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Effect of replications and environment on wheat plant height

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EFFECT OF REPLICATIONS AND ENVIRONMENT ON WHEAT PLANT HEIGHT

by

Necdet Budak

A DISSERTATION

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DISSERTATION TITLE

Effect of Replications and Environment

on Wheat Plant Height

BY

Necdet Budak

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GRADUATE COLLEGE
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EFFECT OF REPLICATIONS AND ENVIRONMENT ON WHEAT PLANT HEIGHT

Necdet Budak, Ph.D.

University of Nebraska, 1994.

Advisor: P.S. Baenziger.

The number of replications required to accurately determine plant height and to detect the desired difference between wheat genotypes in diverse environments were determined using statistical formulas and data from a total of eight advanced breeding trials in three distinct ecogeographic zones. Despite the ecogeographic site diversity, measuring plant height on only two replications provided on accurate estimate of the mean for each trial and of detectable differences between wheat genotypes.

The second part of study emphasized the effect of environment on wheat plant height. Tall wheats (*Triticum aestivum* L.) are preferred in drought prone western Nebraska. However, semidwarf wheats are desirable for eastern Nebraska where water is less of a limitation. Selecting tall wheats for western Nebraska is difficult in eastern Nebraska where the early generation breeding nurseries are often located. To determine the importance of genotype differences in height and the genotype x environment interaction, a combined analysis of variance over Nebraska environments representing three ecogeographic zones was performed using plant height data on released cultivars and advanced experimental genotypes. Genotypes were significantly different and the genotype by environment interaction was significant for plant height. Similar results were obtained when the genotypes were classified and analyzed separately as semidwarf (gibberellic acid (GA)-insensitive) or conventional height (GA-sensitive) wheats. The

genotype by environment interaction was partitioned and mean squares associated with the environment x (semidwarf vs conventional height wheat), environment x semidwarf wheat, and environment x conventional height wheat were all found significant. Using regression estimates of stability, semidwarf genotypes were more stable (lower b values) than conventional height genotypes. Though GA-sensitive (conventional height) genotypes were on average taller than insensitive (semidwarf) genotypes, semidwarf genotypes with excellent stability could be identified that were not too tall in eastern Nebraska, and retained their height in western Nebraska. Conventional height wheats with similar environmental responses were not identified. The stability of yield was independent from the stability of plant height.

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This dissertation is dedicated to my family: my wife and my son.

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EFFECT OF REPLICATIONS ON MEASURING WHEAT PLANT HEIGHT

ABSTRACT

Plant height is an important selection criterion in wheat (*Triticum aestivum* L.) breeding programs that develop varieties for diverse environments. It is important to precisely measure plant height within a location to make recommendations to farmers while minimizing labor input. The number of replications that should be measured to accurately determine plant height and to detect the desired difference between wheat genotypes were determined using statistical formulas and data from a total of eight advanced breeding trials in three distinct ecogeographic zones. Despite the ecogeographic site diversity, measuring plant height on only two replications provided a very accurate estimate of the mean for each trial and of the detectable difference between two wheat genotypes.

INTRODUCTION

In the Great Plains, wheat cultivars are grown in many diverse environments to accurately estimate their performance across the region prior to release. Tall wheat cultivars emerge better in dry soils and leave more residue (Burleigh et al., 1965). Crop residue improves soil structure and helps control soil erosion (Skidmore and Siddoway, 1978). Tall wheats are also important for easy harvest. Semidwarf wheats can become too short for harvest in drought prone western Great Plains. Hence, tall wheats are preferred in the western Great Plains where drought occurs more frequently. Conversely, semidwarf wheats are desirable in eastern Great Plains where rainfall is higher. Semidwarf wheats are more resistant to lodging, have high yields, and are more responsive to fertilizer (Pearman et al., 1978) when water is generally less of limiting factor.

Nebraska consists of three ecologically diverse environments that are representative of wheat growing areas of the Great Plains. The three ecologically diverse environments were identified by Peterson (1992) using yield data from regional nurseries. The annual rainfall for western (using Hemingford, NE as representing a drought prone environment) and eastern Great Plains (using Lincoln, NE as representing higher rainfall conditions) is 37 cm and 68 cm, respectively based on 30 years meteorological data (personal communication with High Plains Climate Center at University of Nebraska, October, 1993).

Due to the importance of plant height, plant breeders need efficient, precise methods to measure it and know detectable differences among genotypes to make

recommendations to growers. It is well known that measuring a quantitative trait with more replications increases precision, and decreases the variance and the coefficient of variation of the mean (e.g. Hafez et al., 1976; and Havey and Frey, 1978). However, it may be inefficient and prohibitively resource intensive to measure plant height on all replications in multiple environments in a large breeding program. The goal should be to measure plant height with as few replications as possible with a minimal reduction in precision of plant height measurement in each environment.

Fewer replications and more testing locations were suggested by Dofing and Francis (1990) who stated that one replicate may be recommended for situations in which the cost of an additional location relative to the cost of an additional replication is not excessive. Bradley et al. (1988) estimated that single replicates could be used to maximize location testing with limited seed. Error estimates can be obtained by analyzing repeated checks arranged in a systematic design within a location. Although research has been done to determine the best sample size, number of replications and locations for grain yield (Dofing and Francis, 1990; Bradley et al., 1988), there are no studies on the optimal number of replications in locations to estimate wheat plant height. The purpose of this study, therefore, is to determine the number of replications that should be measured: 1) to accurately determine plant height and 2) to detect the desired difference between wheat genotypes in diverse environments.