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**QUANTITATIVE GENETICS OF MAIZE (*Zea mays L.*)
DURING SEEDLING ESTABLISHMENT
UNDER COOL CONDITIONS**

**A thesis presented in partial fulfillment of the requirements
for the degree of Master of Agricultural Science in
Plant Science at Massey University**

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*' Whoever recommends and helps a good cause, becomes a partner therein.
And whoever recommends and helps an evil cause, shares in its burden.
And Allah hath power over all things.'*

(The Holy Qur'an : 4 : 85)

Abstract

Two experiments were conducted to study cool tolerance in maize (*Zea mays* L.). The first experiment was carried out under controlled environment to evaluate several genotypes from five synthetic populations which are currently being used to develop hybrid maize for better adaptation to New Zealand climate and to study the quantitative inheritance of maize seedling growth under cool conditions. In this study, diurnal temperature of 16 °C day/6 °C night was used and characters related to seedling growth were examined.

The second experiment conducted to study the effect of temperature on maize during its early growth and to examine whether the initial seed constitution and germination characteristics could be used as selection criteria for improvement of the subsequent seedling growth. Eleven physical, chemical, and morphological characters were measured. The growth was studied in germinators under two temperature regimes of 25/20 and 16/6 °C.

The genotypic variation was highly significant for all nine characters examined in the first experiment. For the three repeatedly measured characters (i.e. chlorophyll content, shoot and root dry masses), the genotype x time interaction effect was significant. In the second experiment, the variation due to genotypic difference was highly significant only for the initial seed constitution characters and the amount of ion leakage during the early hours of germination process. It was non significant for the time to germinate, seedling growth rates, and seedling growth functions. The variation due to the difference of temperature regimes was significant for the time to germinate and seedling growth but not the growth functions.

The genotypes of synthetic line NZS3 showed the best performance for general combining ability (GCA) for almost all characters studied in the first experiment. From all genotypes evaluated, however, only few of them consistently showed good GCA over the characters.

Four of the characters studied in the first experiment had moderate to high narrow sense heritabilities, namely total leaves at 50 days after planting (82 %), chlorophyll content (46 %), anthocyanin (69%), and leaf area (62 %). In the second experiment, the estimated broad sense heritabilities observed ranged from very low to very high over all characters. The high broad sense heritabilities were recorded on most of the initial sees constitution characters, the conductivity of ion leakage, and the growth rates of root (length) and shoot (dry mass).

Both the phenotypic and genotypic correlation coefficients between pairs are in good agreement and followed the same direction. Amongst the characters examined in the first experiment only time to achieve second mature leaf, total leaf number at 50 day after planting, chlorophyll content, leaf area had considerable correlations to the dry masses. In the second experiment a good correlation with growth rate was observed for the seed weight, nitrogen and maltose contents.

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Table of Contents

	Page
1. Introduction	1
2. Review of Literature	3
2.1. Maize distribution and adaptation	3
2.2. Maize germination and seedling growth at low temperature	4
2.3. Breeding for cool tolerance	9
2.3.1. Germplasm for cool tolerance	9
2.3.2. Genetic variation	10
2.3.3. Nature of inheritance	11
2.3.4. Screening technique	12
2.3.5. Plant improvement	13
2.4. Quantitative genetic analysis	15
2.4.1. Quantitative character and plant improvement	15
2.4.2. Estimation of variance component	18
2.4.3. Estimation of genetic variation	20
2.4.4. Estimation of heritability	21
2.4.5. Correlation among characters	23
3. Testcross Evaluation for Cool Tolerance During Seedling Establishment	25
3.1. Objective	25
3.2. Materials	25
3.3. Environment	29
3.4. Cultural	31
3.5. Harvest	31
3.6. Data collection and measurement	31

3.7.	Data analysis	34
3.7.1.	Statistical analysis	34
3.7.2.	Genetical analysis	44
3.7.2.1.	Genetic variance estimation	44
3.7.2.2.	Heritability estimation	45
3.7.2.3.	Correlation analysis	49
3.8.	Results	50
3.8.1.	General values	50
3.8.2.	Variance component estimates	50
3.8.2.1.	Variance components of environmental effects	50
3.8.2.2.	Variance of genotypic effects	56
3.8.3.	Means discrimination	57
3.8.4.	Genetic variance and heritability estimates	87
3.8.5.	Phenotypic and genetic correlation estimates	89
4.	Genotypic Variability in Initial Seed Constitution, Germinability, and Seedling Growth	92
4.1.	Objectives	92
4.2.	Materials	92
4.3.	Experimental	93
4.3.1.	Determination of initial chemical composition of the seeds	93
4.3.2.	Determination of ion leakage	94
4.3.3.	Evaluation of germination and seedling growth performance	94
4.4.	Data analysis	95
4.4.1.	Statistical analysis	95
4.4.2.	Genetical analysis	101
4.4.2.1.	Estimation of Heritability	101
4.4.2.2.	Correlation analysis	102

4.5.	Results	102
4.5.1.	General values	102
4.5.2.	Germinative change	104
4.5.3.	Heritability estimate	114
4.5.4.	Phenotypic and genotypic correlation estimates	117
5.	Discussion	121
5.1.	Genetic study	121
5.2.	Lines evaluation	122
5.3.	Physiological study	123
6.	Conclusion	124
	References	126
	Appendices	135

List of Tables

	Page
3.1. Exp.I. Genotypes and their generation	26
3.2. Exp.I. Pedigree of the synthetic populations	30
3.3. Exp.I. The degree of freedom, expectation of Mean Square, and F-ratio for nested design (Model I)	38
3.4. Exp.I. The degree of freedom, expectation of Mean Square, and F-ratio for Randomized Complete Block design (Model II)	39
3.5. Exp.I. The degree of freedom, expectation of Mean Square, and F-ratio for Split Plot in Time (Model III)	41
3.6. Exp.I. The degree of freedom, expectation of Mean Square, and F-ratio for Extended Split Plot in time (Model IV)	43
3.7. Exp.I. Genotypes and their inbreeding coefficient	46
3.8. Exp.I. The grand Means, their range and coefficient of variations	51
3.9. Exp.I. Variance component estimates involving genotypic effect, their standard errors and significances	52
3.10. Exp.I. Variance component estimates involving environmental effect, their standard errors and significances	53
3.11. Exp.I. Contrast amongst the origin group of the genotypes	58
3.12. Exp.I. Discrimination among genotypic means for emergence time (EMERGE)	59
3.13. Exp.I. Discrimination among genotypic means for number of day to attain second mature leaf(2MATLEAF)	62
3.14. Exp.I. Discrimination among genotypic means for total leaves at 50 days after planting (TOTLF50D)	65
3.15. Exp.I. Discrimination among genotypic means for chlorophyll concentration (CHPHYLL)	68

3.16.	Exp.I. Discrimination among genotypic means for anthocynin score (ANTHOCY)	71
3.17.	Exp.I. Discrimination among genotypic means for leaf area (LFAREA)	74
3.18.	Exp.I. Discrimination among genotypic means for leaf thickness (LFTHICK)	77
3.19.	Exp.I. Discrimination among genotypic means for shoot mass (SHOOT)	80
3.20.	Exp.I. Discrimination among genotypic means for root mass (ROOT)	83
3.21.	Exp.I. Additive genetic varianc and heritability estimates	88
3.22.	Exp.I.Phenotypic correlation (r_p) amongst characters pairs and their significances	90
3.23.	Exp.I.Genotypic correlation (r_c) amongst characters pairs and their significances	91
4.1.	Exp.II. The degree of freedom, Expectation of Mean square, and F-ratio for Completely Random Design (Model I)	97
4.2.	Exp.II. The degree of freedom, Expectation of Mean square, and F-ratio for Pooled-RCBD (Model I)	99
4.3.	Exp.II. The grand means, their range values and coefficient of variations	103
4.4.	Exp.II. Variance components and their standard errors and significances for the initial seed constitution characters	105
4.5.	Exp.II. Variance components and their standard errors and significances for germinability and seedling growth rate characters.	106
4.6.	Exp.II. Wilks' generalized variance components and their standard errors and significances for seedling growth functions	107
4.7.	Exp.II. Zhivotovsky's generalized variance components and their standard errors and significances for seedling growth functions	108

4.8.	Exp.II. Discrimination amongst genotypic means for the initial seed constitution characters	109
4.9.	Exp.II. Discrimination amongst genotypic means for germination and seedling growth characters	110
4.10.	Exp.II. Discrimination between two environmental means for germination and seedling growth characters	111
4.11.	Exp.II. Discrimination amongst Least Square Means of Genotypic-Environmental interaction for germination and seedling growth rate characters	112
4.12.	Exp.II. Heritability estimates of the initial seed constitution characters	115
4.13.	Exp.II. Heritability estimates of the germination and seedling growth rate characters	115
4.14.	Exp.II. Heritability estimates of the seedling growth function characters (Estimated from Wilks' generalized variances)	116
4.15.	Exp.II. Heritability estimates of the seedling growth function characters (Estimated from Zhivotovsky's generalized variances)	116
4.16.	Exp.II. Phenotypic correlation (r_p) amongst characters pair and their significances	118
4.17.	Exp.II. Genotypic correlation (r_G) amongst characters pair and their significances	119

1. Introduction

Maize (*Zea mays L.*) is generally recognized as a thermophilic crop. It requires a relatively high temperature to achieve an optimal growth and development. Nevertheless, for several reasons maize cultivation has been extended to areas that cannot fulfill this condition. Indeed, maize has become a crop of increasing importance in temperate regions situated at latitudes ranging from 30-55° (Shaw, 1977) of which the northern United States, Canada, and Western Europe are outstanding examples. At these latitudes a frost free growing period is relatively short. Of equally importance is that in spring, in which maize is commonly sown, the temperature is above freezing but still below the threshold of the plant growth and this condition is often responsible for the crop failure. Consequently, the availability of maize varieties that are capable of rapid emergence and of becoming well established in such environments would be most important.

For many years, considerable effort has been expended to understand cool tolerance and how maize lines can be developed toward more endurance in cool conditions. To date, some physiological and genetical aspects of the cool tolerance in maize have revealed. Furthermore, the source of germplasms from which the cool tolerance genes can be obtained have been reported several workers. Mock and Eberhart (1972), for instance, have demonstrated that maize germplasm of the U.S. Corn Belt Dent possessed adequate genetic variation for cool tolerance to permit its improvement through selection. Recent researches (Eagles and Hardacre, 1979; Eagles *et al.*, 1983) showed that populations containing germplasm of highland tropical origin had better seedling performances under 10 °C compared to the U.S. Corn Belt Dent.

Recurrent selection method has been extensively used in maize breeding programmes to improve many characters of economic importance. With respect to the improvement for cool tolerance, Mock and Bakri (1976) have

showed that recurrent selection could be used effectively to improve this character of maize genotypes adapted to the Central U.S. Corn Belt.

In maize hybrid breeding program, the value of a population for improvement by recurrent selection and as a source of inbred line depends on the mean performance of the population and on the genetic variability in the population for the traits of economic importance. To determine such value, progeny testing is commonly used.

The present study is conducted in two experiments. The first experiment, described in chapter 2, focused on evaluation of maize populations which are currently being use to developed maize hybrid with better adaptation to New Zealand climate and to study the quantitatative inheritance of seedling growth under cool conditions. The second experiment, described in chapter 3, was aimed to study the effect of temperature on maize during its early growth and to examine if the initial seed constitution and germination characteristics could be used as selection criteria for improvement of the subsequent seedling growth.