CHAPTER I

INTRODUCTION

The qualitative effects of soil compaction upon the growth, maturity, and general physiological behaviour of plants has been frequently observed and reported in the literature. The yield response to soil compaction is, however, unpredictable. Smith and Cook (1947) found that yield of sugarbeets in the greenhouse decreased with increasing compaction. Hubbell and Staten (1951) found that yields of field grown cotton increased with increasing compaction. Flocker and co-workers (1958, 1959 and 1960) have reported greenhouse and field studies in which yields of certain winter cover crops, potatoes and tomatoes have been reduced by compaction, but noted that moderate compaction was sometimes beneficial to plant growth. Physiological responses other than yield have also been related to soil compaction, but here, too, the evidence is contradictory. For example, Heath (1937) reported that maturation of field grown cotton plants was hastened by compaction, while Phillips (1959) has observed that compaction delayed silking and tasseling dates for field corn.

As the soil is compacted its bulk density increases. As a result of increase in bulk density, a series of changes in soil physical properties are brought about. The increased bulk density decreases the porosity, void ratio, hydraulic conductivity and gaseous diffusion whereas it increases the availability of moisture mechanical impedance, crust strength, thermal conductivity and heat capacity of soil. Compaction of soil thus appears to modify all the four physical edaphic factors, namely, soil air, soil moisture, soil temperature and mechanical strength. As a result of compaction, the aeration porosity decreases, the yield also correspondingly decreases in case of potato (Bushnell, 1953), sugarbeet and wheat (Nagmoush, 1961), tomato (Flocker and Nielsen, 1961), barley (Rosenberg, 1961) and corn (Bateman, 1963). The nutrient absorption was also influenced by the restriction of soil aeration in compacted soil (Lawton, 1946). A soil which has been compacted may cause impedance because of its increased mechanical strength. The roots actually may have to exert more force to penetrate the soil mass (Lutz, 1952). The rigidity of the pore structure is also a factor governing mechanical resistance to root penetration (Wiersum, 1957).

It appears that every crop needs an optimal soil physical condition for the best growth. It means that each crop has a specific requirements of air, temperature, water and mechanical anchorage. If these soil and plant parameters are well defined within a certain range, it is possible to create the same under field conditions. Soil bulk density measurements are frequently used for the appraisal of the physical conditions of the soil. According to Vomocil (1957) "Bulk density data are readily interpretable in terms of fundamental soil properties and properties which affect plant growth". This statement explains the importance of soil bulk density measurements in plant growth studies. Excepting rice, optimum bulk densities for some crops have been reported by Vomocil (1955). Therefore, it appears that critical densities for growth of rice crop on a given soil might be determined by observing the response of plants growing in soils compacted over a wide density range.

Rice happens to be one of the most important cereal crops. In West Bengal alone, rice covers nearly 72 percent of the total cropped area. An examination of the systems of rice cultivation in India shows that there are three types of cultivation. They are dry, semi-dry and wet. In the dry cultivation, the land is ploughed a number of times in the months of May and June. The fine seed bed thus prepared facilitates drilling, dibbling or broadcast sowing operations. Generally 8 to 10 ploughings with a country plough at frequent intervals are considered desirable to attain a fine seed bed. The crop is grown as rainfed crop. In the semi-dry system, the preparatory cultivation is same as that adopted for the dry system and seed is broadcasted, usually in July-August, when the southwest monsoon is active, rainwater is impounded in the fields and the young crop of five to six weeks is ploughed cross-wise with a narrow wooden plough with about two inches of standing water in the field and planked. The crop recovers and grows vigorously.

In the wet system, the land is thoroughly ploughed with a country plough or iron mould board plough with two to three inches of standing water in the field. The field is ploughed repeatedly three to four times with an interval of about four days between each ploughing, and levelled before planting. This process of ploughing with standing water is known as puddling. The puddling is considered to provide a soft seed bed which facilitates the transplanting, eliminates weeds, reduces the hydraulic conductivity of the soil, helps to promote reduced condition which is considered congeneal for the rice crop growth and fertilizers are mixed well with soils and distributed evenly all over the field. The physical condition of a puddled soil, however, is not well defined.

In the wet system of cultivation, rice is almost grown in flooded soils, the reasons for the necessity of this practice are not clearly understood. In the field of rice research not a single valid reason has been cited by workers for the necessity of this practice. If the principal advantages of flooding are elimination of soil moisture tension, increased availability of nutrients (Subramanyam, 1937 and Lin, 1946) and control of weeds, it might be possible to achieve the benefits of flooding with a partially saturated profile.

It is clear that in order to explain some of the reasons for the preference of rice for the puddled and submerged milieu there is a need for the characterization of soil physical environment for rice growth. An attempt has been made to answer some of these problems in the present investigation. Despite the difficulty of measuring all possible soil variables this study was undertaken to investigate some growth responses of rice crop under a definite physical environment by compacting the soil. The results of the present investigation, namely, "the influence of soil compaction and water regime on shoot and root growth, ion uptake and yield of rice", might shed more light on the behaviour of the rice plant and pave the way for more detailed studies and hoped that it will contribute to a better understanding of a much neglected phase of rice culture.

The present investigation is divided into two parts. First part deals with the effect of soil compaction on rice plant growth. The effect of soil compaction on the physical properties of soil and the physical properties of the compacted soil as affected by the rice plant growth are also investigated. The second part of the investigation deals with the response of rice plants to various levels of soil water regime at a constant bulk density level. Thus the present investigation is divided into following four parts.

1. Study on the physical properties as affected by soil compaction.

2. Soil physical changes brought about by the rice plant growth.

3. Rice plant growth as affected by the soil compaction.

4. Rice plant growth as affected by the soil water regime.