CHAPTER 1
INTRODUCTION

Rice (Oryza sativa L.), which is the staple food for more than sixty percent of the world's population, supplies 26% of world's food calories and 17% proteins. It takes a fourth place in world cereal production. In India, rice crop occupies perhaps the largest area in the world. It deserves pre-eminent position in the country and specially in Uttar Pradesh which has 4.482 million hectares under this crop out of a total of 37.3843 million hectares in India. If, anyhow, only rice yields per unit area are increased we may be more comfortable on our food front.

Despite its largest area and varied adaptability, the average yield of rice crop in India could not be raised to the extent it ought to be. The main factors responsible for it are the low yield potential of indigenous tall varieties occupying the larger area, deficient irrigation facilities and water-utilization technology. These factors are further coupled with the use of lower doses of fertilizers and overall poor management of high yielding varieties presently available for cultivation.

The newly high yielding rice varieties developed by the plant breeders are short stature, with leaves typically short, narrow, erect, rather thickened, dark green and functional even as the grain approaches maturity. They are less prone to mutual shading, make more efficient use of
sunlight, are less susceptible to lodging and respond favourably to nitrogen application by giving increased grain yield. These have relatively high level of protein nitrogen in plant tissues and the senescence is quite slow. Consequently, nitrogen uptake continues actually until the end of growth which increases the percentage of filled and ripened grains resulting in higher yields.

In the main rice crop of rainy season in the tropics, because of high temperature at planting, vegetative growth is vigorous and the plant size becomes excessive. Since solar radiation during ripening is lower than the optimum the resulting grain yield is low. In tropical monsoon Asia, the dry season crop which can produce grain yields much higher than in other seasons, starts with short day-length which gradually becomes longer with growth. Thus, varieties for dry season planting should be photoperiod non-sensitive. To grow same varieties in both the rainy and dry seasons photoperiod non sensitive varieties are preferred. If suitable varieties are grown, and proper attention is paid to management, rice yields per unit area in the tropics can be as high as those of temperate climates. The potential yield per unit area per year is actually considerably higher in the tropics than in the temperate regions.

Although we have a few good varieties of rice at present in this State but the optima of different nutrient elements for those varieties in relation to yield and quality under varied agro-climatic conditions are not suffi-
ciently known so far. The importance of nitrogen hardly needs any emphasis in the present context. It is found in complex chemical combinations in the seeds and in all parts of the plant, thereby having a deciding influence on its regular development. In transplanted crops it stimulates the roots to absorb even further nutrient elements and thus plays vital role in the life processes of rice plant.

Our soils being initially poor in this element, can not supply it to the plant in needed amounts if same is not enriched with nitrogen fertilization. All these factors and several others are responsible for universal response of this particular element in rice crop.

Phosphorus ranks next to nitrogen in its essentiality for the rice crop in the tropics. The influence of phosphorus in rice production is seen in the development of particularly the root and caryopsis. A high supply of this element promotes early growth by increasing the contents of nucleic acid and phospholipids. Phosphorus also plays role in large number of enzymatic reactions which depend upon phosphorylation. It also increases resistance to bad weather particularly drought and speed up maturation. Since our soils are poor in phosphorus which is a vital factor for plant life there has been a considerable response to phosphorus fertilization in cereals.

The particular importance of potassium lies in the fact that its presence increases resistance to lodging and some diseases. Its presence in soil improves root development. It regulates carbon assimilation and protein
synthesis and is required as cofactor in enzymatic degradation of carbohydrates. Our soils, by and large, are potentially not so poor in potassium and so do not respond to this element in dwarf rice above 60 kg K₂O per hectare.

Of the micronutrients, rice plants absorb Mn in relatively large amounts, and its requirement for this crop is very much higher than that of other trace elements. Nowadays Zn and Mn are becoming deficient for rice in our soils due to the use of high doses of NPK fertilizers necessitated by adoption of fertilizer responsive dwarf varieties and multiple cropping. Comparatively more work on Zn nutrition among the micro-nutrients has been done and also is in hand but scientific information on Mn nutrition of rice particularly under upland conditions is deficient.

Manganese regulates photosynthesis and carboxylic acid metabolism in plants. It functions directly or indirectly in chloroplast formation. It also serves as an activator for a wide variety of enzymes engaged in important metabolic reactions. This element also takes part in glycolysis and is required in enzymatic steps in fermentation and phosphate transformation. Plants receiving an insufficient supply of Mn frequently become chlorotic in minor deficiency, while marked deficiency often results in complete breakdown of the plant's metabolic processes which further results in low crop yields.

The uptake of these and other nutrients varies with several factors, particularly, the crop species, varieties, and soil and agro-climatic conditions. Also, the absorption
of one element has its effects on that of the others. In any specific set of environments the pattern of nutrient absorption ultimately leads to dependable clues as to the quantity of nutrients through fertilizers and when they are to be applied for maximum benefit. There exist certain correlations between fertilizer levels, nutrient uptake, dry-matter production and grain yields in the rice crop which varies in accordance with the variety, soil and the climate. The speed of varietal improvement in rice by the plant breeders is so fast that agricultural chemists will have to make continuous prompt efforts to couple the new varieties with the fertility management technology suitable for different location and soil types. Such type of coordinated approach is very fruitful in scientific world. Nutrient uptake studies at the speed parallel to that of varietal improvement is, therefore, a must.

Since N & P are the most limiting in rice production in our country and Mn is needed by dwarf rice plants in relatively huge amounts a special attention should have to be paid for studying the uptake of nutrients under graded doses of N, P & Mn over an uniform optimum level of K for its onward translation in terms of fertilizer requirements containing such nutrients, and also the time of their application. In general, such investigations for newly developed rice varieties, particularly under upland conditions, have been very sporadic.

Having developed the new dwarf high yielding rice varieties the problem of improvement of quality features,
such as desirable grain type, high milling, good cooking behaviour and high protein content comes before the agricultural scientists because the farmers and trade agencies are particularly tempted towards the quality rice for valuable foreign exchange earnings in its export. Moreover, with the economic advancement in our country the Indian consumers are also becoming more and more quality conscious. Thus, it is an imperative for the agricultural chemists to be vigilant on this aspect also without delay. They should develop suitable fertilization techniques which can improve the quality characters in rice grains.

The word quality in rice is a broad term. For consumers size, shape and fragrance of grains are the most important. On the other hand, while millers consider the hulling, milling and head rice recovery; the chemical composition like starch, protein, vitamins and minerals etc. is the basis of evaluation for the nutritionists. Moreover, the housewives think in terms of thermal behaviour particularly, the water uptake, volume expansion and kernel elongation.

The mineral nutrition and some of the quality characters of rice grains are closely related which varies with the varieties and soil-climatic environments. So far, only the effects of most limiting nutrients on the yield and uptake of minerals in newly developed dwarf rice have been studied at a few places, but no adequate systematic investigation appears to have been carried out regarding the effects of these nutrients including Mn on the quality
characters of rice in Uttar Pradesh.

From the aforesaid discussion it is reflected that there is deficient information on the efficient use of macro and micro-nutrients for the exploitation of full yield potential of rice in tropics particularly, under upland conditions. Moreover, the information about the quality characteristics of promising rice varieties grown under different set of environments and various modifying factors affecting it is almost non-existent. Such studies are of major importance for improving the crop qualities by breeding and fertilization techniques.

Taking these enumerated problems in view, the present investigation entitled "Studies on the Mineral Nutrition and Variability in Quality Characteristics of Rice" was carried out with the following objectives:

1. To study the uptake of nutrients viz. N, P, K, Ca, Mg and Mn at various stages of growth by dwarf rice plants under upland conditions and graded fertilization.
2. To study the effect of N, P and Mn and their interactions on dry matter, grain production and harvest of economic products in dwarf rice.
3. To find out the nutritional requirements of dwarf rice for upland light soils.
4. To study the effect of fertility, location, and variety upon the variability in the quality composition of rice.

************
****
***