CHAPTER 3C

Managing Root Systems for Efficient Water Use: Breeding Plants for Efficient Water Use

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I. INTRODUCTION

Insufficient water during some period of plant growth limits crop production on most of the world’s arable land. Rainfall patterns, availability of irrigation water, temperature, and photoperiod generally have determined which crop species are adapted to a given geographical area. Microclimate differences influence the annual yields of adapted species. In this chapter I have limited my discussion to increasing the efficiency with which available water supplies are used by adapted species. Modifying plant species to change their general areas of adaption would be an extremely long-range approach to achieve more efficient use of water.

The goal of most plant breeders is to develop cultivars that produce the highest marketable yield per unit land area over a range of environments. During the selection and evaluation phases of the breeding program, various degrees of water stress are usually encountered. Unfortunately, the stress periods often occur at random, so that different growth stages are affected in the different environments. This type of stress pattern increases genotype × environment interactions without providing plant breeders with the controlled selection intensity needed to make rapid and significant changes in efficiency of water use. In cases where this efficiency may have been changed by selecting for increased marketable yield, the factor(s) responsible for the improvement have often not been identified. An increase in efficiency of water use is frequently not even considered as a possible cause for increased yielding ability.

When addressing the problems and opportunities involved with breeding to increase the efficiency with which available water supplies are used it is necessary to analyze the constraints on maximizing crop production. Estimates are not available on the potential yields of our present crop species in the absence of all environmental limitations. However, we can assume that under most environments some level of water stress will reduce the crop