.<br>7 South 437 Dugan Road<br>Sugar Grove, IL 60554 | *Work Phone:* (630) 466-1060<br>*Fax Number:* (630) 466-1068<br>*email:* jdodd@psrcorn.com |
| Trevor Doerksen | University of Guelph<br>Dept. of Plant Ag<br>Crop Science Bldg. | *Work Phone:* (519) 824-4120<br>*Fax Number*: (519) 763-8933<br>*email:* tdoerkse@uoguelph.ca |
| John Dudley | Univ. of Illinois<br>Department of Crop Science<br>S112 Turner Hall<br>1102 S. Goodwin Ave.<br>Urbana, IL 61801 | *Work Phone:* (217) 333-9640<br>*Fax Number*: (217) 333-9817<br>*email:* jdudley@uiuc.edu |
| Donald Duvick | Iowa State University<br>P.O. Box 446<br>6839 NW Beaver Drive<br>Johnston, IA 50131 | *Work Phone:* (515) 278-0861<br>*Fax Number*: (515) 278-0861<br>*email:* dnd307@aol.com |
| Jode Edwards | Monsanto Company<br>llinois Technology Center<br>101 Tomaras Ave.<br>Savoy, IL 61874 | *Work Phone:* (217) 356-6879<br>*Fax Number*: (217) 356-7863<br>*email:* jode.w.edwards@monsanto.com |
| Sherry Flint-Garcia | Univ. of Missouri-Columbia<br>110 Curtis Hall<br>University of Missouri<br>Columbia, MO 65211 | *Work Phone:* (573) 882-2349<br>*Fax Number*: (573) 884-7850<br>*email:* saflint@teosinte.agron.missouri.edu |
| Ben Ford | Iowa State University<br>Dept. of Agronomy<br>1529 Agronomy Hall<br>Ames, IA 50011 | *Work Phone:* (515) 294-8690<br>*Fax Number*: (515) 294-3163<br>*email:* benford@iastate.edu |
| Charles Foresman | Iowa State University<br>Dept. of Agronomy<br>1327 Agronomy Hall<br>Ames, IA 50011 | *Work Phone:* (515) 294-8624<br>*Fax Number*:<br>*email:* foresman@iastate.edu |
| Travis Frey | University of Wisconsin<br>Dept. of Agronomy<br>1575 Linden Drive<br>Madison, WI 53706 | *Work Phone:* (608) 262-5087<br>*Fax Number*: (608) 626-5217<br>*email:* travisfrey@students.wisc.edu |

# 2001 Roster of Attendance

| | | |
|---|---|---|
| John Golden | USDA/ARS<br>Department of Agronomy<br>Iowa State University<br>Ames, IA 50011 | *Work Phone:* (515) 294-2130<br>*Fax Number*: (515) 294-9359<br>*email:* jcgolden@iastate.edu |
| Geoff Graham | Pioneer Hi-Bred International<br>Maize Research<br>7300 NW 62nd Avenue<br>P.O. Box 1004<br>Johnston, IA 50131 | *Work Phone:* (515) 253-5862<br>*Fax Number*: (515) 270-4312<br>*email:* grahamgeof@phibred.com |
| Paulo Guimaraes | Iowa State Univ.<br>Dept. of Agronomy<br>1525 Agronomy Hall<br>Ames, IA 50011 | *Work Phone:* (515) 294-8641<br>*Fax Number*: (515) 294-3163<br>*email:* guimarae@iastate.edu |
| Arnel Hallauer | Iowa State University<br>1505 Agronomy Hall<br>Ames, IA 50011 | *Work Phone:* (515) 294-7823<br>*Fax Number:* (515) 294-3163<br>*email:* hallauer@iastate.edu |
| Gary Heichel | Univerisity of Illinois<br>Urbana, IL 61801 | *Work Phone:*<br>*Fax Number*:<br>*email:* |
| Lori Hinze | Iowa State University<br>Dept. of Agronomy<br>1541 Agronomy Hall<br>Ames, IA 50011 | *Work Phone:* (515) 294-9429<br>*Fax Number*: (515) 294-3163<br>*email:* lhinze@iastate.edu |
| Tom Hoegemeyer | Hoegemeyer Hybrids<br>1755 Hoegemeyer Rd.<br>Hooper, NE 68031 | *Work Phone:* (402) 654-3399<br>*Fax Number*: (402) 654-3342<br>*email:* |
| Joel Holthaus | Holden's Foundation Seeds L.L.C.<br>P.O. Box 839<br>201 North Maplewood Ave.<br>Williamsburg, IA 52361 | *Work Phone:* (319) 668-1100<br>*Fax Number*: (319) 668-2453<br>*email:* joel.holthaus@holdens.com |
| Bert Hornbrook | Syngenta Seeds<br>1301 W. Washington St.<br>Bloomington, IL 61701 | *Work Phone:* (309) 823-9412<br>*Fax Number*: (309) 827-7711<br>*email:* |
| Jean-Luc Jannink | Iowa State University<br>Dept. of Agronomy<br>Ames, IA 50011 | *Work Phone:* (515) 294-4153<br>*Fax Number*: (515) 294-6505<br>*email:* jjannink@iastate.edu |
| Matthew Krakowsky | Iowa State University<br>1541 Agronomy Hall<br>Ames, IA 50011 | *Work Phone:* (515) 294-5755<br>*Fax Number:*<br>*email:* mdk@iastate.edu |

2001 Roster of Attendance

| | | | |
|---|---|---|---|
| Laura Krouse | 825 Abbe Hill Rd<br>Mt. Vernon, IA 52314 | *Work Phone:*<br>*Fax Number*:<br>*email:* | (319) 895-6924<br><br>lkrouse@cornell-iowa.edu |
| Buppa Kongamai | Iowa State University<br>Department of Agronomy<br>Ames, IA 50011 | *Work Phone:*<br>*Fax Number*:<br>*email:* | (515) 572-4674<br><br>buppa@iastate.edu |
| Robert Lambert | University of Illinois<br>Department of Crop Sciences<br>1102 South Goodwin Ave.<br>Urbana, IL 61801 | *Work Phone:*<br>*Fax Number*:<br>*email:* | (217) 333-9642<br>(217) 333-9817<br>rjlamber@uiuc.edu |
| Kendall Lamkey | USDA/ARS<br>Department of Agronomy<br>Iowa State University<br>Ames, IA 50011 | *Work Phone:*<br>*Fax Number*:<br>*email:* | (515) 294-7826<br>(515) 294-9359<br>krlamkey@iastate.edu |
| Elizabeth Lee | University of Guelph<br>Plant Agriculture Dept.<br>Crop Science Bldg.<br>Guelph, ON N1G 2W1 | *Work Phone:*<br>*Fax Number*:<br>*email:* | (519) 824-4120<br>(519) 763-8933<br>elee@plant.uoguelph.ca |
| Kory Maughan | Golden Harvest/JCR<br>59400 190th St.<br>Nevada, IA 50201 | *Work Phone:*<br>*Fax Number:*<br>*email:* | (515) 382-4619<br><br>kmaugha@jcrob.com |
| Mark Millard | Iowa State University<br>Plant Introd. Station<br>Ames, IA 50011 | *Work Phone:*<br>*Fax Number*:<br>*email:* | (515) 294-3715<br>(515) 294-1903<br>mjmillar@iastate.edu |
| Bob Miller | Syngenta Seeds<br>P.O. Box 999<br>Washington, IA 52353 | *Work Phone:*<br>*Fax Number*:<br>*email:* | (800) 992-2157 |
| Kevin Montgomery | Central Golden Harvest Research<br>RR #3, Box 257<br>Clinton, IL 61727 | *Work Phone:*<br>*Fax Number*:<br>*email:* | (217) 935-8945<br>(217) 935-6305<br>goldharv@dave-world.net |
| Ronald Mowers | Garst Seed Company<br>P.O. Box 500<br>Slater, IA 50244 | *Work Phone:*<br>*Fax Number*:<br>*email:* | (515) 685-5110<br>(515) 685-5080<br>Ron.Mowers@GarstSeedCo.com |
| Kebede Ponta | Iowa State University<br>Department of Agronomy<br>Ames, IA 50011 | *Work Phone:*<br>*Fax Number*:<br>*email:* | (515) 294-8704<br>(515) 294-3163<br>mpkebede@iastate.edu |
| Rich Pratt | OSU-OARDC<br>1680 Madison Ave.<br>Wooster, OH 44691 | *Work Phone:*<br>*Fax Number:*<br>*email:* | (330) 263-3972<br>(330) 263-3887<br>pratt.3@osu.edu |

2001 Roster of Attendance

| | | |
|---|---|---|
| Tom Prest | NOVARTIS Seeds<br>P.O. Box 485<br>1001 Montana Street<br>Glidden, IA 51443 | *Work Phone:* (712) 659-3691<br>*Fax Number*:<br>*email:* |
| Andrew Ross | Iowa State University<br>Dept. of Agronomy<br>1203 Agronomy Hall<br>Ames, IA 20011 | *Work Phone:* (515) 294-6868<br>*Fax Number*:<br>*email:* ajross@corn2.agron.iastate.edu |
| Ken Russell | University of Nebraska<br>Dept. of Agronomy<br>Plant Science 279<br>P.O. Box 830915<br>Lincoln, NE 68583 | *Work Phone:* (402) 472-1562<br>*Fax Number*: (402) 472-7904<br>*email:* krussell3@unl.edu |
| Oscar Smith | Pioneer Hi-Bred International<br>7300 NW 62nd Avenue<br>P.O. Box 1004<br>Johnston, IA 50131 | *Work Phone:* (515) 270-3539<br>*Fax Number*: (515) 270-4312<br>*email:* smitho@phibred.edu |
| Slobodan Trifunovic | Iowa State University<br>1311 Agronomy Hall<br>Iowa State University<br>Ames, IA 50011 | *Work Phone:* (515) 294-2750<br>*Fax Number*:<br>*email:* tslobodan@corn2.agron.iastate.edu |
| A. Forrest Troyer | University of Illinois<br>611 Joanne Lane<br>DeKalb, IL 60115 | *Work Phone:* (630) 801-2302<br>*Fax Number*: (630) 801-2345<br>*email:* |
| Clint Turnbull | Iowa State Unversity<br>1515 Agronomy Hall<br>Ames, IA 50011 | *Work Phone:* (515) 294-9721<br>*Fax Number:*<br>*email:* cturnbul@iastate.edu |
| Freemen Whitehead | Cargill Seed Research<br>PO Box 774<br>Grinnell, IA 50112 | *Work Phone:*<br>*Fax Number*: (515) 236-3607<br>*email:* |
| Zeno Wicks, III | South Dakota State Univ.<br>Dept. of Plant Science<br>Box 2140-C<br>Brookings, SD 57007 | *Work Phone:* (605) 688-5542<br>*Fax Number*: (605) 688-4452<br>*email:* zeno-wicks@sdstate.edu |
| David Willmot | University of Missouri<br>204 Curtis Hall<br>University of Missouri<br>Columbia, MO 65211 | *Work Phone:* (573) 882-4734<br>*Fax Number*: (573) 884-7850<br>*email:* willmot@uiuc.edu |
| Jiangang Wu | Garst Seed Company<br>Box 500<br>Slater, IA 50244 | *Work Phone:* (515) 685-5125<br>*Fax Number*:<br>*email:* Jeff.wu@garstseedco.com |

# 2001 Roster of Attendance


| | | | |
|---|---|---|---|
| Oscar Valentinuz | University of Guelph<br>Dept. of Plant Ag<br>Crop Science Bldg. | *Work Phone:*<br>*Fax Number*:<br>*email:* | (519) 824-4120<br>(519) 763-8933<br>ovalenti@uoguelph.ca |
| Kenneth Ziegler | Iowa State University<br>Dept. of Agronomy<br>1565 Agronomy Hall<br>Ames, IA 50011 | *Work Phone:*<br>*Fax Number*:<br>*email:* | (515) 294-7827<br>(515) 294-1897<br>kenzieg@iastate.edu |