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Book Reviews

Plant breeding — Analysis and exploitation of variation

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Text books on Plant Breeding by Indian authors which rigrously enunciate the principles of state of the art statistical and biometrical methods for analysing quantitative genetic variation are rather rare. The present book by Darbeshwar Roy under review is an unique effort in this direction.

The book is divided into 36 chapters comprehensively covering various aspects of plant breeding. The first chapter deals with biochemistry of the gene in brief followed by description of characters related to plant productivity, plant physiological concepts of photosynthesis, respiration, translocation and characters associated with resistance to abiotic stresses.

In the second chapter, basic concepts of classical genetics, laws of probability, estimation of gene frequency, genetic diversity and X^2 test of goodness of fit have been described.

The third chapter deals with systems in plant kingdom. Evolution of incompatability systems in plants, their genetic/physiological/biochemical basis and their utilization in plant breeding have been described. Genetic and cytoplasmic genetic male sterility systems have also been discussed.

The fourth chapter deals with analysis of quantitative traits. Applications of statistical/biometrical methods in the analaysis of quantitative traits have now become explicitly pragmatic. The basic principles underlying the test of significance, statistical inference, expectations of mean squares from random, fixed and mixed models form the subject matter of the 5th chapter. Brief description of a few field plot designs and their variations, techniques of univariate and multivariate regression and correlation, partial regression, as also the multivariate analysis such as principal component analysis, factor analysis, canonical analysis, discriminant function and principal coordinate analysis are also described in the chapter.

The next chapter 7 deals with analysis of means following the Birmingham school. Chapter 8 describes partitioning of variances, use of covariances and correlation between relatives and estimation of components of variance from a random mating population. Analysis of data from North Carolina I, II & III mating designs, and underlying models for genetic analysis of heterogeneous F_2 population maintained by random mating for estimating the average degree of dominance in the population have been described.

Diallel mating and analysis has been extensively used by plant breeders during past 50 years and is described in details in the 9th chapter. The method of diallel crossing was introduced as early as 1909 by Schmidt. Later many sophisticated statistical analyses based on diallel cross progenies were developed. Weaknesses of such analysis have been described. The varietal diallel cross based on Eberhart and Gardner, 1966 has also been given but explicit formulae for partitioning of meansquares from various derived populations have not been given. This is followed by analysis of 3-way crosses.

Fundamental to successful plant breeding is an understanding of genotype-environment interaction, its estimation and utilization in a breeding programme chapter 10 briefly describes statistical concepts and methods such as the univariate methods of regression analysis and stability parameters, multivariate methods using principal components and Bi-plot method. Weaknesses and limitations of such methods need further elaboration. Next section of this chapter deals with non-parametric methods available for analysing G × E interaction. The last but one section of this chapter describes the genotype × environment interaction at genetic level and is followed by last section on genetic control of environmental sensitivity.

Reciprocal differences that occur when both direct

and reciprocal crosses are attempted create problem in analysis of quantitative variation. Chapter 11 of the book is devoted to a study of such differences and their implications in drawing valid inferences from diallel cross and other mating designs.

The next chapter 12 deals with linkage disequilibrium, its detection and effect of random mating on linkage disequilibrium, followed by effect of linkage on covariances between relatives. This chapter also describes briefly, the effect of non-allelic interactions on estimation of variance components in different populations and detection of linked epistasis.

In the next chapter 13, a brief account of theories of heterosis is followed by a few statistical parameters for its estimation; the dominance ratio from genetic variances and effect of linkage disequilibrium on estimates of dominance ratio. The role of g × e interaction and maternal effects on heterotic expression is discussed. Also briefly described are the concepts of genetic distance/genetic divergence. Inbreeding depression and inbreeding in populations.

Chapter 14 on polyploids and haploids deals with genetic analysis of means and variances of auto tetraploids in random mating population followed by analysis of triploids, identification of haploids and effect of linkage disequilibrium on various statistics.

The next chapter 15 deals with competition in population of mixtures. Control of environmental variation in assesment of genetic worth of genotypes is an important consideration in plant breeding. Chapter 16 describes the methods of minimizing this environmental variation through various procedures. It also describes how sampling error arises and steps to minimize it. A brief description of Augmented designs is also provided Heritability of a metric trait is one of the most important property of a population. Chapter 17 gives definition and types, methods of estimation, effect of G × E interaction on heritability estimates and uses of the estimates of heritability and problem associated with such uses. Chapter 18 is on estimation of number of effective factors, though in the present day knowledge, the utility of such an information is doubtful.

Chapter19 describes the two features of skewness and krustosis which are useful for comparing anormal frequency distribution which may arise due to various causes. Effect of skewness on selection is briefly described.

Test of significance from statistical analysis and statistical inference is mostly based on assumptions of normality of the data. Next chapter deals with transfomation of scale e.g. for transforming Binomical and Poission to Normal distribution. However, inclusion of a method for identifying suitable transformations based on density function would have added value to this chapter.

Next chapter deals briefly with genetic structure of populations. Extensions of Hardy-Weinberg Law from one locus case to case of multiple alleles, sex linked genes and polygenic traits have been briefly given for random mating populations. Effect of non-random mating e.g. assortative mating, sib mating, negative assortative mating, self fertilization etc. have been briefly mentioned. Subsequent treatment of this topic is more or less in line with Falconer, e.g. effect of selection, mutation, migration and genetic drift etc. on a random mating population.

Evolution is the subject matter of chapter 22 listing briefly Darwinian principle of evolution. This is followed by mechanism of speciation. This chapter also covers the cytological and molecular basis of evolution finally concluding with crop evolution.

Selection is the foremost method for genetic improvement of populations. Chapter 23 of the book deals with selection theory and related concepts of selection differential, genetic gain and correlated response to selection. One section of this chapter is devoted to path analysis in terms of statistical concept of standard partial regression, residual effect etc. We hope this will help the students to understand the utility part of the analysis which has often been misused by students and plant breeders alike. We wish author should have given some attention to conditions where such analysis is applicable such as choice of characters, additive systems etc. Selection index is briefly described and followed by types of selection such as individual selection, family selection and within family selection.

Modes of reproduction (Chapter 24) are prelude for Breeding methods to be followed in self (Chapter 25) and cross (chapter 26) fertilizing species. In self fertilizing species four methods of breeding namely Pedigree, Bulk, Single seed descent and dihaploidy have been described. The variances for two methods of producing pure breeding lines for four different models i.e. (i) when population is in linkage equilibrium and epistasis is absent (ii) Epistasis present but linkage is in equilibrium, (iii) No epistasis but linkage disequilibrium exists and (iv) when both epistasis and linkage disequilibrium exist, have been described in terms of gene effects and genotypic frequencies.

The next chapter on hybrid breeding lists when to go for hybrids, types of hybrids, steps involved and methods for development of hybrids, single and 3-way cross hybrids, comparison of efficiency of different hybrids, use of incompatibility systems in hybrid

development, male sterility systems and methods of inducing male sterility.

A full chater (28) has been devoted to backcross methods of breeding, followed by a chapter each on Multiple crosses in plant breeding (Chapter 29), Synthetics & composited (Chapter 30) and Clone breeding (Chapter 31).

Variability for metric traits can be increased through induced mutations. Chapter 32 is devoted to Mutation Breeding in crop plants. It includes sections as (i) Mutagenic agents (2) Material suitable for induction of mutations, (3) Factors affecting the radio sensitivity (4) Isolation of useful mutants (5) Mutation breeding in vegetatively propagated plants and (6) Applications of *mutation breeding.*

Host parasite interactions are very important for breeding disease free plant varieties. In Chapter 33, host parasite interactions, physiological races and race classification, biotype of insects, virulence analysis and race survey, host resistance and types of resistances. mechanism of resistance, resistance to insects, induced resistance, genetics of resistance, hypovirulence and genetical analysis for disease resistance, disease progress, cure in epidemics, polycyclic and monocyclic diseases, deviation from logarithmic spread, disease assessment and problem with assessment, virulences and aggressiveness, gene for gene hypothesis for resistance to host and a gene for virulence, host insect interactions, analysis of aggressiveness, specificity of resistance, variability in pathogen population, variability in insects, selection, race competition and adaptability, genetic structures of pathogens, resistance breeding, breeding for race specific resistance, problems associated with breeding for horizontal resistance, multi line breeding for durable resistance, breeding for resistance to viruses, breeding for resistance to nematodes, breeding for tolerance, sources of resistance and gene transfer constitute important sections of this chapter.

The 34th chapter, and probably a very important one on the most important breeding methodology, is on application of Tissue culture and Genetic engineering, covering various aspects related with it, such as application of tissue culture and different culture techniques, genetic engineering, molecular marker technology, gene cloning, recombinant DNA technology. QTL analysis, molecular markers and marker assisted selection, application of molecular markers to studies of evolution etc. Thus, the chapter, the longest one in the book, covers the whole gamut of topics related with genetic engineering.

Chapter 35 deals with genetic resources, their *management, uses storage and gene bank.*

Chapter 36 is on Matrices, an important tool having wide utility in genetic analysis of polygenic traits. Some of the topics included are on matrix operation, method of obtaining inverse of a matrix, dispersion matrices, orthogonal matrices and diagnolization of a symmetric matrix.

At the end of each chapter, relevant references have been given.

The book can serve as an excellent text book for post graduate students of plant breeding. However, the author may consider formulating and adding questions at the end of each chapter, so that the students are able to judge their comprehension of the subject matter.

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