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Combining Ability – Importance and Utilization of in Plant Breeding

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SUMMARY

In any hybridization program, recognition of the best combination of two (or more) parental genotypes to maximize variance within related breeding populations, and as a result the chance of recognizing superior transgressive segregants in the segregating populations, are the most critical challenge to plant breeders. Since the combining ability was proposed in 1942, efforts to uncover the genetic basis underlying this phenomenon have been ongoing. This article concentrates on our current understanding of combining ability in plant breeding.

INTRODUCTION

The combining ability is a concept crucial to hybrid breeding and the exploitation of heterosis. Identification of the best performing lines (for commercial release) and lines which can be used as parents in future crosses are two principal objects considering in most crop breeding programs. Based on the multi environmental trails followed by statistical analysis, the best performing lines for desirable characters are selected. A well-designed trial accompanied by statistical analysis distinguishes genetic and environmental influences. The parental lines selection can be performed by particular mating designs. Through conducting such designs, the genetic influences of a line can be partitioned into additive and non-additive components.

What is Combining Ability?

Combining ability or productivity in crosses is defined as the cultivars or parents ability to combine among each other during hybridization process such that desirable genes or characters are transmitted to their progenies. In another definition, combining ability is an estimation of the value of genotypes on the basis of their offspring performance in some definite mating design. It is measured by progeny testing. When parental plants produce potent offspring, they are said to have good combining ability

Types of Combing Ability

Two concepts of combining ability viz. general combining ability (GCA) and specific combining ability (SCA) have had important influence on inbred line evaluation and population development in crop breeding. Sprague and Tatum defined GCA as the average performance of a genotype in a series of hybrid combinations. They defined SCA as those cases in which certain hybrid combinations perform better or poorer than would be expected on the basis of the average performance of the parental inbred lines. Parents showing a high average combining ability in crosses are considered to have good GCA while if their potential to combine well is bounded to a particular cross, they are considered to have good SCA. From a statistical point of view, the GCA is a main effect and the SCA is an interaction effect. Based on Sprague and Tatum, GCA is owing to the activity of genes which are largely additive in their effects as well as additive × additive interactions. Specific combining ability is regarded as an indication of loci with dominance variance (non-additive effects) and all the three types of epistatic interaction components if epistasis were present. They include additive × dominance and dominance × dominance interactions.

Commonly used Methods to Estimate Combining Ability

With a progress in biometrical genetics, several techniques are suggested for the estimation of combining ability. Three main methods namely diallel, line × tester and North Carolina designs, which are mostly used in different studies.

Diallel Design

In diallel mating, the parental lines are crossed in all possible combinations (both direct as well as reciprocal crosses) to recognize parents as best or poor general combiners by GCA and the specific cross combinations by SCA. All the types of diallel estimate variation due to the crosses (Table 2) which is partitioned into sources due to GCA and SCA. So the differences between the diallels are based on whether parents or reciprocal effects are included in the model. The reciprocal crosses estimate the variation due to maternal effects, which are expected for some traits.

Line × tester design

The line × tester is the most widely used mating design for hybrid development.
The combining ability in line × tester design is estimated using a formula suggested by Singh & Chaudhary

Standard errors (SE) for combining ability effects: SE of GCA for lines = (MSE/r x t)1/2; SE of GCA for testers = (MSE/r x l)1/2; SE of SCA effects = (MSE/r)1/2;

Where, MSE = mean square error from the analysis of variance table.

A tester is a genotype that is used to identify superior germplasm in accordance with breeding objectives in a hybrid-oriented program. A broad genetic based tester is considered for GCA selection while a narrow genetic based tester is used for SCA selection.

North Carolina Design

The North Carolina designs can just be defined as a class of factorial mating designs or schemes where certain groups of parents are designated male (factor 1) and others female (factor 2) for use in crosses. They are useful for studying combining ability in fixed model experiments and gene action when random models are applied. There are three types of north carolina designs depending on the crossing pattern. All the designs are equally useful in the estimation of combining ability

Applications of Combing Ability

With an emphasis on important traits, these are the main uses of combining ability in plant breeding. Combining ability for yield, nutritional value, antioxidant properties and for pest resistance.

CONCLUSION

Although considerable progress has been made in crop improvement by plant breeding, it is essential that it continue. Through commonly applied breeding techniques, current breeding programmes continue to evolve. Combining ability could largely contribute in achieving this object. Combining ability as a considerable analysis tool is not only useful for selecting favorable parents but also provides information concerning the nature of and importance of gene effects influencing quantitative traits.

REFERENCES

Allard RW. Principles of Plant Breeding, John Wiley and Sons Inc, New York, USA; 1960.

Fasahat P., Rajabi A., Rad J. M., Derera J., 2016. Principles and utilization of combining ability in plant breeding. *Biom Biostat Int J.* 2016;4(1):1–22.

Griffing B. 1956. A generalized treatment of the use of diallel crosses, in quantitative inheritance Heredity. *Australian Journal of Biological Sciences.* ;10:31–50.

Kulembeka HP, Ferguson M, Herselman L, 2012. Diallel analysis of field resistance to brown streak disease in cassava (*Manihot esculenta* Crantz) landraces from Tanzania. *Euphytica*;187(2):277–288.

Oakey H, Verbyla A, Pitchford W, 2016. Joint modeling of additive and non-additive genetic line effects in single field trials. *Theoretical and Applied Genetics*.;113(5):809–819.

Singh RK, Chaudhary BD. Biometrical methods in quantitative genetic analysis, Kalyani Publishers, New Delhi, India. 1985.

Sprague GF, Tatum LA. 1942General versus specific combining ability in single crosses of corn. *Journal of the American Society of Agronomy*.;34:923–932.

Topal A, Aydın C, Akgun N, et al. 2004. Diallel cross analysis in durum wheat (*Triticum durum* Desf.): identification of best parents for some kernel physical features. *Field Crops Research*.;87:1–12.

Vasal SK, Cordova H, Pandey S, 1986. Tropical maize and heterosis. CIMMYT research highlights, Mexico, DF, CIMMYT.