G x E Interaction in Sunflowers for the Northern Plains

NSA Research Forum Jan 10th, 2013

Alison Stone, NDSU, Dept. of Plant Sciences, Fargo, ND; Brent Hulke, USDA-ARS, NCSL, Fargo, ND; Mike Ostlie, NDSU, Carrington Research Center, Carrington, ND; Paul Gregor, Winfield Solutions, Thief River Falls, MN; David Archer, USDA-ARS, Mandan, ND

NDSU NORTH DAKOTA STATE UNIVERSITY

What is G x E Interaction

- The ability of a genotype to interact with its environment either positively or negatively
- If there is no interaction, then the best genotype in one environment will be superior in them all
- If an interaction is present, then a particular genotype will perform differently when placed in different environments

Background

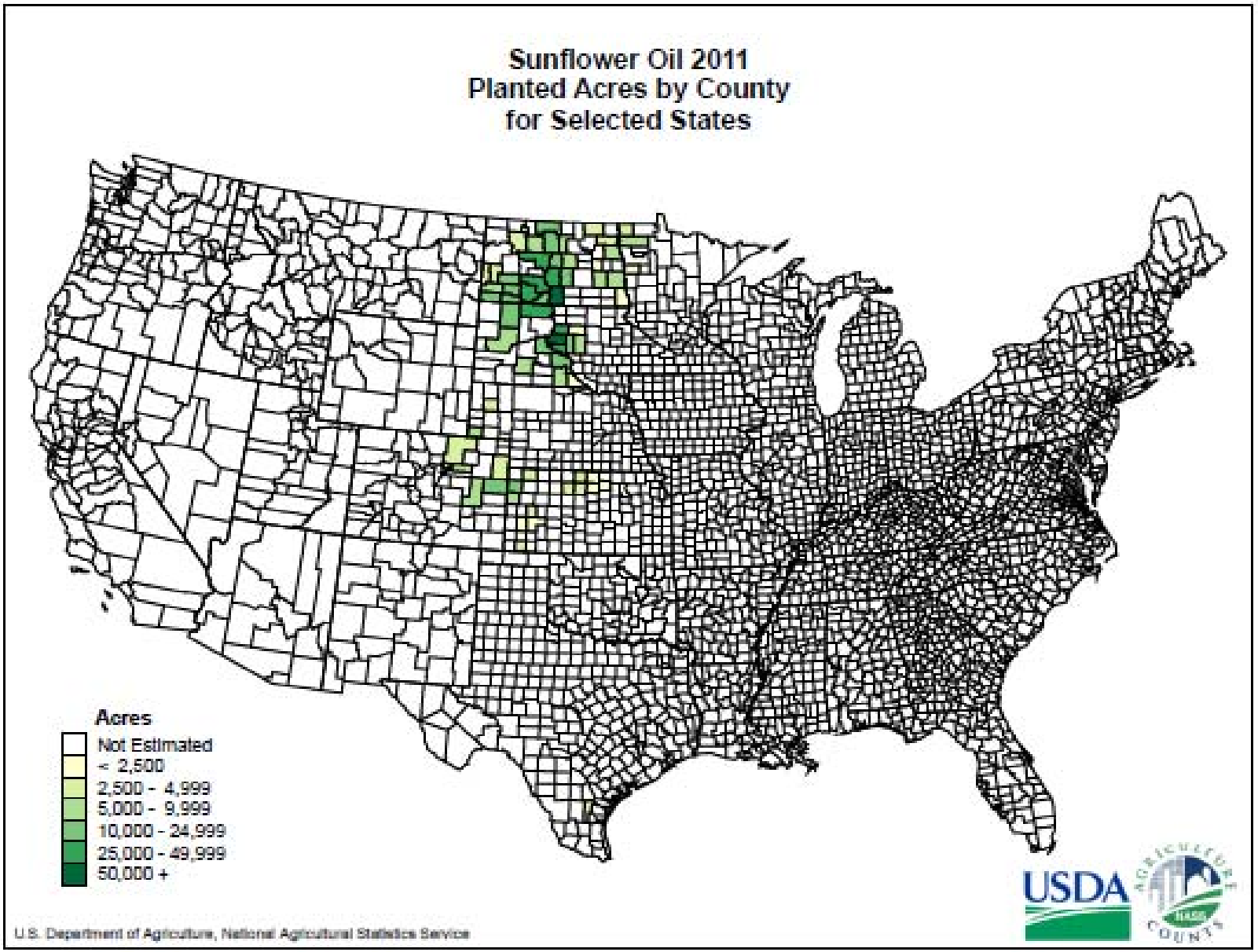
- Importance of G x E interaction
  - Over half a century
  - Many crops, most famously maize
- G x E in sunflowers has been studied in many countries
  - South Africa, Sudan, Italy, Argentina
- Very little research done in the Northern Plains

Objectives

- Understand G x E in this region
  - Yield and Oil
  - Determine mega-environments
- Analyze the rate of improvement
  - 1970-present

Impact

- Understand sunflower breeding's testing environments currently available
- Ability to optimize resources
- Understand how germplasm has changed over 40 years
- Provide a phenotypic dataset to evaluate genomic prediction models for future studies


Sunflower Oil 2011
Planted Acres by County
for Selected States
Acres
Not Estimated
< 2,500
2,500 - 4,999
5,000 - 9,999
10,000 - 24,999
25,000 - 49,999
50,000 +
USDA
U.S. Department of Agriculture, National Agricultural Statistics Service

NDSU NORTH DAKOTA STATE UNIVERSITY

Locations

Cultural

- No-till vs conventional
- Populations

Environmental

- Soil Type
- pH
- Rainfall
- Elevation

Materials and Methods

- 6 locations, 2 replications, 2 years
- USDA maintaining Velva, Mandan, Wyndmere and Eureka
- Carrington, NDSU
- Crookston, Winfield Solutions

NDSU NORTH DAKOTA STATE UNIVERSITY

Materials and Methods

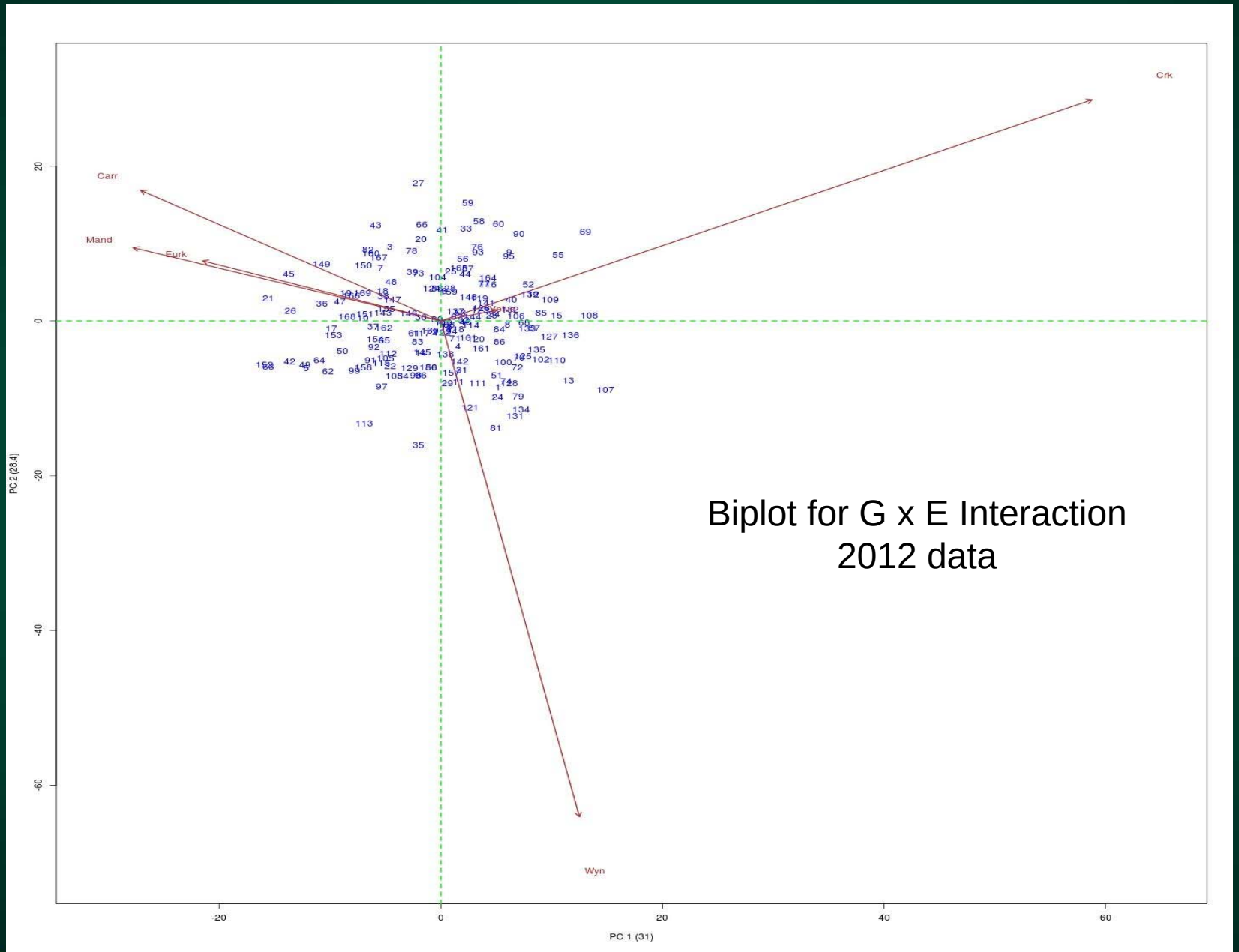
- 79 A-line from the USDA since 1970 x 2 R-line testers (373 & 377)
- 7 treatments are commercial hybrids
- 4 are modern hybrids currently used in the USDA

- RCBD with each rep as a lattice
  - 169 treatments total
  - 13 units per incomplete block

- AMMI function of R used to run the analysis on Peppermint Linux OS

AMMI Model

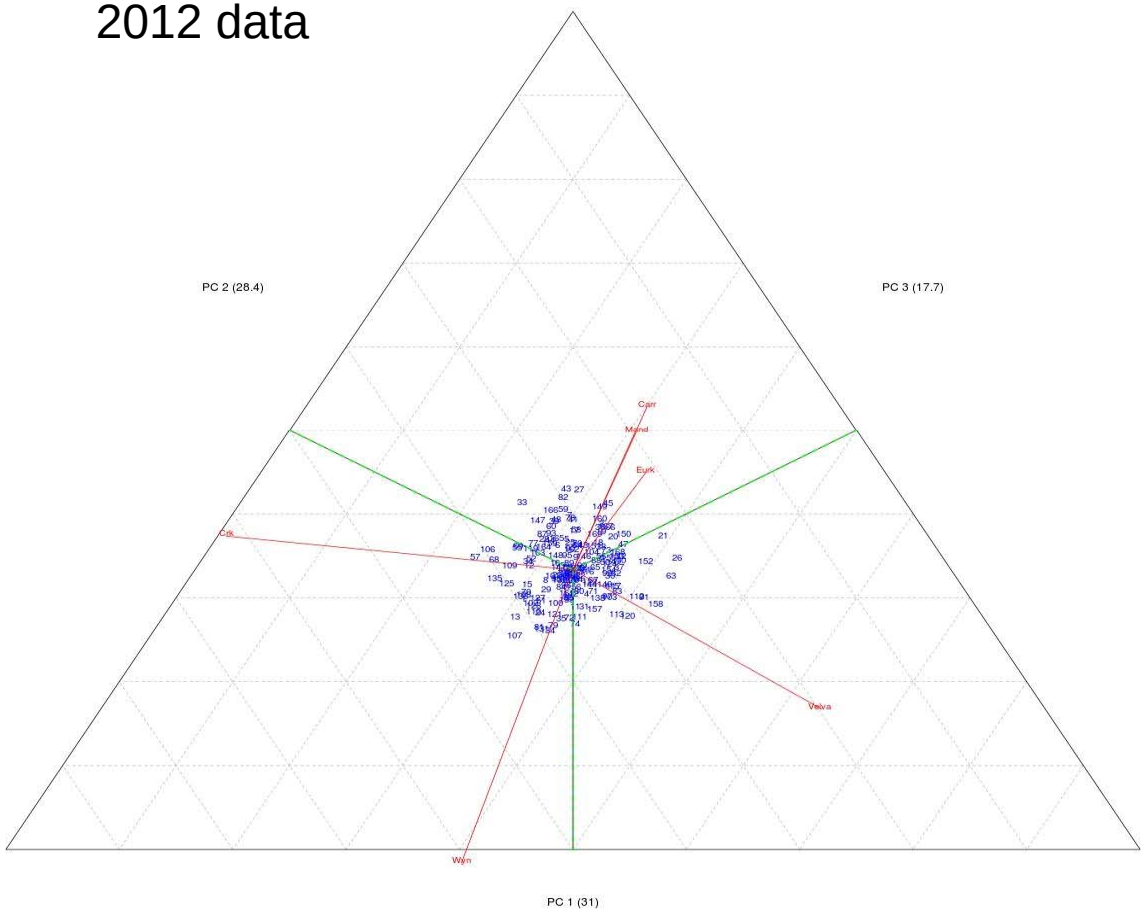
- Additive Main Effect and Multiplicative Interaction
  - Combines the analysis of variance and principal components analysis
  - Analysis of variance
    - Additive main effects analysis
  - PCA
    - G x E interaction
- Summarizes patterns within the relationships of genotypes and environments
- Results are shown using a biplot or triplot graph



Biplot for G x E Interaction
2012 data

NDSU NORTH DAKOTA STATE UNIVERSITY

Triplot for G x E Interaction 2012 data



NDSU NORTH DAKOTA STATE UNIVERSITY

Conclusions

- A genotype by environment interaction exists
- Many are stable across all the environments
- Many of the commercial hybrids are trending towards the western environment, but in general the material is broadly adapted
- Carrington, Mandan and Eureka are all very similar environments
- Wyndmere and Crookston are in an environment all their own
- Analyzing the triplot shows Velva weakly separated into another environment

NDSU NORTH DAKOTA STATE UNIVERSITY

Thank you!

- National Sunflower Association
- National Sclerotinia Initiative
- Dr. Brent Hulke , Leanne Matthiesen, summer students
- Winfield Solutions
- USDA – Mandan
- NDSU – Carrington
- Curt Lee – Agrotech, Velva
- David Grenz – Eureka
- Todd and Arnold Woodbury - Wyndmere

NDSU NORTH DAKOTA STATE UNIVERSITY

Questions?

Go Bison!!!

NDSU NORTH DAKOTA STATE UNIVERSITY