CHAPTER-I
INTRODUCTION

The vast potential of rainfed as well as irrigated agriculture needs to be unlocked through knowledge based management of natural resources for increasing productivity and income to achieve food security in the developing world. India is being the leading groundnut producing country since it accounts for about 21% of world’s groundnut area and about 17% production (Anon, 2014). States of India growing groundnut have a wide variability for groundnut productivity which would be largely explained by inappropriate soil, water and crop management options used at the farm level coupled with poor and marginal lands prone to persistent degradation. Therefore, soil and water management play a very critical role in increasing groundnut productivity in rainfed as well as irrigated areas in India.

Groundnut being a leguminous crop and rich in oil requires higher amounts of phosphorus (P) as compared to other nutrients. Further, phosphorus is receiving more attention as a non-renewable resource, a costlier fertiliser input and as an environmental concern for pollution of water bodies. One of the unique characteristic of phosphorus is its low availability due to slow diffusion and high fixation in soils. Moreover, the availability of soil phosphorus is greatly altered by soil type as well as the physico-chemical characteristic of the soil. Therefore, maintaining a proper P-supplying level at the root zone can maximize the efficiency of plant roots to mobilize and acquire P from the rhizosphere.

Phosphorus is an important nutrient in crop production. It promotes plant root growth and help in energy transformations as well as photosynthesis of plant. The major problem of phosphorus is its availability. Only 1 to 3% of phosphorus in any soil is in plant available form. The P cycle in soil is a dynamic system involving soils, plants, microorganisms. Major processes includes uptake of soil P by plants, recycling through return of plant and animal residues, biological turnover through mineralization-immobilization, fixation reactions at clay and oxide surfaces, and solubilization of mineral phosphates through the activities of microorganisms. Soil P exists in various chemical forms including inorganic P (Pi) and organic P (Po). These P forms differ in their behavior and fate in soils. More than two third of Indian soils under groundnut cultivation are frequently characterized by its low availability of
phosphorus due to slow diffusion and high fixation with carbonate minerals in calcareous soils (Pal et al., 1999). Application of phosphatic fertilizers in these soils has the problems of high P–fixation and low recovery by the plants. Therefore, efficiency of P fertilizers in these soils is generally very low because P applied to the soil reacts with Ca forming minerals such as DCP, TCP, OCP, ultimately hydroxylapatite (Leytem and Mikkelsen, 2005).

A survey of the interactions between phosphorus (P) species and the components of calcareous soils shows that both surface reactions and precipitation take place, especially in the presence of calcite and limestone. The principal products of these reactions are dicalcium phosphate and octacalcium phosphate, which may interconvert after formation. The role of calcium carbonate in P retention by calcareous soils is, however, significant only at relatively high P concentrations; noncarbonated clays play a more important part at lower concentrations. In the presence of iron oxide particles, occlusion of P frequently occurs in these bodies, especially with forms of the element that are pedogenic in origin. Progressive mineralization and immobilization, often biological in nature, are generally observed when P is added as a fertilizer.

The phosphorus forms exist in complex equilibria with each other, representing from very stable, sparingly available to plant-available P pools such as labile P and solution P. Overall P dynamics in the soil-plant system is a function of the integrative effect of P transformation, availability, and utilization caused by soil, rhizosphere, and plants. Therefore, the holistic P management involves a series of strategies such as increasing P uptake efficiency by plants, reducing overuse of chemical fertilizer P, and improving recycling efficiency of manure and/or the integrated approach of P management may greatly reduce the chemical P fertilizer requirement in groundnut crop and thus of huge importance for optimizing P-resource use in the groundnut production system in future.

Similarly, sulphur (S) is increasingly being recognized as the fourth major plant nutrient. It is well known for its role in synthesis of sulphur containing amino acids viz., cystine, cysteine and methionine. It is required for the formation of chlorophyll, vitamins, glucosides, ferredoxins, and certain disulphide linkages besides activation of proteolytic enzymes and ATP-sulphurylase. Sulphur is also considered as a cost effective acidifier where each mole of sulphur produces two moles of hydrogen ions (H⁺) on its oxidation in the soil and reducing soil pH that leads to
dissolution of nutrients especially soil phosphorus in the rhizosphere. Sulphuric acid produced from sulphur oxidation causes the solubility of insoluble phosphate compounds. Generally sulphur oxidizing microbes performed well under slightly acidic conditions compared to calcareous alkaline soils. Therefore, direct applications of sulphur not only supplement the sulphur requirement of the crop but also solubilized the precipitated calcium phosphate in calcareous soils under groundnut cultivation.

It is well evidenced that uses of organics and microorganisms play an important role for improving the phosphorus availability in agricultural soils. Phosphate solubilizing bacteria (PSB) are the microbes involved in a range of processes that affect the transformation of soil phosphorus and are thus an integral component of the soil P cycle. Particularly these are effective in releasing P from inorganic and organic pools of soil phosphorus through solubilization and mineralization. The microbial biomass phosphorus in soil also contains a significant quantity of immobilized P that is potentially available to plants. Therefore PSB are the critical for the transfer of P from poorly available soil pools to plant available forms and are important for maintaining P in readily available pools. These processes are likely to be most significant in the rhizosphere of plants. Keeping these aspects in view, an experiment entitled “Mobilization of soil phosphorus for groundnut (Arachis hypogea L.) nutrition using sulphur and PSB in calcareous soil” was conducted during summer, 2016 at Instructional Farm, Department of Agronomy, College of Agriculture, JAU, Junagadh with the following objectives:

1. To mobilize native soil phosphorus for nutrition of groundnut crop
2. To study the effect of sulphur and PSB on soil phosphorus dynamics
3. To study the combined effect of sulphur and PSB on growth, yield and nutrient uptake by groundnut