CHAPTER - I
INTRODUCTION

1.1 Sulphur

It is a vital nutrients for crops, animals and humans, and is one of the mail building blocks for life. It is an important component for protein and one of the most essential elements needed by plants. Sulphur also plays an active role in the production of chlorophyll, enzymes and other basic compounds.

Sulphur is the fourth major plant nutrient after nitrogen, phosphorus and potassium for Indian agriculture. It is essential for synthesis of amino acids, proteins, oils, and a component of vitamin A and activates enzyme system in plant. Three amino acids viz. methionine (21% S), cysteine (26% S) and cystine (27% S) contain S which are the building blocks of proteins. About 90% of Sulphur is present in these amino acids. Sulphur is also involved in the formation of chlorophyll, glucosides and glucosinolates (mustard oils), activation of enzymes and sulphhydryl (SH-) linkages that are the source of pungency in oilseeds. Adequate Sulphur is therefore very much crucial for oilseed crops. Sulphur is also a constituent of vitamins biotine and thiamine (B1) and also of iron Sulphur proteins called ferrodoxins. Sulphur is associated with the production of oilseed crops of superior nutritional and market quality.

1.1.1 History of Sulphur

Sulphur is a vital, rather indispensable raw material for the production of Sulphuric acid which enabled the production of a large number of fertilizers. Sulphuric acid is perhaps the most widely used chemical in the world. Until the beginning of the 19th century, Sulphur was used primarily as a component of gun powder. Over the last 200 years, its main use has been to produce Sulphuric acid. Elemental Sulphur has been historically known as Brimstone. It can be a mined material or recovered from sour oil and gas. Marketable elemental S was first produced in 1894 in Sulphur, Louisiana, USA. The most important process for mining of Sulphur was the hot water process invented by Herman Frasch (1851–1914). Elemental S was recovered from the large Sulphur mines in Texas and Louisiana states of the USA by the Frisch process around 1895. At present, considerable tonnage of Sulphur is being recovered from oil and gas deposits.

(Source: Anon., 2016a.)
1.1.2 Sulphur in Agriculture

Sulphur is an essential building block for all life on earth, and it is critical in agriculture. Sulphur is crucial in a number of key processes in the crop:

- Production of oils
- Production of proteins
- Production of chlorophyll
- Uptake of other nutrients – especially nitrogen

(Source: Anon., 2016b.)
1.1.3. Sulphur Deficiency

Without adequate Sulphur, crops cannot reach their full potential in terms of yield, protein content and quality. Crops also need Sulphur to make an efficient use of nitrogen, phosphorus, and other vital elements.

Sulphur is in greater demand than ever before and Sulphur deficiency in soil are expected to increase due to growth of high yielding crop varieties, use of Sulphur free fertilizers, and the removal of Sulphur from industrial emission. Following are the general visual symptoms due to Sulphur deficiency:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Leaves of a plant, having Sulphur deficiency, cover with crust and begin to turn yellow. Plants looks withering. Plant is lower than the normal one. Panicles are shortened. Amount of spikes/seeds decreases.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rice</td>
<td>Leaves are light green and yellowish. Size of leaves and internodes decreases. Leaves chlorosis starts from edges and spreads to center. In the case of high deficiency, entire plant turns yellow and leaves are falling. Flowering and ripening is delayed.</td>
</tr>
<tr>
<td>2</td>
<td>Soybean</td>
<td>When Sulphur deficiency, leaves, especially young, turn yellow. Plant growth slows down. Leaves chlorosis is accompanied with green traces parallel to midribs. Leaves become narrow and short.</td>
</tr>
<tr>
<td>3</td>
<td>Wheat</td>
<td>Leaves are folding. Lower part of a leave and stem become reddish. Flowering stops earlier, consequently there are less pods forming. Sulphur deficiency leads to oil content decrease in seeds.</td>
</tr>
<tr>
<td>4</td>
<td>Mustard</td>
<td>Leaves and flowers grow pale. Stem is lower, internodes are shorter than usually. Number and size of leaves are lesser.</td>
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<tr>
<td>5</td>
<td>Sunflower</td>
<td></td>
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</tbody>
</table>
### Introduction

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th><strong>Sulphur deficiency affects upper parts of plants. The entire length of a plant grows yellow between midribs. Then it turns red at the base of the stem and at the edges of leaves, spreading to the center.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Potato</td>
<td><strong>Young leaves are folding. Stem grows yellow.</strong></td>
</tr>
<tr>
<td>8</td>
<td>Tomato</td>
<td><strong>Color of plants is pale green. Yellowing can be noticed at any part of the plant. In the case of high deficiency, stem and scape turn red.</strong></td>
</tr>
</tbody>
</table>

(Source: Anon., 2016c.)

#### 1.1.4. Sulphur Deficiency - World Wide

The big problem with Sulphur in agriculture is quite simple there’s not enough of it. Plant Nutrient Sulphur (PNS) deficiencies have been growing for years, and have reached the point in many parts of the world where they are beginning to severely limit crop production.

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**Key Causes of Sulphur Deficiency in Agricultural Soils**

(Source: Anon., 2016d.)
Three main causes for these deficiencies:

**1. Increased Yields Means More Sulphur Put.**

Between 2000 and 2009, the world’s crop production increased 22%. This has been tremendous but essential progress, as the world’s population has continued to grow extremely quickly. According to the UN, three will be more than 9 billion people on this planet by 2050. Over the same time period, however, the amount of land devoted to agriculture in the world actually went down by 1%. That means that the world is demanding much more from its land than ever before, and the negative effects of this high-intensity cropping are being seen. Many micronutrients and secondary macronutrients like Sulphur are being depleted very quickly due to crop removal.

**2. Relatively Greater Usage of High Analysis N, P, and K Sources Means Less Sulphur in.**

It used to be that growers all over the world applied significant volumes of PNS in their fertilizers incidentally. Nitrogen, Phosphorous, and Potassium are the nutrients which crops generally require in the highest volumes these are called the primary macronutrients. Historically, growers used more N, P, and K sources that contained Sulphur like ammonium sulphate nitrogen fertilizer (24% S), single superphosphate phosphorous fertilizer (14% S), and potassium sulphate fertilizer (17% S). Today, these are giving way more and more to higher analysis sources of N, P, and K, which contain little or no Sulphur, like urea, mono-ammonium phosphate (MAP) and Muriate of Potash (MOP).

**3. Decreased SO₂ Emissions Mean Less Sulphur in.**

Over the past decade, global industry has made tremendous progresses in reducing the emissions of greenhouse gases, like Sulphur dioxide (SO₂). SO₂ is a common emission from coal fired power plants which, upon chemical reaction with atmospheric gases, produces Sulphuric acid and is deposited back to the earth in the form of “acid rain”.

Reductions in SO₂ emissions are a very positive step forward from an environmental standpoint. However, the unintended consequence has been the reduction in crop available plant nutrient Sulphur in the soils of many regions. As we have cut down on SO2 emissions, we have also decreased many regionally concentrated supplies of PNS. (Source: Anon., 2016e.)
Sulphur deficiency is everywhere. Because of the intensified agriculture Sulphur uptake from arable lands by yields also increased. Because of diminished industrial emissions to the atmosphere, income of the Sulphur to the soil decreased. Studies on different crops around the world show that there a decrease in yields and quality of crops when soil deficiency. S is one of the most limiting nutrients for agricultural production in many Asian countries creates S deficiency in soils due to continuous cropping and regular use of S free fertilizers in several agro-ecological zones. Continuous removal of S from soils by plant uptake has led to widespread S deficiency and soil S budget all over the world. (Source: Anon., 2016f.)

![fig.1 Regional Plant Nutrient Sulphur Deficit World wide](image)

Asia has the largest regional deficit around the world with India and china in the land. (Source: Anon., 2016g.)

1.1.5. Sulphur Deficiencies in India

Sulphur deficiencies in India are widespread and scattered. On an average, 41 per cent of Indian soils are deficient in S and it is widespread in coarse textured alluvial, red and lateritic, leached acidic and hill soils and black clayey soils. Deficiency of Sulphur in Indian soils is on increase due to intensification of agriculture with high yielding varieties and multiple cropping coupled with the use of high analysis Sulphur free fertilizers along with the restricted or no use of organic manures have accrued in depletion of the soil Sulphur reserve. Crops generally absorb Sulphur and phosphorus in similar amounts. On average, the Sulphur absorbed per
tonne of grain production is 3-4 kilograms in cereals, 8 kilograms in pulses, and 12 kilograms in oilseeds. Soils, which are deficient in Sulphur, cannot on their own provide adequate Sulphur to meet crop demand resulting in Sulphur deficient crops and sub optimal yields.

With the adoption of intensive farming, the farmers have shifted from organic to inorganic high analysis S-free fertilizers leading to more widespread and more intense S deficiencies in Indian soils. In early 1990’s S deficiencies in Indian soils were estimated to occur in about 130 districts and recently about 45% districts of our country showed more than 40% S deficiency

As crop demands for S increase, deficiencies are more likely to occur on soils that inherently supply less available S within rooting zone. Minimum use of low-analysis fertilizers like ammonium sulphate and single super phosphate and organic manures has rendered the Indian soils deficient in Sulphur.

Yield improvement with Sulphur applications has been attributed to enhanced nitrogen use efficiency possibly by increasing nitrate reductase activity. Application of different S fertilizers at 10-50 kg S ha -1 significantly increased the seed yield of rapeseed and mustard crops ranging from 5.2-26.7 per cent as compared to control Oil content in mustard is reduced due to application of high analysis fertilizers. Di-ammonium phosphate is used as phosphorus source in place of single super phosphate leads to S deficit in soil. In S-deficient soil, the efficiency of applied NPK fertilizers may be seriously affected and crop yield may not be sustainable. (Source: Tandon.,1991.)

1.1.6 Profile of the Company

Crop Life Science Ltd. had started as a small scale unit for the manufacturing of crop protection chemical almost more than one decade ago in 2002. Currently company has main two units in Ankleshwar. By Acquisition, backward and forward integration, CLSL now has become one of the leading manufacturers of wide range of products-Insecticides, Fungicides, Herbicides, Micro Fertilizers, Plant Growth Regulators and Soil Plant Health Products. CLSL believes in the strategy of continuous expansion and development of high value and branded products with thrust on registration and marketing according to customer requirement. CLSL has manufacturing units located at Ankleshwar in Gujarat. It runs on world class technologies and quality services. Company focused on quality to serve its customers.
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R & D is Major strength for company and it continues to invest in innovative formulation that are environmental and user friendly. The company is fully committed to maintain and expand its portfolio. The aim of CLSL is to build strong relationship with customers to understand their needs and deliver real performance in term of usage. The company produce variety of micro fertilizers like Suforty-90, Hunter, Boxer, Purti zinc plus, Hiramoti and Bio-Shakti. (Source: Anon., 2016h)

1.1.7 Statement of the Problem

Sulphur (S) Ranks thirteenth in terms of abundance in the earth’s crust. It is one of the mineral nutrients which are essential for the growth and development of all plants. Sulphur is also essential for humans and animals. It is increasingly being recognized as the fourth major plant nutrient after Nitrogen (N), Phosphorus (p) and Potassium (K). Sulphur is taken up from the soil solution by the plant in the Sulphate form (SO$_4^{2-}$). In the plant Sulphur is a component of methionine, cysteine and cystine, three of the 21 amino acids which are the essential building blocks of proteins. Animals need to consume methionine in their diet as they cannot manufacture it themselves; methionine is essential for dairy cattle in particular. Sulphur is also a component of key enzymes and vitamins in the plant and is necessary for the formation of chlorophyll. In legumes Sulphur is necessary for the efficient fixation of nitrogen by the plant. This makes Sulphur of fundamental importance in the establishment and maintenance of legume-based improved pastures. It is also essential for flowering and seed set in canola. Plants which are deficient in Sulphur show a pale green colouration of younger leaves first as Sulphur is not very mobile in the plant. In severe cases of Sulphur deficiency the entire plant can be stunted and pale green. Affected plants may be thin-stemmed and spindly; brassica and canola crops may develop a reddish colouration on the underside of leaves and on stems and flowers may be pale to greyish in colour. (Source: Anon., 2016i)

This study was focus on to measure farmers’ knowledge about application and usage of Sulphur as a micro nutrient and their preference for Sufoty-90.
1.1.8 Practical Utility of the Research Study

The present study will be helpful to understand farmers’ knowledge about Sulphur application and usage and farmers’ awareness about the effect of Sulphur on growth, yield and quality of crops. It will be helpful to identify the farmers’ preference towards Suforty-90 and also helpful to find out market share and market potential of Suforty-90.

1.1.9 Limitations of the Study

This survey was restricted to Talala taluka only. The sample size for the survey is small which might not be representing the entire population. The result was totally derived from the respondent’s answers based on their memory. There might be difference between the actual and projected results.

1.1.10 Objectives of the Study

The present study was carried out with following objectives:
1. To measure farmers’ knowledge about Sulphur application and usage
2. To understand farmers’ awareness about the effect of Sulphur on growth, yield and quality
3. To identify the farmers’ preference towards Suforty-90
4. To find out market share and market potential of Suforty-90