Chapter -1

INTRODUCTION

1.1 GENERAL

Soil moisture plays a cardinal role in sustaining ecological balance and agricultural development. Unfortunately this resource is finite and its usage has not been very prudent. In spite of several water management programs organized in this country, the actual water utilized in agriculture is only one third of the total utilizable surface and ground water resources. Therefore there is a distinct need for a critical review and proper planning for the optimal utilization of water for crop production. The different physical processes making up the soil water balance are infiltration from rainfall or irrigation, redistribution of the infiltrated water in the soil water zone, plant water uptake mainly in the form of actual evaporation and percolation out of or capillary rise into the reservoir of soil water.

The better utilization of rain fall, irrigation facilities and effective control of soil erosion and run off depend largely on the water retention characteristics and erodibility indices of the soil. Soil texture, organic matter and cation exchange capacity to a large extent determine the water retention/ release and infiltration rate in soil (Sharma and Verma 1972; sharma et al. 1987). The water movements in the unsaturated zone, together with the water holding capacity of this zone, are very important for the water demand of the vegetation, as well as for the recharge of the ground water storage. The water that falls on the land or added to a soil by irrigation moves in a number of directions. In vegetated areas, 5 – 40% is usually intercepted by plant foliage and returns to the atmosphere by evaporation without ever reaching the soil. In some evergreen forest areas, one third to one half the precipitations is intercepted and does not reach the soil. In level areas with friable soils, most of the added water penetrates the soil. But in rolling to hilly areas, especially if the soil is
not loose and open, considerable run off and erosion take place, thereby reducing the proportion of water that can percolate into the soil.

Once the water penetrates the soil, part of it is subjected to downward percolation and eventual loss from the root zone as drainage occurs. In humid areas, up to 50% of the precipitation may be lost as drainage water. However, during periods of low rainfall, some of this downward percolating water may later move up into the plant root zone by capillary aeration, and thereby become available for plant absorption.

Water is the major input for the growth and development of all types of plants. Plants absorb water. The availability of water, its movement and its retention are governed by the properties of soil. The properties like bulk density, mechanical composition, hydraulic conductivity etc. depend on the nature and formation of soil and land use characteristics in addition to the weathering processes and the geological formations.

It is essential to maintain readily available water in the soil if crops are to make satisfactory growth. The plant growth may be retarded if the soil-moisture is either deficient or excessive. If the soil moisture is only slightly more than the wilting coefficient, the plant must expend extra energy to obtain it and will not grow healthy. Similarly, excessive flooding fills the soil pores with water, thus driving out air. Since air is essential for satisfactory plant growth, excessive water supply retards plant growth. The optimum moisture percentage is thus that which leads to optimum growth of the plant. When watering is done, the amount of water supplied should be such that the water content is equal to the field capacity. ‘Field Capacity’ (FC) is the amount of water remaining in the soil after all gravitational water has drained. Water will gradually be utilized consumptively by plants after the water application, and the soil moisture will start falling. When the water content in the soil reaches a specific value, called the Permanent Wilting Point (PWP), fresh dose of irrigation may be done so that water content is again raised to the field capacity of soil.

Moisture conservation and efficient utilization of rainfall are important for the successful production of crops in dry land agriculture. Soils differ among themselves in some or all the properties depending on the differences in the genetic
and environmental factors. They serve as a reservoir of nutrients and water, required for crops. The entry and storage of rain water in soil depend upon soil characteristics. According to Dr. H.H. Bennet, “Soil without water is desert and water without soil is useless”. The problem of conserving moisture is of paramount importance in the extensive regions of low and uncertain rainfall. The key to water conservation is the utilization and treatment of land according to its water retention capabilities.

Study of soil and its water holding capacity is essential for the efficient utilization of irrigation water. Hence identification of geotechnical parameters which influence the water retention capacity and the method of adding admixtures to improve the retention capacity of soil, play an important role in irrigation engineering. Coir pith, Coir Pith Compost and Vermi Compost are good admixtures for improving the water retention capacity as well as nutrients of the soil. India is one of the leading countries of the world in area and production of coconuts. The coconut husk finds numerous applications due to its fibrous structure and resilience. Coir pith is a waste product produced during the process of extraction of fibre from coconut husk which contains one third of fibre and two third of pith. Thus for every tonne of fibre about 2 tonnes of coir pith waste is generated. This is mostly unutilized at present and poses a great problem to the fibre manufacturing units as it occupies large area due to its fluffy nature (dry density = 0.2gm/cc). Apart from space problem it also poses environmental problems due to fire hazards and pollution. The adverse effects of acidic nature can be mitigated by rinsing it with water three to four times.

Although several methods have been suggested for the disposal and utilization of coir pith, only a few have been successful and only a nominal part of the total production could be successfully made use of. This is mainly due to economic reasons, restricted demands for the products and finally for the lack of appropriate technology developed for its proper use.

In spite of the above limitations of coir pith, it is possible to convert this waste into wealth. This can be done by proper exploitation of its useful properties viz. phenomenally high water holding capacity, low bulk density, excellent aeration, good hydraulic conductivity, high infiltration rate, inbuilt slow release mechanism
and some macro and micro nutrients content. All the above properties clearly point to its potential use in agriculture.

Composted coir pith is being widely used along with organic supplements for many crops especially in Horticulture and Floriculture. Composted coir pith is highly beneficial in improving crop productivity in plants by raising the water holding capacity and leading to a high conversion ratio. Moreover, its ability in management of certain root diseases has also been well recognised. Now several techniques have been perfected to convert it in to useful products. Vermi Compost is the excreta of the earth worm which is rich in humus. It increases the aeration porosity and provides moderate water holding capacity and increases the drainage in heavy soils.

The above three admixtures increase in addition to water holding capacity, the nutrient contents favourable to the growth of plants and also make changes in hydraulic conductivity favourable to plant growth.

In this study investigations were carried out to determine the functional properties like water holding capacity and hydraulic conductivity and chemical properties of soils from various locations of Trivandrum district without additives and with additives to improve the above properties. The results of the investigations are used to suggested a suitable irrigation schedule for soils with and without admixtures for the efficient utilization of irrigation water.

The contents of various chapters of this thesis are briefly described below.

Chapter 1 presents the need of water for plant growth and the significance of proper planning for the optimum use of water for crop production and the studies required on the soil to assess the water retention characteristics.

Chapter 2 presents the review of the investigations by earlier research workers. The different methods of irrigations used and the soil classification methods are described. The soil physical properties like texture, structure, bulk density and soil moisture properties like evaporation, field capacity, permanent wilting point, hydraulic conductivity and the parameters which affect the chemical properties are discussed. The general properties of the admixtures used here to improve the above properties are also mentioned.
Chapter 3 describes in detail the materials used, their physical and chemical properties and also the different methods used for this investigation including measurement of soil moisture tension using pressure plate apparatus.

Chapter 4 gives a detailed description of the investigations carried out on untreated soil. Based on the investigation, the results obtained are discussed and a method for irrigation scheduling is suggested for the better utilization of water.

Chapter 5 discusses in detail the studies made on soils treated with admixtures. The improvements in the functional and chemical properties due to the addition of admixtures are described. From the results, the percentage of admixture required to maintain a particular water content for a particular period and irrigation interval for the better utilisation of water are suggested.

Chapter 6 presents the conclusions derived, methods and procedures that have been established from the detailed investigations for the efficient use of irrigation water.