PLNT 7670 QUANTITATIVE GENETICS AND PLANT BREEDING

Instructor

Dr. A. L. Brûlé-Babel
Rm 247A Agriculture Building
474-6062 (Office)
E-mail: anita_brulebabel@umanitoba.ca
Office: Available for consultation on an appointment basis.

Objectives of the Course

Through this course students will be able to:

1) Understand quantitative genetic theory and principles as they apply to plant breeding.

2) Read, understand and evaluate literature involving quantitative genetics as it relates to plant breeding.

3) Design, execute, analyse, and interpret results of experiments involving polygenically controlled characters of interest in a plant breeding program.

For this course, students should have a solid understanding of genetics at the intermediate level, a good understanding of basic statistical principles (including analysis of variance, covariance and linear regression), and a thorough understanding of plant breeding principles.

Textbook (on reserve)

Falconer, D. S. and Mackay 1996. Introduction to Quantitative Genetics Fourth Edition. Longman Inc. New York. pp. 464. **This text is on 4 h reserve in the William Newman library. Note: Chapters listed in the course outline refer to chapters from this text.**

Other resources will be placed on reserve in the William Newman Library as required.

Grading

Assignments (Total of 6 @ 10% each)	60%
Major Paper and Presentations (Total of 1 @ 25% each)	25%
Participation in discussion	15%
Total	100%

Due dates will be established when assignments are issued.

Note: Academic dishonesty is a serious offence. Please refer to the General Academic Regulations and Requirements section in the Graduate Calendar for information on `plagiarism and cheating' and `examination personation'.

Evaluative feedback from some assignments will be provided prior to the final date for voluntary withdrawal from the class (March 18, 2011).

Reference Texts (not required)

Baker, R.J. 1986. Selection Indices in Plant Breeding. CRC Press, Inc. Florida. pp.218.

Bernardo, R. 2002. Breeding for Quantitative Traits in Plants. Stemma Press, Woodbury, MN. pp.369.

Crow, J.F. and Kimura, M. 1970. An Introduction to Population Genetic Theory. Harper & Row. New York. pp.591.

Doolittle, Donald P. 1987. Population Genetics: Basic Principles. Advanced Agricultural Series 16. Springer-Verlag. pp. 264.

Hallauer, A.R., Carena, M. J. and Miranda Filho, J.B. 2010. Quantitative Genetics in Maize Breeding. Handbook of Plant Breeding. Volume 6, 2010, DOI: 10.1007/978-1-4419-0766-0 Springer New York. Available on-line through U of M libraries.

Hartl, D.L. and Clark, A.G. 2007. Principles of Population Genetics. Fourth. Ed. Sinauer Associates, Inc. Massachusetts, U.S.A. pp. 652.

Kang, M.S. 2002. Quantitative Genetics, Genomics and Plant Breeding. CABI Publishing, Baton Rouge. pp. 400.

Li, C.C. 1976. First Course in Population Genetics. The Boxwood Press. U.S.A. pp.631.

Li, W.H. 1997. Molecular Evolution. Sinauer Associates, Inc. Massachusetts, U.S.A. pp.487.

Liu, B.H. 1998. Statistical Genomics. CRC Press. New York, U.S.A. pp. 611.

Lynch, M.L. and Walsh. B. 1998. Genetics and Analysis of Quantitative Traits. Sinauer Associates, Inc. Massachusetts, U.S.A. pp.980.

Mather, K. and Jinks, J.L. 1982. Biometrical Genetics. Chapman and Hall. Great Britain. pp. 396.

Mayo, O. 1987. The Theory of Plant Breeding Second Edition. Oxford University Press. New York. pp.334.

Roughgarden, J. 1996. Theory of Population Genetics and Evolutionary Ecology. Prentice Hall, Upper Saddle River, NJ. pp. 612.

Sleper, D. A. and Poehlman, J.M. and 2006. Breeding Field Crops. Iowa State University Press. pp.424.

Steel, R.G.D. and Torrie, J.H. 1980. Principles and Procedures of Statistics Second edition. McGrae-Hill Book Company. U.S.A. pp.633.

Weir, B.S., Eisen, E.J., Goodman, M.M. and Namkoog, G. (Editors). 1988. Proceedings of the Second International Conference on Quantitative Genetics. Sinaur Associates, Inc. U.S.A. pp.724.

Weisling, K., Nybom, H., Wolff, K., and Kahl, G. 2005. DNA Fingerprinting in Plants – Principles, Methods and Applications. Second Edition. CRC Press Inc. Taylor & Francis Group. Boca Raton, FL. pp. 444. **(This text is on 4 h reserve in the William Newman Library).**

Wricke, G. and Weber, W.E. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter & Co. Berlin. pp. 406.

Wu, R. Ma, C.X. and Casella, G. 2007. Statistical Genetics of Quantitative Traits: Linkage, Maps, and QTL. Springer New York. . Available on-line through U of M libraries. For SpringerLink: http://dx.doi.org/10.1007/978-0-387-68154-2

Other references will be provided as required throughout the course.

COURSE OUTLINE

PLNT 7670 QUANTITATIVE GENETICS AND PLANT BREEDING

1. INTRODUCTION

- Genetic basis of population and quantitative genetics

2. MEASURMENT OF GENETIC VARIATION

- Phenotype
- Genotype
- Product-based variation
  - Visible traits
  - Protein-based
- DNA-based variation
  - RFLPs
  - RAPDs
  - AFLPs
  - SSRs

3. GENETIC STRUCTURE OF POPULATIONS (Chapter 1, Falconer and Mackay)

- Hardy-Weinberg Law
- Single Locus
- Multiple Alleles
- Multiple Loci
- Autosomal Linkage

4. SYSTEMATIC FORCES (Chapters 2 and 11, Falconer and Mackay)

- Migration
- Mutation
- Selection
  - Average fitness
  - Selective Advantage
  - Changes in gene frequency with phenotypic selection
  - Standardized selection differential
  - Probability of fixation

5. DISPERSIVE FORCES (Chapters 3, 4, and 5, Falconer and Mackay)

- Small Populations

  - Effective population size
  - Probability of fixation
- Wright's Inbreeding Coefficient F
- Coefficient of Coancestry
- Pedigreed Inbreeding
  - selfing
  - full-sibs and half-sibs
  - backcrossing
  - parent-offspring matings
- Effect of Population Size on Inbreeding

6. REVIEW OF STATISTICAL CONCEPTS

- Frequency Distributions
- Population Parameters and Sample Estimates
- Mean, Variance, Covariance, Correlation and Regression
- Expectations of Mean Squares

7. GENETIC VALUES AND MEANS (Chapter 7, Falconer and Mackay)

- Genotypic Value
- Average Effect
- Breeding Value

8. GENETIC VARIANCE (Chapters 8, Falconer and Mackay)

- Additive Genetic Variance
- Dominance Genetic Variance
- Interaction Variance

9. COVARIANCES AMONG RELATIVES (Chapter 9, Falconer and Mackay)

- Offspring and One Parent
- Offspring and Mid-Parent
- Full-sibs
- Half-sibs
- Intraclass Correlation
- Estimation of Genotypic Variances

10. GENOTYPE-ENVIRONMENT INTERACTION (Selected papers to be provided as this section is covered)

- Theoretical Model

- Operational Model
- Analysis of Genotype-Environment Interaction
  - analysis of variance
  - joint regression
  - genotypic correlations
  - cross-over interactions

11. HERITABILITY (Chapter 10, Falconer and Mackay)

- Comparison of Definitions of Heritability
- Methods of Estimating Heritability
  - offspring-parent relationships
  - sib-analysis
  - selection experiments
- Precision of Estimates of Heritability

12. RESPONSE TO SELECTION (Chapters 11, 12 and 13, Falconer and Mackay; Chapter 6, Hallauer et al. 2010; Crow and Kimura)

- Expected Response
- Schemes for Artificial Selection
  - mass selection
  - single seed descent
  - full-sib family selection
  - half-sib family selection
  - within-family selection
  - sib selection
- Variance of Response to Selection
- Practical Considerations

13. MULTIPLE TRAIT SELECTION (Chapters 18 and 19, Falconer and Mackay and selected references to be provided as this section is covered)

- Genotypic Correlation
- Indirect Selection
- Multiple Trait Selection
  - Tandem Selection
  - Independent Culling
  - Selection Indices
  - Combined Selection

14. METHODS FOR STUDYING QUANTITATIVE GENETICS (Selected references to be provided as this section is covered)

- Diallel Analysis
- North Carolina Design I, II, III
- Generation Mean Analysis

15. QUANTITATIVE TRAIT LOCI (Chapter 21, Falconer and Mackay and selected references to be provided as this section is covered)

- Genetic Markers
- Construction of Genetic Maps
- Statistical Analyses and Confidence Intervals
- Identification and Verification of QTL