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EVALUATION OF CHANGES IN ADAPTED X EXOTIC MAIZE POPULATIONS IMPROVED BY ADAPTIVE MASS SELECTION

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EVALUATION OF CHANGES IN ADAPTED x EXOTIC MAIZE POPULATIONS IMPROVED BY ADAPTIVE MASS SELECTION

by

WILSON Y.F.MARANDU

A DISSERTATION

Presented to the Faculty of

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Prof. William A.Compton

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TITLE

Evaluation of changes in adapted x exotic maize populations

improved by adaptive mass selection.

BY

Wilson Y. F. Marandu

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EVALUATION OF CHANGES IN ADAPTED x EXOTIC MAIZE POPULATIONS IMPROVED BY ADAPTIVE MASS SELECTION.

by W.Y.F. Marandu Ph.D.

University of Nebraska - Lincoln.

Advisor: Dr. W.A.Compton

Populations containing exotic germplasm undergoing adaptive mass selection (AMS) in Nebraska were evaluated in two seasons. Incorporation of exotic germplasm populations was done by crossing them with adapted Corn Belt varieties, except in one case in which both parental populations were exotic. Backcrosses to the adapted parental population or random mating of the population hybrids was done for several generations before beginning AMS which was based on early maturity, yield assessed visually on the ear, number of ears per plant and freedom from disease. Two Corn Belt varieties were advanced in the same way as the semi-exotic populations as checks. The populations were grown in isolation plots each year as cycles were advanced.

This study was done to evaluate these populations by comparing two generations from each population as far apart as possible. A Stiff Stalk Synthetic population improved by S1 testing scheme was included in the study as a check. Randomized Complete Block Design with split-plot arrangement was used, with populations as whole plots and generations as sub-plots. The experiments were repeated under five moisture regimes.

The results suggest that AMS was effective in changing yield and maturity of the semi-exotic populations in the desired direction. Yield increases were associated with increased number of ears per plant, earlier maturity for the late maturing plants, decrease in silk delay and better stability under low yielding environments. The method failed to increase the proportion of upright plants resulting in significant decrease in some populations. Plant and ear heights decreased in most populations. Response to a yield index was inconsistent due to genotype x environment interactions.

It is suggested that some of the populations need to be further improved for other important traits by mass selection or other selection schemes.

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W.Y.F.M.

DEDICATED

to

Fathaeli & Lea Marandu; Arnold & Helina Msele

Juliet, Inno, Doreen & Sia

Melck, David, Robert & Ernest.

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INTRODUCTION

Genetic improvement of crops depends on availability of genetic variability. Commercial maize hybrids currently being grown in the United States of America have been derived from a relatively narrow genetic base. Since the advent of hybrids in the 1930's many breeders have been primarily concerned with the development of inbred lines that could be used to produce hybrid seed. To a much lesser extent maize breeders have been concerned with the long-term consequences of genetic uniformity. De Wet (1978) stated that the gene pools used in breeding programs are being rapidly eroded away by replacing traditional local materials with experimentally bred lines. A few breeders have recognized this problem and have long-term objectives that include widening of the genetic base of populations currently undergoing selection.

A major limitation to widening of the genetic bases of breeding populations is the cost to the breeder in terms of labour and time. Population improvement programs have the major objective of developing better sources of germplasm. Different selection methods are used in population improvement

programs to pursue the objective in the most efficient way, depending on the type of materials available and the short term objectives of the breeder. The balance between long- and short-term objectives is often hard to decide when time and labour costs are considered. In some cases the breeder is forced to forego some of the advantages of well-balanced list of goals in order to get fast progress in the shortest period of time. Although quantitative genetic theory and empirical data are used to develop selection methods, these methods have to be practised in prevailing conditions. If in the future, contrasting conditions occur, such as new pests, diseases or even a radical change in agronomic practices, the improved populations originating from wide genetic bases are more likely to have the desired variability than those originating from narrow genetic bases.

The use of local germplasm to widen the genetic base is not particularly promising because in many cases the ancestry of such materials can be traced back to a limited level of diversity. It is in such situations that exotic germplasm becomes useful and has been used by some breeders to increase variability and widen the genetic bases of their

breeding populations successfully.

Hallauer and Miranda (1981) defined exotic germplasm to include all germplasm that does not have immediate usefulness without selection for adaptation for a given area. They suggest that because of poor adaptation it is not advisable to use exotic germplasm in breeding programs simply because it is exotic. Very often the choice of exotic germplasm is made based on a search for genes conditioning specific traits which can be introduced into the breeding populations, lines or cultivars. The exotic germplasm of choice can range from an improved cultivar to the wild relatives of maize. In any case, the use of exotic germplasm often introduces agronomically undesirable genes that must be eliminated by selection.

The task of adapting a newly formed breeding population and eliminating agronomically undesirable traits may require long periods of time and resources. For this reason there is need to look for cheap and simple schemes for adapting exotic germplasm to the environment in which it is expected to be used.

This study is part of a long-term program to study adaptation using a number of exotic maize

populations at Lincoln, Nebraska. The objectives of this study are:

1) to evaluate changes that occurred after several generations of mild mass selection for some adaptive traits,

2) to evaluate correlated response in agronomic traits for which no selection has been done and

3) to study the response of the selected populations to seasonal and irrigation regime environments at Lincoln, Nebraska.

LITERATURE REVIEW

Need for Exotic Germplasm.

Since the early 1950's, the need for using exotic germplasm in maize breeding programs has been emphasized by various researchers including Brown (1953), Wellhausen (1965), Brandolini (1969), Hallauer and Sears (1972), Lonnquist (1974), Brown and Goodman (1977), and Compton, Mumm and Mathema (1979). Often exotic germplasm has been viewed as a source of single genes to meet immediate needs. Efforts to collect and characterize the various races of maize in Central and South America have been continued and some breeders have developed an interest in using some of the races for improvement of their breeding populations. The outbreak of Southern Corn Leaf Blight fungus (*Helminthosporium maydis* Nisik. & Miy.) in 1970 caused concern among breeders about genetic vulnerability in maize and other crops owing to their narrow genetic bases (National Academy of Science, 1972). Partly as a result of the anticipated danger of narrow genetic base and partly as a result of work done previously, the importance of exotic germplasm for long-term objectives has been realized and considered more

seriously. Exotic germplasm can be used to increase genetic variance in a breeding population. Goodman (1965) studied the effect of adding exotic germplasm to adapted maize by using a series of half-sib and full-sib families from the Corn Belt Composite and the West Indian Composite. The West Indian Composite was obtained by crossing superior West Indian types with the same inbred lines used in developing the Corn Belt Composite. The study showed that estimates of genetic variances for West Indian Composite were consistently greater than those of the Corn Belt Composite, resulting in expected gains from selection that were consistently larger for the West Indian Composite. The study also showed that the mean yield of the resulting population was comparable to that of the Corn Belt Composite. It was concluded that the West Indian Composite could be used to increase genetic variability of breeding populations without yield reduction. Shauman (1971) studied the genetic variances in Krug x Tabloncillo and found that the presence of exotic germplasm in Krug did not result in large changes in genetic variances, but additive genetic variance for yield was greater in Krug x Tabloncillo than in Krug alone.

Timothy (1963) discussed the possible use of exotic germplasm in Colombia in order to take advantage of genetic diversity in Central and South American material. Most of the materials tested were not promising *per se*, but when crossed with the local variety ETO, some exhibited impressive heterosis in yield.

Further discussion on the use of exotic germplasm was presented by Wellhausen (1965) who emphasized the potential of exotic germplasm for the improvement of Corn Belt maize. His discussion was based on observations made on materials collected in Mexico from different parts of Central and South America. These materials were highly variable and had many traits that could be exploited in the United States Corn Belt. It was pointed out, however, that since the yields of Corn Belt populations were already high the exotic germplasm would not be immediately useful. Wellhausen also indicated that linkage restrictions would be expected to slow progress when exotic germplasm was used.

Hanson and Johnson (1981) evaluated an exotic maize population (Tuxpeno) adapted to North Carolina