INTRODUCTION

CHAPTER I

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Introduction of dwarf genotype of wheat has brought about wheat revolution in India and enhanced its production to 31.3 million tons. The production of wheat has to be doubled to meet the total food grain requirement of 230 million tons by 2000 AD. The target is attainable only by intensifying productivity. Water and fertilizer nitrogen (N) are the major resource constraints to this intensification programme. Only 65 per cent of the total area under wheat is irrigated and the application efficiency of irrigation water is less than 55 per cent by surface methods. Similarly the resources for fertilizer N is also limited and it meets only 75 per cent of the total consumption of N. It thus becomes imperative that wheat production can be enhanced only by maximising the yield with optimal inputs of water and fertilizer.

Growth and production of crops are directly related to plant water use in dry land areas (Hanks et al., 1969). A high water use efficiency is achieved when irrigation scheduling is based on actual crop water use and water supplying capacity of the soil. Irrigation for wheat has been generally scheduled based on critical phenological stages, of which crown root initiation is the most vital one followed by jointing, flowering and grain formation (Day and Intalap, 1970; Cheema et al., 1973). More recently irrigation schedule has been decided based on crop water use predicted from climate data. By this approach scheduling irrigation at 0.75-1.0 ratio of irrigation water to cumulative pan evaporation has been found to be optimum for wheat (Prihar et al., 1974; 1976). Although the relative susceptibility of growth stages to water stress has been identified and irrigation scheduling criteria have been defined,a high water use efficiency is still to be attained. It implies that the applied irrigation water is not efficiently utilized by the crop for its dry matter production. The growth and distribution of roots may not be extensive and effective enough to make a exhaustive use of the applied irrigation water.

The growth and penetration of wheat roots are greatly encouraged by the application of fertilizer N (Linscott et al., 1962; Campbell et al., 1977). The nodal roots which may even initiate in relatively dry surface soil, penetrate deep when the sub-soil layers have adequate moisture and N. At higher levels of N the crop develops active and deep root system with greater water extraction capabilities (Smith, 1953). The significance of this deep root development through N fertilization for extraction of sub-soil moisture is also reflected in the drought resistance of the fertilized crop (Kmoch et al.,1957 ; Pesek et al., 1955). Obviously N fertilization may play a significant role in raising the water use efficiency of the crop.

Increased root growth and enhanced water uptake also help enhancing the use efficiency of applied N which is recovered by the crop only to an extent of 60 per cent (Fluhler, et al.,1977). When irrigations are frequently applied, the applied N is liable to leaching losses, while with less frequent irrigation and resultant drier soil water regime the denitrification losses (Volz et al., 1976) are more probable. A planned deficit irrrigation schedule leaving room for rain,minimises leaching losses of N, but in coarser soil with low water holding capacity, this practice may result in yield loss if irrigations are poorly timed and rainfall does not occur during the growing season (Watts and Hanks, 1978). Thus, the availability and use of applied N by the crop are in turn largely dependent on irrigation water schedule. A strong interaction between fertilizer N and irrigation water has been documented in the literature (Singh et al., 1979; Eck, 1984).

The use efficiency of both N and water may be enhanced if irrigation schedules are also based on the rate and timing of N fertilization. However, the concept of deciding irrigation schedule based on N application rate essentially needs basic information on the uptake of water and N by plant roots in relation to soil wetness and N concentration. A little is known about the uptake of water and N by wheat roots. As physical evaluation of the uptake processes is difficult, macroscopic simulation models have been successfully employed to predict the flux of water or N to plant roots in isolation to soil water movement.

Scheduling irrigation based on the uptake patterns of water and N, is of special significance to wheat cultivation in low retentive and N deficient deep alluvial soil as prevalent in northern India. Because of low retentivity these coarse textured soils are highly prone to leaching losses of water and N. The rate and timing of the application of irrigation water and fertilizer N on this soil should be decided in such a way that the losses of these two costly inputs are kept at minimum and the crop rarely experiences any yield reducing water or N stress. In an effort to establish such irrigation schedules for varying levels of N the present field investigation on winter wheat was undertaken in Loamy sand ustipsamment in 1984-85 and 1985-86 with the following objectives :-

i) determining growth and yield responses to irrigation water regime and N application rate,

ii) defining depth and time patterns of root growth under varying irrigation water regime and N application rate,

iii) assessment of water extraction pattern under varying irrigation water regime and N application rate,

iv) simulation of root extraction rate of stressed and non-stressed wheat at low and high N application rates,

v) modelling flux of nitrate N from soil to root system in fertilized and unfertilized soil under stressed and nonstressed conditions, and

vi) comparison of modelled soil water profile and N uptake with their field measured counterparts.