MORPHO-PHYSIOLOGICAL BASES OF DROUGHT TOLERANCE IN BREAD WHEAT (*Triticum aestivum* L.) AND MODELLING FOR SEMI ARID AREAS OF KENYA

KIMURTO PAUL KIPROTICH

A Thesis submitted to Graduate School in partial fulfilment of the requirements of the Doctor of Philosophy Degree in Agronomy (Crop Physiology) of Egerton University

EGERTON UNIVERSITY

SEPTEMBER, 2008

ABSTRACT

Breeders have traditionally applied methods where grain yield comparison is used as the main selection criterion for drought tolerance. The approach has often succeeded in the absence of in-depth knowledge about morpho-physiological bases for superior performance of existing germplasm. This study therefore was aimed at identifying morpho-physiological and biochemical bases of drought tolerance in bread wheat and the possibility of their use as indirect selection to augment yield-based selection procedures; and to also predict productivity of wheat in semi-arid Kenya. Experiment one involved evaluation of 16 wheat genotypes in 3 sites (Katumani, Naivasha and Mogotio) for four seasons using Randomized complete block design (RCBD). Experiment II and III involved evaluation of 12 out of 16 genotypes under rain shelter at KARI, Njoro by simulation drought during seedling and reproductive stages, respectively. Moisture applied ranged from 210-320 mm. RCBD in split plot design was used with water regimes as main plot and genotypes as subplots. Experiment IV evaluated the 12 genotypes for drought responses under growth chamber in Berlin Germany. Parameters measured included biomass, seedling vigour, yield and yield components, evapotranspiration (ET), photosynthesis, stomatal conductance, transpiration efficiency, water use efficiency, total non-structural carbohydrates, protein content, chlorophyll fluorescence and electron transport. Data was analyzed using analysis of variance and means separated using Duncan multiple range test (DMRT). The findings showed that overall variability in grain yield between the 4 growing seasons (3sites) ranged between 7% to approximately 400%, which was mainly accounted for by differences in seasonal precipitation confirming the importance of rainfall for higher wheat yields in drylands. In Kenya, marginal rainfall wheat growing areas can be classified into three distinct environments corresponding to; severe and early drought stress, severe terminal reproductive-stage drought stress to moderate intermittent. Test genotypes R960, Chozi, R965, Duma, Km14 and R963 had greater yield across years and sites compared to Heroe, Km20, Km15 and R917. Several traits mainly, early vigour, high biomass accumulation, reduced tiller abortions, greater seed number, high water use efficiency for grain, harvest index, photosynthesis, stomatal conductance, reduced chlorophyll florescence and high electron transport contributed in minimizing the effects of drought. Their use as selection criterion in wheat breeding programme is recommended. The developed model fairly predicted the productivity of wheat and is therefore recommended to be used to predict performance of wheat in drylands, since it would finally reduce the costs of carrying out dryland research in Kenya.

TABLE OF CONTENTS