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Application of diallel analyses in crop improvement

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Abstract

The most suitable method of crop improvement in diallel analysis. A diallel cross is a mating technique used by geneticists and plant and animal breeders to study the genetic basis of qualitative and quantitative traits. Diallel mating design can be divided into four categories: i. Full diallel, which includes both parents and reciprocal crosses, as well as F1 ii. Half diallel without reciprocal crossings and with parent iii. Full diallel with no parents; iv. Half diallel with no parents or reciprocal crosses. For improving both quantitative and qualitative traits of various crops, a variety of breeding strategies are available. Diallel crosses are the most effective way for determining the general (GCA) and specific (SCA) combining skills of putative parents, as well as the breeding method to use. The goal of this review is to clarify the importance of diallel analysis in crop development in this way.

Keywords: Crop improvement, Diallel crosses, Diallel analyses, Qualitative and Quantitative traits.

Introduction

A diallel cross is a mating technique used by geneticists and plant and animal breeders to study the genetic basis of qualitative and quantitative traits. In a full diallel, all parents are crossed to make hybrids in all possible combinations. Variations include half diallel with and without parents, omitting reciprocal crosses (Obi, 2013). Full diallel requires twice as many crosses and entries in experiments but allows for testing for maternal and paternal effects (Obi, 2013). If such "reciprocal" effects are assumed to be negligible, then a half diallel without reciprocals can be effective.

Types of diallel mating design: According to Obi (2013), there are four main types of diallel mating design:

(i) Full diallel in which parents and reciprocal crosses are involved along with F1

(ii) Half diallel with parent and without reciprocal crosses

(iii) Full diallel without the inclusion of parents

(iv) Half diallel without parents or reciprocal crosses

Assumptions of diallel cross analysis: The following are the assumptions of diallel cross analysis as described by Obi (2013)

1. Normal diploid segregation
2. Lack of maternal effects
3. Absence of multiple alleles
4. Homozygosity of parents
5. Absence of linkage among genes affecting the character
6. Lack of epistasis
7. Random mating

Approaches to Diallel Analysis: There are two approaches to diallel analysis

a) Hayman's graphical approach

b) Griffings numerical approach

Hayman's graphical approach: The following six components of variation are estimated:

D = additive genetic variance

H1 = dominance variance

H2 = H1 [(1 – (U – V$)^{2}$]

Where u and v are proportions of positive and negative genes, respectively, in the parents.

E = expected environmental component of variance

F = mean of FV over the arrays, where FV is the covariance of additive and dominance effects in a single array.

h2 = dominance effect, as an algebraic sum over all the loci in heterozygous phase, in all the crosses.

Genetic ratios

1. Average degree of dominance = √ H1/D = (H1/D) ½

0 = there is no dominance

>0<1 = parental dominance

1, 0 = complete dominance

>1 = over dominance

2. Vr – Wr Graph

Vr = the variance of the rth array, and

Wr = the covariance between the parents and the offspring on the rth array

Inferences from the Vr – Wr graph

(a) When the regression line passes through the origin it depicts complete dominance (D = H1)

(b) When the regression line passes above the origin cutting Wr axis, it suggests the existence of partial dominance (D > H1)

(c) When it passes above the origin, cutting the Wr axis and touching the limiting parabola, it suggests the absence of dominance.

(d) But when the regression line passes below the origin, cutting the Vr axis, it denotes the presence of overdominance.

(e) The position of parental points on the regression line indicates the dominance order of the parents. The parents with more dominant genes are located nearer to the origin, while those with more recessive genes fall farther from the origin. The parents with equal frequencies of dominant and recessive genes occupy an intermediate position.

Griffing's Numerical Approach: This is based on the estimation of general combining ability (GCA) and specific combining ability (SCA) variances and effects. Griffing (1956) gave four different methods of diallel analysis depending on the material (s) included in the experimentation.

Materials included in the experiment number of entries in the experiment (F1's + parents)

Parents, F1's and Reciprocals n2

Parents and F1's (w/o Reciprocals) n (n + 1)/2

F1's and Reciprocals (w/o Parents) n (n – 1)

F1's (w/o parents & w/o Reciprocals) n (n – 1)/2

In their approach, gene action is deduced through the estimates of GCA and SCA variances and effects. The GCA component is primarily a function of additive genetic variance.

Conclusion

With the use of diallel analysis, it is easy to separate various components of different varieties, whether genotypic, phenotypic, or environmental variance. It also helps to seek out varieties that have general combining ability or specific combining ability. This will also help the plant breeder to estimate the type of gene action (additive gene action, dominant gene action, additive-additive gene action, etc).

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With these, the plant breeder will be able to know the type of breeding method to adopt in his crop improvement

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