Reciprocal Diallel Crosses Impact Combining Ability, Variance Estimation, and Heterotic Group Classification

X.M. Fan*, Y.D. Zhang, W.H, Yao, Y.Q. Bi, L. Liu, H.M. Chen, and M.S. Kang

(X.M. Fan and Y.D. Zhang, Contributed equally to the paper) X. M. Fan, Y.D. Zhang, W.H. Yao, Y.Q. Bi, L. Liu and H.M. Chen, Institute of Food Crops, Yunnan Academy of Agricultural Sciences and Tian Rui Seed Company, LTD., Kunming, 650205, Yunnan, China; and M.S. Kang, Dep. of Plant Pathology, Kansas State Univ., Manhattan, KS 66506-5502.

Questions such as the following often arise: 'Should reciprocal crosses be included in a diallel'; and 'Would their inclusion in a diallel impact grain yield (GY), estimates of general (GCA) and specific combining ability (SCA) effects, and heterotic group classification in maize (Zea mays L.)'.

We evaluated a 12-parent maize diallel cross (Griffing's Method 3 and Method 4) in three environments to determine :

1) if reciprocal crosses impact GY of crosses, and GCA and SCA effects;
2) if reciprocal crosses influence the GCA and SCA and residual variance estimates in a diallel analysis;
3) if reciprocal crosses impact maize heterotic group classification.

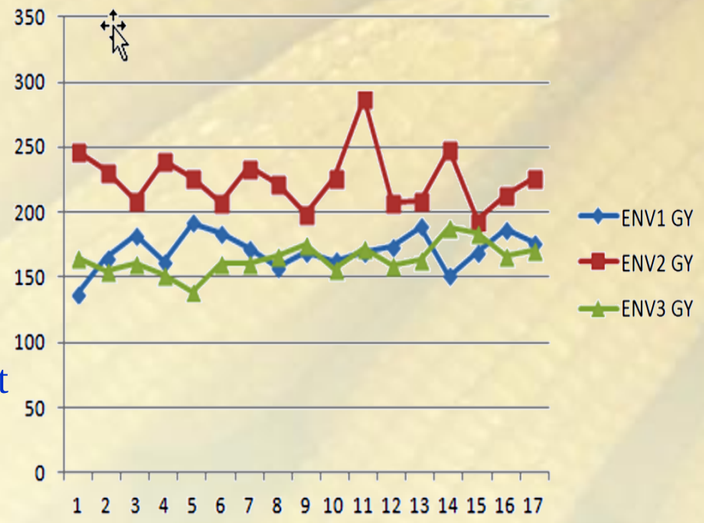

Figure 1. Grain yield mean of 17 crosses at three environments. ENV1_GY, ENVs_GY, and ENV3_GY are mean grain yields at environment 1, 2 and 3, respectively.

This graph (Fig. 1) showed that both GY rank and magnitude were different in the three environments.

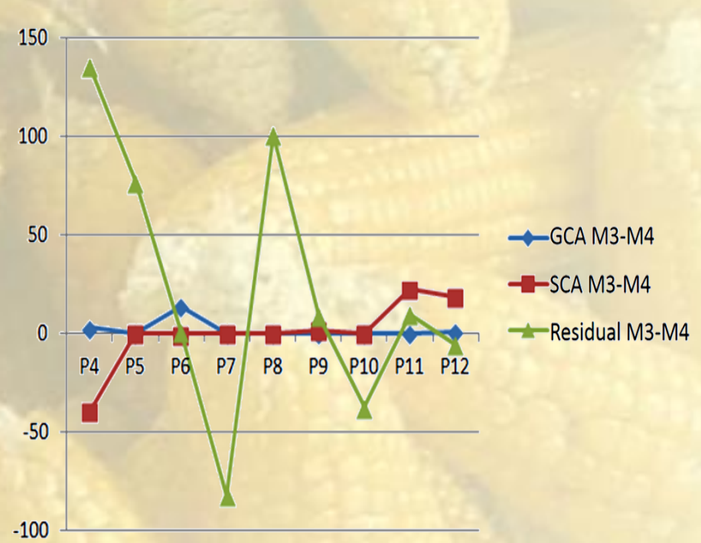

Figure 2. The differences of variances of GCA, SCA, and residual from diallel experiments with parent numbers being from 4 to 12 (P4 to P12).

Results (Fig. 2) revealed that inclusion of reciprocal crosses in a diallel might have little or no impact on variance of GCA for any number of parental lines in a diallel cross. The differences in variances of SCA between Method 3 and Method 4 showed a mild increase as the number of parental lines increased.

Reciprocal Diallel Crosses Impact Combining Ability, Variance Estimation, and Heterotic Group Classification

X.M. Fan*, Y.D. Zhang, W.H, Yao, Y.Q. Bi, L. Liu, H.M. Chen, and M.S. Kang

(X.M. Fan and Y.D. Zhang, Contributed equally to the paper) X. M. Fan, Y.D. Zhang, W.H. Yao, Y.Q. Bi, L. Liu and H.M. Chen, Institute of Food Crops, Yunnan Academy of Agricultural Sciences and Tian Rui Seed Company, LTD., Kunming, 650205, Yunnan, China; and M.S. Kang, Dep. of Plant Pathology, Kansas State Univ., Manhattan, KS 66506-5502.

One hundred sub-samples of the diallel dataset with 4, 5, 6, 7, 8, 9, 10 and 11 parental lines were randomly extracted and analyzed. The mean differences in variances of GCA, SCA, and residual between Method 3 and Method 4 were calculated from the 100 subsamples and the differences in GCA, SCA, and residual variances with the different number of parent lines are shown in Fig. 3.

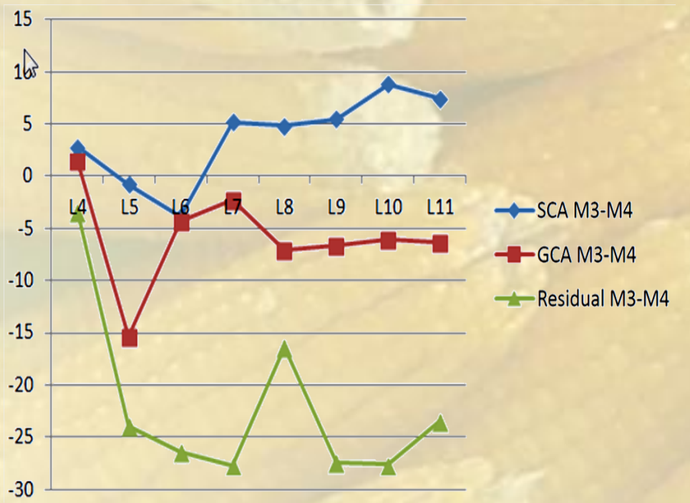

Figure 3. The average differences of variances of GCA (avg_GCA_M3_M4) ,SCA (avg_SCA_M3_M4), and residuals (avg_Err_M3_M4) between Griffing method 3 and Method 4 from 100 re-samples

◆The results showed that inclusion of reciprocal crosses in a diallel greatly impacted GY and estimates of GCA and SCA effects.

◆Under the assumption of a random-effects model, the inclusion of reciprocal crosses caused the residual and GCA variances to decrease and the SCA variances to increase as the number of parental lines increased in a diallel cross.

◆ Because inclusion of reciprocal crosses impacted GY and SCA estimates, reciprocal crosses would have great impact on maize heterotic group classification.

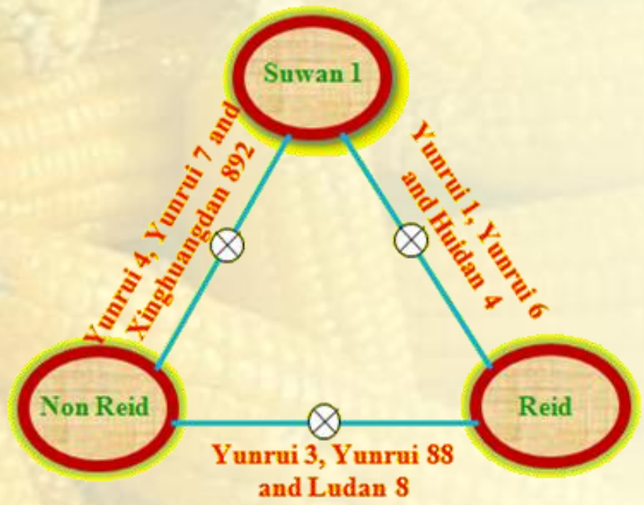

Figure 4. Three heterotic groups of maize in southwest China with some released maize hybrids in the region.

With the application of this TriHG theory to their maize breeding programs, many super maize hybrids have been developed and released in southwest China, a few released and widely used maize hybrids in the region were shown in Figure 4.

The maize heterotic groups might be classified differently with and without the inclusion of reciprocal crosses. Based on our dataset from southwest China, three heterotic groups seemed to be an ideal number for improving maize breeding efficiency.