

# Genotype-By-Environment Interactions for Yield and Specific Gravity in the Potato National Chip Processing Trial

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The National Chip Processing Trial (NCPT) is a collaborative effort between the public breeding programs and potato industry to identify new varieties. After 3–4 years of assessment within a state breeding program, clones are submitted to the NCPT for multi-state evaluation of tuber shape, appearance, size, yield, vine maturity, specific gravity, and chip color. As with many crops, the issue of how broadly adapted a potato clone should be to warrant commercialization is complex. To help guide resource allocation decisions, our objective was to characterize genotype-by-environment (GxE) interaction in the NCPT between 2011 and 2016.

**Table 1. Locations for the National Chip Processing Trial.** Coordinates are approximate because different fields were used each year as part of the crop rotation.

| State | Nearest city | Latitude | Longitude |
|-------|--------------|----------|-----------|
| CA    | Bakersfield  | 35.26    | 118.88    |
| FL    | Hastings     | 29.68    | 81.43     |
| MI    | Lakeview     | 43.35    | 85.17     |
| MO    | Charleston   | 36.93    | 89.38     |
| ND    | Hoople       | 48.53    | 97.62     |
| NC    | Plymouth     | 35.87    | 76.65     |
| NY    | Ithaca       | 42.43    | 76.39     |
| OR    | Hermiston    | 45.81    | 119.28    |
| TX    | Dalhart      | 35.97    | 102.73    |
| WI    | Hancock      | 44.12    | 89.54     |

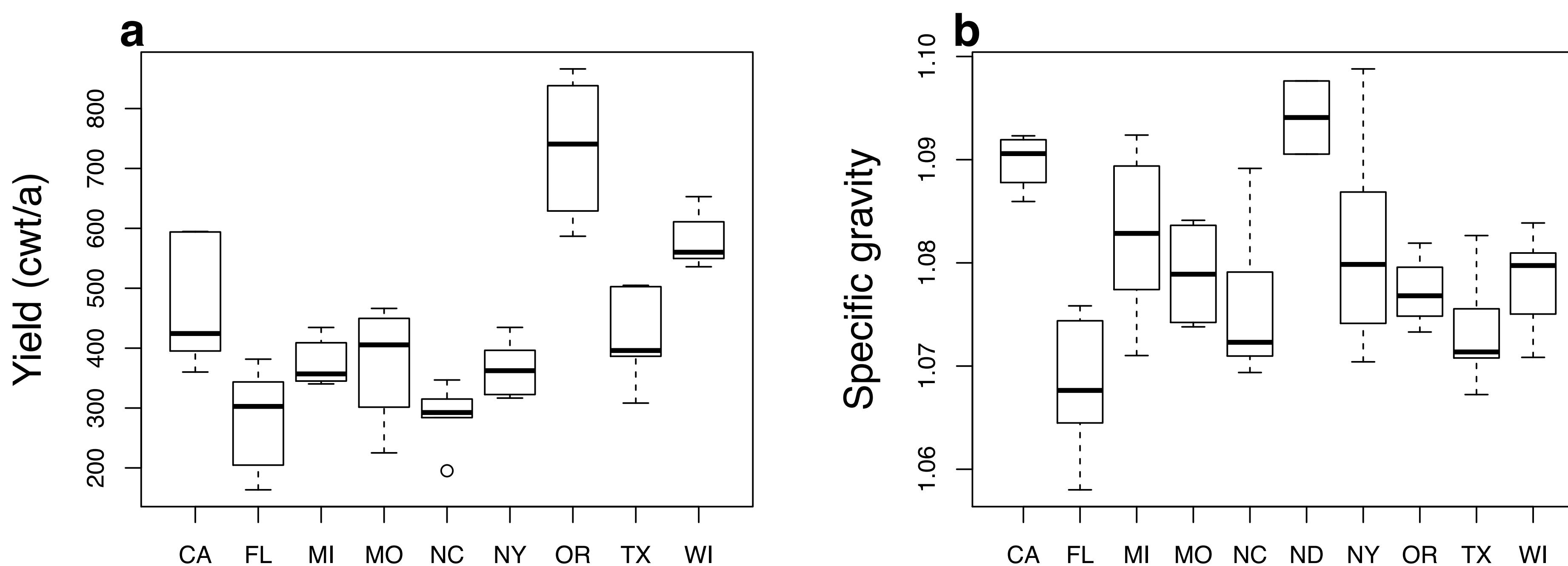


Figure 1. Distribution of environment means for (a) total yield and (b) specific gravity, from 2011–2016.

Our baseline model assumes the genetic correlation between each pair of locations is the same in a given year. For yield, this correlation was 0.50, while for specific gravity it was 0.72. This result indicates the relative ranking of clones with respect to specific gravity is more consistent across locations than for yield.

The baseline model was extended to allow some pairs of locations to be more highly correlated than others. This more complex model gave a significantly better fit to the data for yield but not for specific gravity, most likely because of the high correlation between locations for specific gravity.

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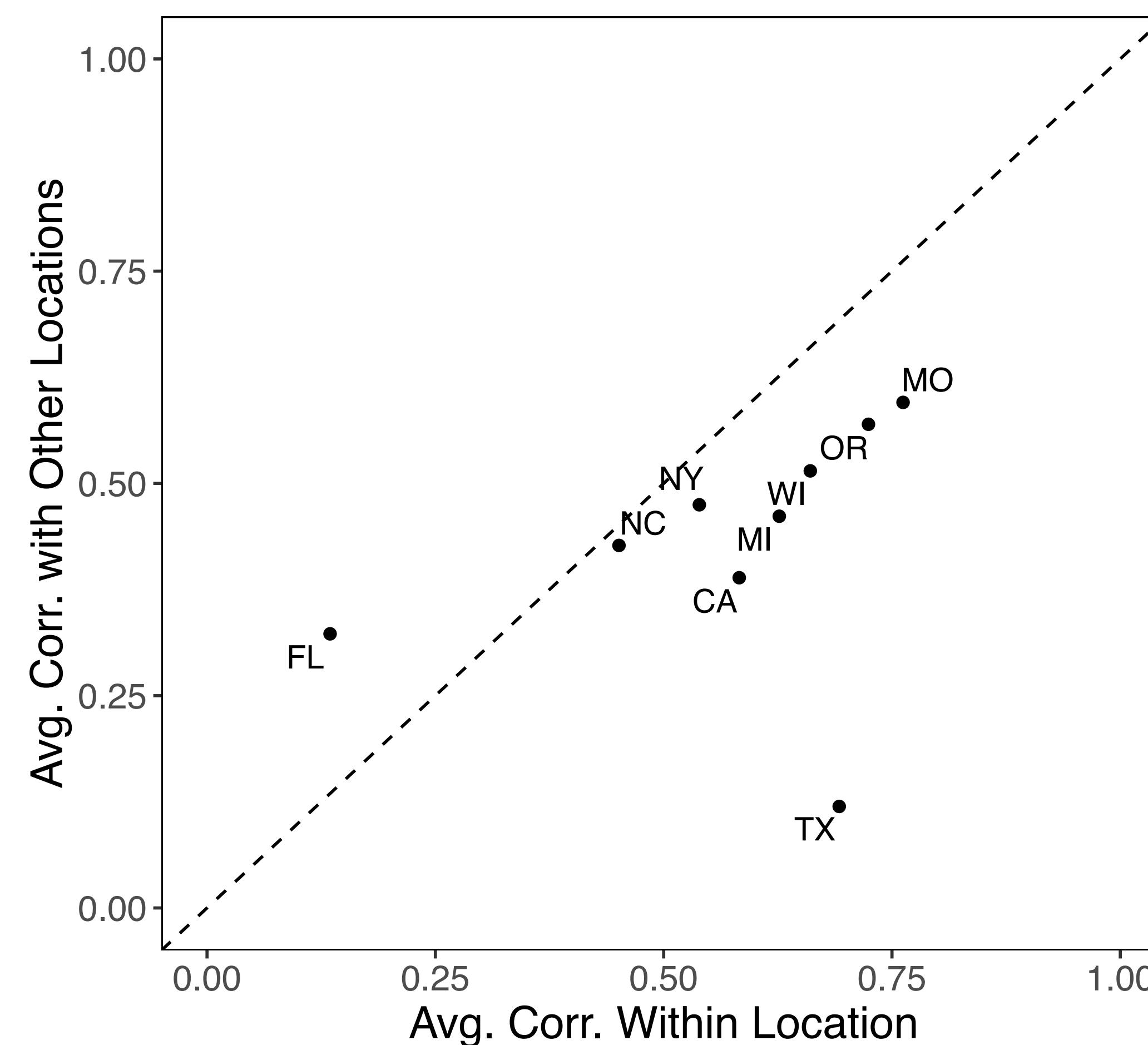


Figure 2 (left) shows the average genetic correlation for yield across years at one location (x-axis) vs. the average correlation between different locations. Most of the locations fall slightly to the right of the diagonal line, which means the amount of variation across years at the location was similar to the variation across locations.

Florida is an outlier in Figure 2 due to year-to-year inconsistency in the relative yield performance of clones. Texas is also an outlier but for a different reason: its position on the x-axis is comparable to the other states, indicating some consistency to the ranking of clones over time, but the low y-axis value indicates the yield ranking was very different from other locations.

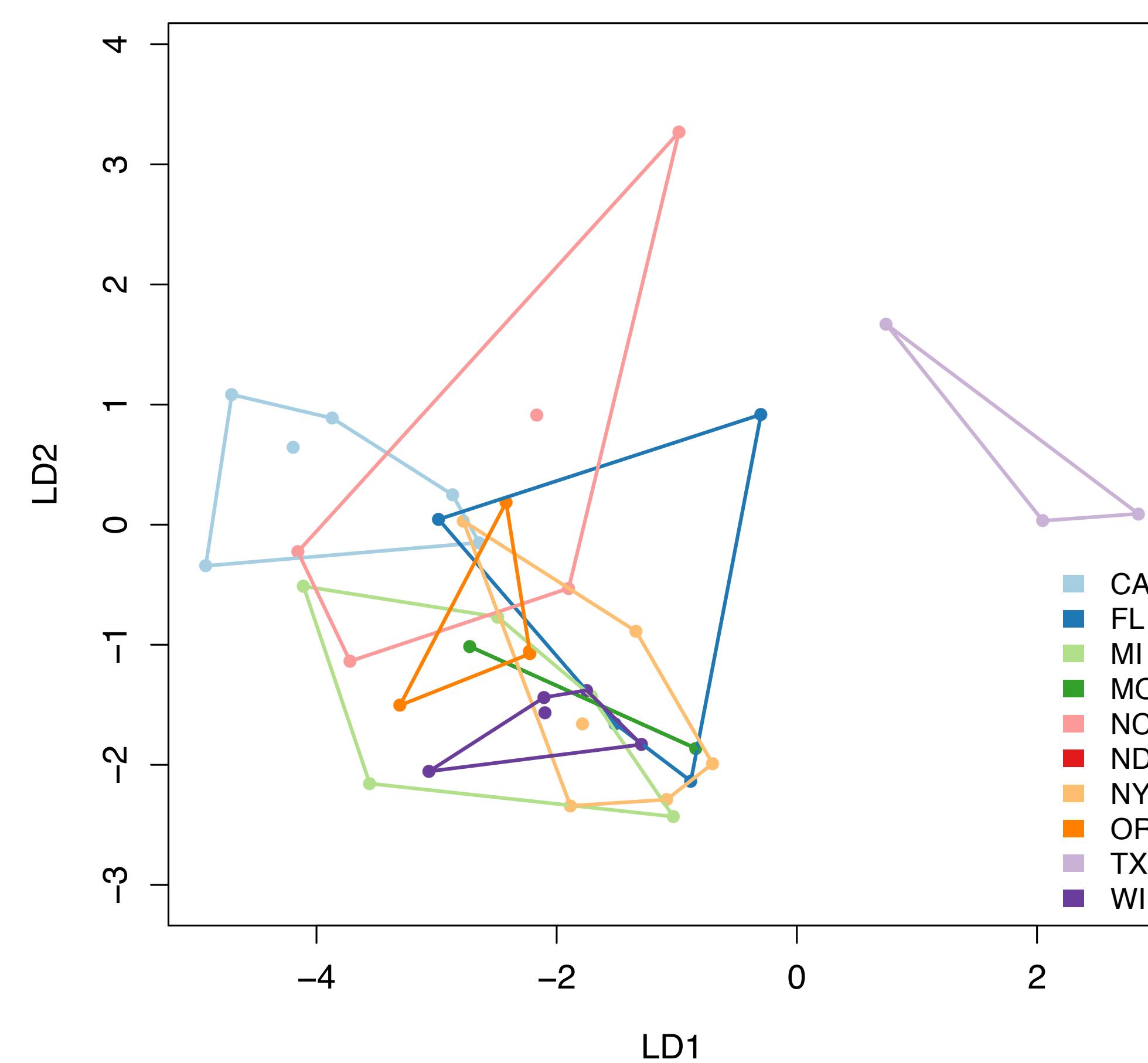


Figure 3 (left) is a graphical representation of the yield correlation matrix between the locations. Each point represents a location-year combination, with different colors for the different states. The points for each location are enclosed in a polygon, the size of which reflects the amount of variation across years in each state.

The distance between polygons is related to the average correlation between the environments of those locations. For example, using Wisconsin as the focal location, the other locations in order of decreasing average correlation for yield are Missouri (0.75), Oregon (0.69), Michigan (0.66), New York (0.64), California (0.42), Florida (0.39), and Texas (0.12).

Selection decisions in the NCPT are often stratified based on clone performance in the southern (CA, NC, FL, TX) vs. northern (OR, MI, NY, ND) locations. There are good reasons for this, as resistance to cold-induced sweetening is important in the north but not the south, while the reverse is true for internal heat necrosis. However, this study has revealed that the southern locations do not constitute a coherent selection target with respect to total yield.