Maize Phenotyping under the Seeds of Discovery Initiative: The Brute Force Method

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Seeds of Discovery

Genome Wide Association Study (GWAS) in Maize

- Breeder’s Core Collection from the CIMMYT Maize Germplasm Bank (4471 accessions).
- One plant per accession crossed with a CIMMYT hybrid to make a series of modified topcrosses.
  - The same plant was sampled for DNA extraction/GBS
- Accessions were crossed hybrids of their same environmental adaptation (where possible).
  - Tropical Accessions X Tropical Hybrid
  - Subtropical Accessions X Subtropical Hybrids
  - Highland Accessions X Highland Hybrid
Phenotypic Trials

- 36 trials planted - 34 harvested (34,606 rows and over 687,000 unique data points)
- 19 Trials for abiotic Stresses (Drought, Heat, Low Nitrogen)
- 11 Trials for diseases (Tar Spot Complex, Grey Leaf Spot, Turcicum Leaf Blight, Fusarium Ear Rot, Fusarium and Acremonium Stalk Rot)
- 3 Trials hand pollinated to produce grain for Quality Component Analysis.

Yield and Agronomic Data Taken: All Locations

- Yield (field weight, grain and cob weight, moisture, number of ears)
- Plant Height and Ear Height
- Male and Female Flowering (50% of row)
- Stalk and Root Lodging

Experimental Design

- Unreplicated augmented row-column design
- For each trial location accessions are selected for adaptation zone and maturity.
- Overlapping sets of topcross entries
- Two widely adapted commercial checks and resistant and susceptible checks where appropriate

Example of Trial Design

Standard commercial checks (●) and resistant (○) and susceptible (□) checks, to adjust for spatial variance for specific traits within the trial.
**Model for Analysis**

BLUPs - (Best Linear Unbiased predictors) calculated for male accession parent by removing the average effect of the hybrid tester and using check entries to adjust for spatial variation.

**Challenges**

- Range of maturities (flowering extends for 5 weeks)
- Lodging
- Segregation
- Diversity of environments (both origin of accessions and evaluation sites)

**Tar Spot Complex**

- **Tar Spot Trials**
  - 2011B Guadalupe-Victoria, Chiapas – 600 Accession/Topcross entries
  - 2012B Guadalupe-Victoria, Chiapas – 810 accession/topcross entries *(including accessions per se)*
  - 2 foliar ratings 0-5 scale (Ceballos and Deutsch) two weeks apart.
  - Data taken both by row and as average of 6 plants per row

**Comparison of average female flowering date with range of female flowering for 191 accession topcrosses** (per plant data)
Relationship between Tar Spot rating and Yield (2nd foliar rating: scale 0-5; average of 6 plantas)

![Graph showing relationship between Tar Spot foliar rating and yield]

Characterization for Stalk Rot

![Image of crops and research equipment]

Fusarium Stalk Rot: Artificial Inoculation

Evaluation of Accessions PerSe for Acremonium Stalk Rot

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Commercial (resistant check)</td>
<td>0.43</td>
<td>0.5</td>
</tr>
<tr>
<td>PUE45</td>
<td>1.16</td>
<td>1.7</td>
</tr>
<tr>
<td>MORE65</td>
<td>1.53</td>
<td>2.3</td>
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<tr>
<td>GUER125</td>
<td>1.59</td>
<td>2.4</td>
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<td>NAYAGP6</td>
<td>2.13</td>
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<td>CHS128</td>
<td>2.56</td>
<td>2.9</td>
</tr>
<tr>
<td>MICH21</td>
<td>3.21</td>
<td>2.9</td>
</tr>
<tr>
<td>TC X URUG39 (susceptible)</td>
<td>4.5</td>
<td>5.97</td>
</tr>
</tbody>
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![Graph showing relationship between Yield and Stalk Rot Scale (percentage of stalks with disease x intensity of disease)]