NCR-167 2002 Meeting, Guelph, Ontario Station Report - Elizabeth Lee

Guelph Breeding Program

Established in the 1970s primarily to broaden the genetic base of short-season corn, the corn breeding program at Guelph is now contributing commercially useful and genetically unique dent corn inbred lines. Additionally, the program is engaged in breeding methodology research that has the potential to contribute to commercial corn breeding practices.

The philosophy of the program is two-fold. First, that genetically distinct germplasm needs to be "packaged" in an inbred line that has commercial potential. Most commercial breeding programs will not even consider looking at material that does not meet a minimum standard of performance and appearance. To encourage companies to incorporate the material into their own breeding programs requires the material to posses a unique attribute while not bring along with it undesirable attributes. Second, that the mandate of the Guelph corn breeding program is not to compete with commercial companies, but rather to foster the efforts in the <2650 CHU area and to develop/assess breeding methodologies that have the potential to increase breeding efficiency.

There are three main objectives that are ongoing (i.e., have already been started and will not be finished within the 4-year period of this proposal) that encompass (1) development of short-seasoned breeding material, (2) release of commercial caliber short-season inbred lines, and (3) development and evaluation of breeding strategies.

Guelph Program Objectives

a. Examine Breeding Methodologies in 3 areas:

- How does environment affect selection efficiency and population genetic structure in a recurrent selection program? This is a joint research project with Marcelo Carena at NDSU (Fargo, ND).
- General stress tolerance and yield potential - Can more progress be made by directly selecting for general stress tolerance and is it possible to increase yield potential?
- Marker aided breeding - Is it possible to use markers to (1) identify potential sister-line crosses for female parent use, (2) choose testers to fit a particular breeding cross (strategic use of testers), (3) choose crossing material for pulling in exotic or non-adapted germplasm, (4) develop extremely narrow vs. wider line crosses for breeding.

b. Incorporation of Exotic or non-adapted Germplasm into the <2700 CHU germplasm base through:

- GEM project co-operator
- NC State inbred lines
- ISU inbred lines
- Guelph recurrent selection populations

c. Development of Short-Seasoned Inbred Lines (<2700 CHU material) through:

- Recycling CG inbred lines through breeding pools
- Backcrossing of CG60, CG102 and CG107 with the Netherland S_2 lines to develop early versions of the CG lines.
- Half-sib recurrent selection using CG102 on the CG H99/Oh43 population

d. Adaptation of Popcorn Germplasm to <2700 CHU.
- POPGEM co-operator

e. Peripheral Research and Breeding Activities (i.e. not part of OASIS proposal):
- Late-season cold tolerance (with M. Tollenaar) (OCPA funded)
- Ontario Corn Committee performance trials (5 locations) (entry fee funded)
- QTL mapping (NSERC funded)
- Food-grade Corn Breeding, Ridgetown campus (OCPA, Rural Jobs Strategy funded)

Ridgetown Food Corn Program

With OCPA and industry support we initiated the food corn breeding program at U of G Ridgetown Campus in two phases. First, a yellow corn breeding program was launched in 1996 that was aimed at "longer-season maturities" (Lyn Kannenberg). Most of the germplasm acquired for this project was food grade quality and the emphasis of this program was shifted towards development of food grade yellow inbred lines. The white food corn breeding program at the Ridgetown campus in 1998 (myself). The germplasm for the white program was a mix of later maturing commercial white inbred lines, 2 white populations that have undergone recurrent selection, adapted yellow commercial food grade type hybrids, and earlier maturity inbred lines from the U of G Guelph campus program.

Our progress to date is the following: (1) We have just finished our first early generation testing of the first group of S2 and S3 lines to come out of the white program (summer 2001). Some of the breeding material is superior in yield and earlier in maturity that the earliest commercial white hybrids that are currently available. This material is also comparable to some of the yellow food grade hybrids grown in Southwestern Ontario. (2) We have identified 3 experimental hybrids from a series of crosses between IFSI inbred lines and inbred lines from the SDSU breeding program. The 3 promising hybrids have been entered into the multi-state Early White Food Grade Corn Performance trials that are administered by the USDA-ARS in Columbia, Missouri that will be grown during the summer of 2002. (3) We have at least one extremely promising yellow food grade inbred line that will be in our advanced testing program this summer (2002).

a. Development of Short Season (<3400 CHU) White and Yellow Food-Grade Inbred Lines (60%)

Specific end-use purposes are what distinguish white and yellow food grade corn from conventional yellow dent corn. Clarity of kernel color, kernel hardness, cob color, and kernel size are some of the grain quality characteristics that are unique

to food grade corn. Other grain quality characteristics such as insect and disease resistance, while not unique to food grade corn are important to the end-user. From the standpoint of the producer, it is essential that food grade corn hybrids have maturities adapted to the intended area and grain yields that are competitive with adapted commercial yellow dent corn hybrids. Development of high yielding, food-grade white and yellow endosperm inbred lines that have commercial potential and are adapted to southwestern Ontario. It is the intention of the breeding program to compliment commercial corn breeding programs and collaborate with U.S. public corn breeding programs. However, the specific needs addressed will be those that are crucial for fostering food grade corn production in southwestern Ontario.

b. Identification of QTLs Associated with Kernel Quality Factors (30%)
We are interested in the genetics of kernel quality and the relationship of the various quality parameters. The objective of this project is to map quantitative trait loci (QTLs) associated with white food grade quality corn traits.

c. Marker Aided Breeding (10%)
Examine how and if marker aided breeding improves breeding efficiency specifically in two areas: (1) choice of inbred testers lines for evaluating breeding material and (2) choice of breeding crosses both for elite by elite material and for elite by exotic material. This is intended to compliment the work that the Guelph Corn Breeding and Genetics project is doing in this area.

Publications

1. Tollenaar, M., and E.A. Lee. 2002. Yield potential yield, yield stability and stress tolerance in maize. Field Crops Research. (in press).
2. Ying, J., E.A. Lee and M. Tollenaar. 2002. Response of leaf photosynthesis during the grain-filling period of maize to duration of cold exposure, acclimation and incident PPFD. Crop Sci. (in press).
3. Lee, E.A., M.S. Staebler, and M. Tollenaar. 2002. Genetic Variation and Physiological Discriminators for Cold Tolerance in Maize (*Zea mays* L.) during an Early Autotrophic Phase of Development. Crop Sci. (in press).
4. Lee, E.A. and V. Harper. 2002. *Suppressor of pericarp pigmentation 1* (*spp1*), a gene involved in phlobaphene accumulation in maize (*Zea mays* L.) pericarps. Maydica. (accepted).
5. McMullen, M.D., M. Snook, E.A. Lee, P.F. Byrne, H. Kross, T.A. Musket, K. Houchins, and E.H. Coe. 2001. The biological basis of epistasis between quantitative trait loci for flavone and 3-deoxyanthocyanin synthesis in maize (Zea mays L.). Genome 44:667-676
6. Lee, E.A., B. Good, R. Chakravarty, and L. Kannenberg. 2001. Corn inbred lines CG60 and CG62. Canadian Journal of Plant Sci. 81:453-454.
7. Lee, E.A., B. Good, R. Chakravarty, and L. Kannenberg. 2001. Corn inbred line CG102. Canadian Journal of Plant Sci. 81 455-456.

8. Darrah, L.L., D.R. West, R.L. Lundquist, B.E. Hibbard, D.B. Wilmont, A. Schaafsma, E.A. Lee, J. McKinney, W.L. Pearce, F.J. Betran, W. Xu, P.M. Michener, J.K. Pataky, B. Gordon, L.D. Maddux, R.W. Elmore, D.E. Stenburg, P.B. Beauzay, P.R. Thomison, A.B. Geyer, R.J. Minyo, K.E. Ziegler, R. Henry, D.B. Fischer, J.F. Strissel, S. Tragessor, and J.A. Deutsch. 2001. White Food Corn 2001 Performance Tests. Special Report 540. USDA-ARS and Agricultural Experiment Station, University of Missouri-Columbia.

Presentations

1. Harper, V., and E.A. Lee. 2001. *spp1*, a single gene mutation that closely corresponds to the C-glycosyl flavone QTL *rem1* in maize (*Zea mays* L.). ASA annual meetings, Charlotte, NC, Oct 21-25, 2001. (poster)
2. Staebler, M.A., E.A. Lee, and M. Tollenaar. 2001. Physiological responses to cold stress in maize (*Zea mays* L.) during early phases of development. ASA annual meetings, Charlotte, NC, Oct 21-25, 2001. (poster)
3. Ahmadzadeh, A., E.A. Lee and M. Tollenaar. 2001. Physiological basis of combining ability in corn. ASA annual meetings, Charlotte, NC, Oct 21-25, 2001. (poster)
4. Tollenaar, M., E.A. Lee and J. Ying. 2001. Response of leaf photosynthesis during the grain-filling period in maize to duration of cold exposure, acclimation and incident PPFD ASA annual meetings, Charlotte, NC, Oct 21-25, 2001. (poster)
5. Marentes, E., M. Tollenaar, and E.A. Lee. 2001. EST Profiling in maize leaves during the grain-filling period. ASA annual meetings, Charlotte, NC, Oct 21-25, 2001. (poster)
6. T. Doerksen and E.A. Lee. 2001. Impact of recurrent selection on GCA and SCA. ASA annual meetings, Charlotte, NC, Oct 21-25, 2001. (poster)
7. Lee, E.A.. 2001. QTL mapping in the era of functional genomics. Symposium entitled Genomics and Biotechnology. AIC 2001 meetings, Guelph, July 8-11, 2001. (invited symposium talk)
8. Harper, V., and E.A. Lee. 2001. *spp1*, a single gene mutation that closely corresponds to the C-glycosyl flavone QTL *rem1* in maize (*Zea mays* L.). AIC 2001 meetings, Guelph, July 8-11, 2001. (poster)
9. Staebler, M.A., E.A. Lee, and M. Tollenaar. 2001. Physiological responses to cold stress in maize (*Zea mays* L.) during early phases of development. AIC 2001 meetings, Guelph, July 8-11, 2001. (poster)
10. Doerksen, T., and E.A. Lee. 2001. Impact of recurrent selection on GCA and SCA. AIC 2001 meetings, Guelph, July 8-11, 2001. (talk)
11. Ahmadzadeh, A., E.A. Lee and M. Tollenaar. 2001. Physiological basis of combining ability in corn. AIC 2001 meetings, Guelph, July 8-11, 2001. (poster)
12. Tollenaar, M., E.A. Lee and J. Ying. 2001. Response of leaf photosynthesis during the grain-filling period in maize to duration of cold exposure, acclimation and incident PPFD. AIC 2001 meetings, Guelph, July 8-11, 2001. (poster)

Theses

1. Michael Staebler, April 5, 2001, Physiological Responses to Cold Stress in Maize During Early Phases of Development. (M.Sc.).
2. Trevor Doerksen, Janurary 8, 2002, Impact of recurrent selection on GCA and SCA. (M.Sc.).
3. Kris McNaughton, Janurary 10, 2002, Mutations in the ALS Gene Conferring Herbicide Resistance in Redroot Pigweed (*Amaranthus retroflexus*) and Green Pigweed (*A. powellii*. (M.Sc.).

Inbred lines released - none

Germplasm released - none