

# Analysis Of Diallel Mating Designs Nc State University

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## OCONNOR BRENDEN

**Crossover** John Wiley & Sons

Maize is used in an endless list of products that are directly or indirectly related to human nutrition and food security. Maize is grown in producer farms, farmers depend on genetically improved cultivars, and maize breeders develop improved maize cultivars for farmers. Nikolai I. Vavilov defined plant breeding as plant evolution directed by man. Among crops, maize is one of the most successful examples for breeder-directed evolution. Maize is a cross-pollinated species with unique and separate male and female organs allowing techniques from both self and cross-pollinated crops to be utilized. As a consequence, a diverse set of breeding methods can be utilized for the development of various maize cultivar types for all economic conditions (e.g., improved populations, inbred lines, and their hybrids for different types of markets). Maize breeding is the science of maize cultivar development. Public investment in maize breeding from 1865 to 1996 was \$3 billion (Crosbie et al., 2004) and the return on investment was \$260 billion as a consequence of applied maize breeding, even without full understanding of the genetic basis of heterosis. The principles of quantitative genetics have been successfully applied by maize breeders worldwide to adapt and improve germplasm sources of cultivars for very simple traits (e.g. maize flowering) and very complex ones (e.g., grain yield). For instance, genomic efforts have isolated early-maturing genes and QTL for potential MAS but very simple and low cost phenotypic efforts have caused significant and fast genetic progress across genotypes moving elite tropical and late temperate maize northward with minimal investment. Quantitative genetics has allowed the integration of pre-breeding with cultivar development by characterizing populations genetically, adapting them to places never thought of (e.g., tropical to short-seasons), improving them by all sorts of intra- and inter-population recurrent selection methods, extracting lines with more probability of success, and exploiting inbreeding and heterosis. Quantitative genetics in maize breeding has improved the odds of developing outstanding maize cultivars from genetically broad based improved populations such as B73. The inbred-hybrid concept in maize was a public sector invention 100 years ago and it is still considered one of the greatest achievements in plant breeding. Maize hybrids grown by farmers today are still produced following this methodology and there is still no limit to genetic improvement when most genes are targeted in the breeding process. Heterotic effects are unique for each hybrid and exotic genetic materials (e.g., tropical, early maturing) carry useful alleles for complex traits not present in the B73 genome just sequenced while increasing the genetic diversity of U.S. hybrids. Breeding programs based on classical quantitative genetics and selection methods will be the basis for proving theoretical approaches on breeding plans based on molecular markers. Mating designs still offer large sample sizes when compared to QTL approaches and there is still a need to successful integration of these methods. There is a need to increase the genetic diversity of maize hybrids available in the market (e.g., there is a need to increase the number of early maturing testers in the northern U.S.). Public programs can still develop new and genetically diverse products not available in industry. However, public U.S. maize breeding programs have either been discontinued or are eroding because of decreasing state and federal funding toward basic science. Future significant genetic gains in maize are dependent on the incorporation of useful and unique genetic diversity not available in industry (e.g., NDSU EarlyGEM lines). The integration of pre-breeding methods with cultivar development should enhance future breeding efforts to maintain active public breeding programs not only adapting and improving genetically broad-based germplasm but also developing unique products and training the next generation of maize breeders producing research dissertations directly linked to breeding programs. This is especially important in areas where commercial hybrids are not locally bred. More than ever public and private institutions are encouraged to cooperate in order to share breeding rights, research goals, winter nurseries,

managed stress environments, and latest technology for the benefit of producing the best possible hybrids for farmers with the least cost. We have the opportunity to link both classical and modern technology for the benefit of breeding in close cooperation with industry without the need for investing in academic labs and time (e.g., industry labs take a week vs months/years in academic labs for the same work). This volume, as part of the Handbook of Plant Breeding series, aims to increase awareness of the relative value and impact of maize breeding for food, feed, and fuel security. Without breeding programs continuously developing improved germplasm, no technology can develop improved cultivars. Quantitative Genetics in Maize Breeding presents principles and data that can be applied to maximize genetic improvement of germplasm and develop superior genotypes in different crops. The topics included should be of interest of graduate students and breeders conducting research not only on breeding and selection methods but also developing pure lines and hybrid cultivars in crop species. This volume is a unique and permanent contribution to breeders, geneticists, students, policy makers, and land-grant institutions still promoting quality research in applied plant breeding as opposed to promoting grant monies and indirect costs at any short-term cost. The book is dedicated to those who envision the development of the next generation of cultivars with less need of water and inputs, with better nutrition; and with higher percentages of exotic germplasm as well as those that pursue independent research goals before searching for funding. Scientists are encouraged to use all possible breeding methodologies available (e.g., transgenics, classical breeding, MAS, and all possible combinations could be used with specific sound long and short-term goals on mind) once germplasm is chosen making wise decisions with proven and scientifically sound technologies for assisting current breeding efforts depending on the particular trait under selection. Arnel R. Hallauer is C. F. Curtiss Distinguished Professor in Agriculture (Emeritus) at Iowa State University (ISU). Dr. Hallauer has led maize-breeding research for mid-season maturity at ISU since 1958. His work has had a worldwide impact on plant-breeding programs, industry, and students and was named a member of the National Academy of Sciences. Hallauer is a native of Kansas, USA. José B. Miranda Filho is full-professor in the Department of Genetics, Escola Superior de Agricultura Luiz de Queiroz - University of São Paulo located at Piracicaba, Brazil. His research interests have emphasized development of quantitative genetic theory and its application to maize breeding. Miranda Filho is native of Pirassununga, São Paulo, Brazil. M.J. Carena is professor of plant sciences at North Dakota State University (NDSU). Dr. Carena has led maize-breeding research for short-season maturity at NDSU since 1999. This program is currently one the of the few public U.S. programs left integrating pre-breeding with cultivar development and training in applied maize breeding. He teaches Quantitative Genetics and Crop Breeding Techniques at NDSU. Carena is a native of Buenos Aires, Argentina. <http://www.ag.ndsu.nodak.edu/plantsci/faculty/Carena.htm>

[Applied Quantitative Genetics](#) Academic Press

Plants have been successfully selectively bred for thousands of years, culminating in incredible yields, quality, resistance and so on that we see in our modern day crops and ornamental plants. In recent years the techniques used have been rapidly advanced and refined to include molecular, cell and genetic techniques. An Introduction to Plant Breeding provides comprehensive coverage of the whole area of plant breeding. Covering modes of reproduction in plants, breeding objectives and schemes, genetics, predictions, selection, alternative techniques and practical considerations. Each chapter is carefully laid out in a student friendly way and includes questions for the reader. The book is essential reading for all those studying, teaching and researching plant breeding. *Theory, Methods, Applications, and Data Analysis* Springer Science & Business Media  
 It is shown how general combining ability values (GCA's) from cross-, open-, and self-pollinated progeny can be derived in a single analysis. Breeding values are employed to facilitate explaining genetic models of the expected family means and the derivation of the GCA's. A FORTRAN computer program also includes computation of specific combining ability values and several options.



### Encyclopedia of Animal Cognition and Behavior World Scientific

Crossover is a laboratory manual and computer program that work together to teach the principles of genetics. Designed to complement regular textbooks and classroom instruction, Crossover consists of thirty-five modules that can be tailored to fit genetics courses at several levels. Examples, interactive computer models, problems, and self-tests all help students understand difficult concepts and learn the basic mathematical skills needed to study contemporary theories of genetics, evolution, and breeding. The easy-to-use tutorial system lets students work at their own pace. Features include: \* In-depth investigations of meiosis, genetic ratios, linkage mutation, natural selection, Hardy-Weinberg equilibrium, artificial selection, quantitative genetics, breeding methods, mating designs, plant patent law, and the use of molecular markers \* A computer model that allows students to manipulate genetic parameters and compare outcomes. Students can observe evolution and artificial selection in action \* A "Major Concepts" section at the beginning of each chapter to help students focus on the important material to be learned \* A visual, easy-to-understand presentation of material \* Exercises based on genetic data and analyses from actual research projects \* Several stages of complexity within each area of instruction. \* Instant grading of exercises \* "Suggested Readings" at the end of each chapter to direct the student to related books, articles, and computer programs.

### Mendelian to Molecular Approaches Editions Quae

The Book Presents A Comprehensive Account Of The Concept And Genesis Of Diverse Biometrical/Statistical Models As Applied To Plant Breeding Experiments Under Different Situations. Generation And Statistical Treatment Of Data; Presentation, Interpretation And Inferences Of Results; Merits, Demerits And Situations Of Applicability Of Models Are All Explicated For Their Adequate And Appropriate Usage In Plant Breeding. The Whole Volume Comprising 25 Chapters Has Been Zipped Into Five Sections Elucidating; General Statistical/Biometrical Parameters And Field Designs (Chapters 1-4), Multivariate Analysis Of Genetic Divergence (Chapters 6-7), Genotype X Environment Interaction And Stability Parameters (Chapters 8-10), Analysis Of Nature Of Gene Action And Variance Components (Chapters 11 -23), And Lastly The Unique Analysis Of Statistical And Genetical Parameters Related To Selection And Mutation Experiments (Chapters 24-25) In Plant Breeding. Simplification Of The Bewildering Complexities Of Biometrical Notations And Procedures In A Language Which Could Easily Be Grasped By Biologists/Geneticists Having Little Or No Statistical Background Is The Hallmark Of The Treatise. Like A Ready-Reckoner, This Work Offers An Efficient Key To Plant Breeding Data-Management For Both Students And Professional Plant Breeders Alike In Pursuit Of Their Research Goals.

### Estimation of Genetic Parameters Under Optimal and Suboptimal Environments for Body Weight in Chicken Using a Diallel Mating System Springer Science & Business Media

This book discusses special modifications and extensions of designs that arise in certain fields of application such as genetics, bioinformatics, agriculture, medicine, manufacturing, marketing, etc. Well-known and highly-regarded contributors have written individual chapters that have been extensively reviewed by the Editor to ensure that each individual contribution relates to material found in Volumes 1 and 2 of this book series. The chapters in Volume 3 have an introductory/historical component and proceed to a more advanced technical level to discuss the latest results and future developm.

### Plant Breeding Reviews LAP Lambert Academic Publishing

This book presents basic information about population genetics, quantitative genetics, breeding methods and creation of new varieties taking into account the particular characteristics of autopolyploidy. A number of results are given as a function of ploidy level, the case of diploidy being considered as a specific case. QTL detection and marker assisted selection are also addressed. This book is intended for researchers working on autopolyploid species, as well as for lecturers and students who want to gain better knowledge of these issues by considering the ploidy level. It will also be valuable to breeders wishing to choose methods for breeding and creating the most adapted varieties.

### Advances in Molecular Breeding Toward Drought and Salt Tolerant Crops Concept Publishing Company

With near-comprehensive coverage of new advances in crop breeding for drought and salinity stress tolerance, this timely work seeks to integrate the most recent findings about key biological determinants of plant stress tolerance with modern crop improvement strategies. This volume is unique because it provides exceptionally wide coverage of current knowledge and expertise being applied in drought and salt tolerance research.

### Elements Of Bio Metrical Genetics (revised And Enlarged Edition) John Wiley & Sons

Various forms of the diallel crosses play an important role in evaluating the breeding potential of genetic material in plant and animal breeding. In this paper we give the simple method of construction of partial diallel cross design through partially balanced incomplete block design as auxiliary design with the method of analysis and also see the importance of partial diallel cross design through partially balanced incomplete block design when large number of inbred line exist in plant and animal breeding experiment. We compare the efficiencies of our proposed designs with other existing designs for partial diallel cross in the literature and found that several our designs have higher A- and D-efficiency in comparison to the existing designs. The result provides a new partial diallel cross designs for plant and animal breeding experiments.

**Plant Breeding and Cultivar Development** Proper Analysis of the Diallel Mating Design Genetic Analysis of Diallel Tests of Loblolly Pine (Pinus Taeda L.). A new approach was developed for analyzing diallel tests with SAS PROC MIXED and PROC IML. The new method can estimate variance components, obtain BLUE (best linear unbiased estimators) of fixed effects and BLUP (best linear unbiased predictors) of random genetic effects simultaneously. A new formula based on BLUP was further developed to predict individual tree breeding values. This new analytical method was validated using computer simulation and was compared with other existing programs. To analyze disconnected diallel mating designs with more than one diallel, simulated data generated with known parameters were analyzed using BLUP to compare three alternative models, which include diallel as fixed effect (Model 1), random effect (Model 2) or no diallel effect (Model 3). Both Model 1 and Model 3 produced unbiased GCA (general combining ability) variance estimates, while Model 2 resulted in downward biased GCA variance estimate. The accuracy of BLUP prediction for three models was very close, with Model 3 slightly better than the other two. Statistical approaches were also evaluated for combining multiple disconnected diallel test series in a given region. The best GCA sample variance prediction in the class of linear combination of local variance estimates was derived. Simulation study showed that a checklot adjustment was very critical to improve the prediction of genetic values obtained using BLUP analysis. Additional adjustment with improved GCA sample variance prediction could improve the correlation slightly beyond checklot adjustment. Analysis of annual measurement through age 8 from a total of 275 parents, 690 full-sib families from 23 diallel tests of loblolly pine in Northern, Coastal and Piedmont test regions showed: 1) dominance variance was small (20-40% of total genetic variance) relative to additive variance; 2) heritability increased over time, and the magnitude of heritabilities for diameter at breast height (DBH) and volume was comparable with the. Quantitative and Ecological Aspects of Plant Breeding The book contains papers presented at a meeting by eucalyptus experts, scholars, consultants and

company managers from different countries and regions. The authors report: (1) the most recent advances in eucalyptus research from different perspectives — genetics, breeding, cultivation techniques, soil nutrition, plantation management, wood utilization, etc.; (2) the world-wide extension and development of the cultivated eucalyptus as a strategic forest tree with great economic, environmental and social significance; (3) plantation management merging ecological, environmental and legal concerns in operations practised by the private sector; (4) new approaches to utilization of eucalyptus woods. This book also represents a successful combination of academic research and practical operation in managing commercial eucalyptus plantations. Contents: Development and Ecological/Social Impact Breeding Method Genetic Testing and Improvement Nutrition and Site Management Plantation Management Wood Processing and Utilization Readership: Graduate students, academics, researchers, plantation foresters, and natural ecosystem and environmental conservationists. Keywords: Eucalyptus; R & D; Plantation; Cultivation; Management; Yield Improvement; Environment; Wood Utilization **Proper Analysis of the Diallel Mating Design** John Wiley & Sons

Latest figures suggest that approximately 20% of the world's population of six billion is malnourished because of food shortages and inadequate distribution systems. To make matters worse, it is estimated that some 75 billion metric tons of soil are removed annually from the land by wind and soil erosion, much of it from agricultural land, which is thereby rendered unsuitable for agricultural purposes. Moreover, out of a total land area under cultivation 96 of approximately 1.5 x 10 ha, some 12 x 10 ha of arable land are destroyed and abandoned worldwide each year because of unsustainable agricultural practices. Add to this the fact that the world population is increasing at the rate of a quarter of a million per day, and the enormity of the task ahead becomes apparent. To quote the eminent wheat breeder E. R. Sears, It seems clear that plant geneticists can look forward to an expanded role in the 21st century, particularly in relation to plant improvement. The success of these efforts may go a long way towards determining whether the world's increasing billions of humans will be adequately fed. Food for an ever-increasing population will have to be produced not only from an ever-diminishing, but from what will become an ever-deteriorating land resource unless justifiable environmental concerns are taken into account.

### Genetic Data Analysis for Plant and Animal Breeding Springer

Genetic improvement has played a vital role in enhancing the yield potential of vegetable crops. There are numerous vegetable crops grown worldwide and variable degrees of research on genetics, breeding and biotechnology have been conducted on these crops. This book brings together the results of such research on crops grouped as alliums, crucifers, cucurbits, leaf crops, tropical underground and miscellaneous. Written by eminent specialists, each chapter concentrates on one crop and covers cytology, genetics, breeding objectives, germplasm resources, reproductive biology, selection breeding methods, heterosis and hybrid seed production, quality and processing attributes and technology. This unique collection will be of great value to students, scientists and vegetable breeders as it provides a reference guide on genetics, breeding and biotechnology of a wide range of vegetable crops.

### Marker-Assisted Plant Breeding: Principles and Practices Springer Science & Business Media

Plant Breeding and Cultivar Development features an optimal balance between classical and modern tools and techniques related to plant breeding. Written for a global audience and based on the extensive international experience of the authors, the book features pertinent examples from major and minor world crops. Advanced data analytics (machine learning), phenomics and artificial intelligence are explored in the book's 30 chapters that cover classical and modern plant breeding. By presenting these advancements in specific detail, private and public sector breeding programs will learn about new, effective and efficient implementation. The insights are clear enough that non-plant breeding majoring students will find it useful to learn about the subject, while advanced level students and researchers and practitioners will find practical examples that help them implement their work. Bridges the gap between conventional breeding practices and state-of-the-art technologies Provides real-world case studies of a wide range of plant breeding techniques and practices Combines insights from genetics, genomics, breeding science, statistics, computer science and engineering for crop improvement and cultivar development

### Plant Breeding Alpha Science Int'l Ltd.

This book describes the experimental and analytical methodologies available for the genetical analysis of qualitative, quasi-quantitative and quantitative traits and its applications in practical plant breeding and evolution. Models for studying quantitative genetic variation following Birmingham and Edinburgh notations are described. The statistics used is simple and systematic so that the reader will have no difficulty in solving problems in plant genetics. It describes the genetic principles and provides breeding procedures underlying various breeding methods for manipulating qualitative, quasi-quantitative and quantitative traits. It takes into account the latest developments in breeding methodologies including dihaploidy and apomixis, applications of tissue culture for plant breeding use, genetic engineering for production of transgenics and hybrids, and molecular marker technologies in the analysis of quantitative trait loci, marker assisted selection, evolution and conservation of genetic resources. This book will be useful for undergraduates, postgraduates, teachers and researchers working in the field of genetics and plant breeding.

### Official Journal of the Indian Poultry Club John Wiley & Sons

Proper Analysis of the Diallel Mating Design Genetic Analysis of Diallel Tests of Loblolly Pine (Pinus Taeda L.).

### Plant Breeding International Potato Center

A 2 x 2 x 2N confounded diallel mating design (2 series, 2 males, N females per male per series) was used to obtain estimates of the genetic parameters in body weight traits in a noninbred population of New Hampshire chickens grown on 18% and 24% protein rations. Individual selection also was applied to evaluate the reliability of the genetic parameters obtained under each protein level. The analysis showed an extremely large contribution of series effects to the total variation in the traits which was attributed to the environmental influences from one series to the other and to the maternal environment. The component of variance due to series x male interaction was found to be small or zero under the 24% protein ration. An optimal environment may have given certain genotypes a greater opportunity to adapt to the environment. The higher estimates of the component of variance of series x female interaction for one-day body weight suggests the influence of maternal effects from one series to the other and from one dam to the other. Generally, estimates for the component of variance of male effects were higher under the 18% protein ration than under the 24% protein ration. Conversely, the component of variance of female effects showed higher values under the 24% protein ration than under 18% protein ration for most of the traits considered. ...

**Combining-ability determinations for incomplete mating designs** Springer Science & Business Media The properties of continuous variation are basic to the theory of evolution and to the practice of plant and animal improvement. Yet the genetical study of continuous variation has lagged far behind that of discontinuous variation. The reason for this situation is basically methodological. Mendel gave us not merely his principles of heredity, but also a method of experiment by which these principles could be tested over a wider range of living species, and extended into the elaborate genetical theory of today. The power of this tool is well attested by the speed with which genetics

has grown. In less than fifty years, it has not only developed a theoretical structure which is unique in the biological sciences, but has established a union with nuclear cytology so close that the two have become virtually a single science offering us a new approach to problems so diverse as those of evolution, development, disease, cellular chemistry and human welfare. Much of this progress would have been impossible and all would have been slower without the Mendelian method of recognizing and using unit differences in the genetic materials.

**Research, Management and Development** Springer Nature

APPLIED QUANTITATIVE GENETICS resulted from several years of teaching a graduate course on Quantitative Genetics in Plant Improvement. This book fills a critical need in that it presents topics for students from a practical standpoint & makes available some essential computer software. The book should also be useful to teachers & researchers in the areas of quantitative genetics & plant breeding. This publication covers the following topics: 1. Gene Action, genetic variances & effects, & mean; 2. Inbreeding & mating designs; 3. Diallel analyses; 4. Generation mean analysis; 5. North Carolina designs I, II, III; 6. Path coefficient analysis; 7. Heritability & selection; 8. Heterosis; 9. Genotype-by-environment interaction & stability analyses; & 10. Locating quantitative trait loci. The book places special emphasis on Diallel analyses, Stability analyses, & locating quantitative trait

loci; these three important topics either have not been covered at all or have been inadequately covered in currently available texts. The book is available for \$28.50 (shipping & handling included) to individuals or libraries. For students or for orders of four or more copies, the cost is \$24.50 per book. Payment in full may be sent to Dr. M. S. Kang, 2477 Creekside Dr., Baton Rouge, LA 70810-6966.

*Genetic Improvement of Vegetable Crops* Garland Science

This text provides a guide to the experimental and analytical methodologies available to study quantitative traits, a review of the genetic control of quantitative traits, and a discussion of how this knowledge can be applied to breeding problems and evolution.

*Diversity Study Based on Quality Traits and RAPD Markers and Investigation of Heterosis in Ethiopian Mustard* Springer

Plant Breeding Reviews is an ongoing series presenting state-of-the-art review articles on research in plant genetics, especially the breeding of commercially important crops. Articles perform the valuable function of collecting, comparing, and contrasting the primary journal literature in order to form an overview of the topic. This detailed analysis bridges the gap between the specialized researcher and the broader community of plant scientists.