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

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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 quatitative 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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1. Introduction

Maize *(Zea mays L.)* is generally recognized as a thermophylic 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 lattitudes ranging from 30-55° (Shaw, 1977) of which the northern United States, Canada, and Western Europe are outstanding examples. At these lattitudes 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 treshold 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 efford 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 importants. 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 quantititative 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.