CHAPTER 1

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Oilseed crops are important sources of food for humans and animals and have uses in industrial activities. Indian vegetable oil economy is the fourth largest in the world, accounting about 14 percent of world oilseed area and eight percent of world production. However, the productivity in India is only 791 kg/ha as compared to the world average of 1718 kg/ha (Damodaram and Hegde, 2002).

World production of oil crops has grown markedly since the last decade. Harvested area increased from 131.25 million ha in 1991 to 156.98 million ha in 2001 and production increased from 186.49 million tons to 276.95 million tons in 2001; especially for soybean, rapeseed, groundnut, and palm oil, production has been increased by 45% to more than 100% (FAO, 1989, 1998). India is the major producer of groundnut (33.6%), soybean (28.7%) and rapeseed (22.7%) (Damodaram and Hegde, 2002). To meet the increasing demand for oil and oil products in India for the teeming growing population, the production of oilseed crops should increase further. This will require more investments in agricultural research and in the popularization of improved technologies, including balanced fertilizer use.

With the improvement of crop productivity through the adoption of high-yielding varieties and multiple cropping systems, fertilizer use has become more and more important to increase oil crops yield and quality. Sulphur is an essential plant nutrient for crop production. For oil crop producers, sulphur fertilizer is especially important because oil crops require more sulphur than cereal grains. For example, the amount of sulphur required to produce one ton of seed is about 3-4 kilograms sulphur for cereals (range 1-6); 8 kilograms sulphur for legume crops (range 5-13); and 12 kilograms sulphur for oil crops (range 5-20). In general, oil crops require about the same amount of sulphur as, or more than, phosphorus for high yield and product quality. In intensive crop rotations including oil crops, sulphur uptake can be very high, especially when the crop residue is removed from the field along with the product. This leads to considerable sulphur depletion in soil if the corresponding amount of sulphur is not applied through fertilizer.

Although the sulphur content of plants is generally similar to that of phosphorus content, application of sulphur during last two decades has not received as much attention as those of phosphorus application because sulphur requirement was met through precipitation, irrigation water, manure's and sulphur-containing fertilizers, such
as ammonium sulphate and single superphosphate (SSP). The incidence of soil sulphur deficiency is increasing rapidly worldwide due to the intensification of agricultural production and use of high-analysis fertilizers as well as pesticide (containing little or no sulphur). Unfortunately, many producers are losing 10 to 40% of their potential oil crop yield because they are unaware of the importance of sulphur in oil crop production and unable to recognize mild to moderate sulphur deficiency symptoms in their crops. Furthermore, sulphur deficiency in crop production is often masked by the deficiencies of nitrogen and phosphorus, or by depletion of soil sulphur fertility.

To minimise the gap between the demand and supply of oilseed and pulses, intensive efforts are being made to increase their production. As ever-increasing population and urbanisation cannot allow increase in the land area under the cultivation of oilseeds and pulses anymore due to the pressure on land, hence, yield per unit area needs to be improved further. To achieve this objective, agricultural scientists have laid more emphasis on improving production of oilseeds and pulses through proper nutrition of the crops by evolving high yielding varieties and adopting improved agronomic practices as well as plant protection measures, etc. The most important constraints to crop growth are those caused by the shortage of plant nutrients. Sulphur (S) is increasingly being recognised as the fourth major plant nutrient after nitrogen, phosphorus and potassium. The importance of S in Indian agriculture is being increasingly emphasized and its role in crop production is well recognized (Tandon, 1986). Sulphur is best known for its role in the formation of amino acids methionine (21% S) and cysteine (27% S); synthesis of proteins and chlorophyll; oil content of the seeds and nutritive quality of forages (Tandon, 1986). The role of sulphur in improving the yield of rapeseed-mustard is well established (Aulakh et al; 1980; Tiwari and Panday, 1990; Ahmed et al; 1998; Ahmed et al., 1999a, b). Goswamy (1988) have emphasized that sulphur application also improves the yield and quality of pulses. He stated that S deficiency is the major constraint in increasing the production of pulses. There are many reports showing that sulphur application improved the growth, quality and yield of oilseeds and pulses. Increase in the growth of chickpea (Dubey and Mishra, 1970; Rai et al., 1982), peas (Totawat and Singh, 1981), green gram (Jat and Rathore, 1994), soybean (Sacchidanand et al., 1980), and groundnut (Singh and Chaudhari, 1995) were reported with the application of sulphur.

When a soil is deficient in S and the deficiency is not rectified, then full potential of a crop variety cannot be realised, regardless of top husbandry practices (Eppendorfer,
1971). It has been reported that in India more than 41% of soil are deficient in S (Singh, 2001). The major factors responsible for sulphur deficiency in the soil are as follows:

(a). wide gap between the removal and addition of S in soil,
(b). increasing depletion of S through higher yield and cropping intensity,
(c). inadequate recycling of residues in most cropping systems,
(d). large scale shift towards S free product in the fertilizer use pattern,
(e). low level of fertilizer input on high S requiring crops,
(f). losses of S through leaching and soil erosion, and
(g). microbial transformations in the soil.

Consequently, S deficiency which was once localized, has now engulfed much larger areas (Messick and Brey 2001). This was further supported by the studies, where S application resulted in significant crop responses in terms of yield and quality of the produce. The response was obtained in various crops including pulses. In about 125 field trials conducted under FAO sulphur network during 1987-89, significant response to sulphur application were obtained in more than 50% cases (Biswa;s and Tewatia, 1991).

Soybean and Groundnut are two important oilseed crops. They contribute around 64.12% of oil seed production in the country. Although the seed yield and quality of these crops have been increased considerably due to the cultivation of high yielding varieties and development of better agronomic practices, their yield potentials are not yet fully realized due to the S-deficiency in the soil. Most of the agronomic practices developed for the cultivation of oilseeds and pulses either do not include S or it is applied as single basal dose. Consequently, the crop suffers from S-deficiency during the most crucial reproductive phase due to high leaching losses as most of the S-fertilizers release S as SO$_4^{2-}$ ions (an ionic species highly susceptible to the leaching) in the soil solution. This results into the low productivity. Further, because of strong metabolic coupling between S and N assimilation, S also limits nitrogen utilisation efficiency of the crop and ultimately affects growth and yield.

The present study was therefore, undertaken with the following objectives:

(i). To study the effect of sulphur and nitrogen nutrition on N-assimilation of soybean and groundnut at different growth stages.
(ii). To develop improved nutrient management protocol for higher yield and improved quality of these crops.