CHAPTER-I
INTRODUCTION

Mustard (*Brassica juncea* L.) is extensively grown in Europe, Africa and Asia. From India it was spread to Afghanistan and other countries. Worldwide, India is the fourth largest mustard producer. European Union is the leading mustard seed producer in the world accounting for 34 percent of world production, followed by China (23 percent), Canada (19 percent) and India (14 percent).

India is one of the leading oilseed producing country in the world. Oilseeds is second largest agricultural commodity after cereals. Edible oils are next to food grains in Indian diet. Mustard is the second important edible oilseed crop after groundnut, meeting the fat requirement of about 50 percent population of all the northern states. It belongs to family crucifereae, popularly known as ‘rai’ and is an important *rabi* season oilseed crop of north India. It plays an important role in the oilseed economy of the country. It is grown as oilseed crop as well as condiment and for its medicinal use. The young plants are used as vegetable as they supply enough sulphur and minerals in the diet. In the tanning industry, mustard oil is used for softening leather. It is used in the preparation of hair oils, medicines, soaps, greases, etc. the oil cake is used as a cattle feed and manure. The mustard oil cake contains 5.1 per cent N, 1.8 per cent P$_2$O$_5$ and 1.2 per cent K$_2$O. The growing of mustard was known from time immemorial in India. It was introduced in India from China. Its probable origin is Africa. India has 6.70 million hectares area under mustard with production of 7.96 million tonnes and productivity of 1188 kg ha$^{-1}$ (Anon., 2014). Its cultivation is mainly confined to Uttar Pradesh, Rajasthan, Madhya Pradesh, Haryana, Punjab, Orissa, Assam, Bihar, Gujarat and west Bengal. Gujarat is at the fifth rank in the production of mustard after Rajasthan, Uttar Pradesh, Haryana and Madhya Pradesh. Rajasthan and Uttar Pradesh are the major mustard producer and together account for about 62 per cent of the total mustard production in India. In Gujarat, it is mostly cultivated under irrigated condition in different types of soil in northern parts and Saurashtra region. Its area is about 0.28 million hectares with 0.45 million tonnes of total production with productivity of 1582 kg ha$^{-1}$ (Anon., 2014).
Rapeseed-mustard is a group of crops comprising rapeseed (toria, brown sarson and yellow sarson) cultivar of *Brassica campestris*; Indian Mustard (*Brassica juncea* L.); black mustard (*Brassica nigra* L.) and taramira (*Eruca sativa* L.). Some exotic species of Brassicas like gobhi sarson (*B. napus* L.), Ethiopian mustard or karan rai (*B. carinata* L.) and white mustard (*Sinapis alba* L.) have been brought into cultivation in India. The crops of rapeseed group are largely cross pollinated whereas Indian mustard is largely self pollinated. Out of these cultivars Indian mustard fits well in cropping system of rainfed areas and accounts for >75% of the total area under rapeseed-mustard cultivation in India. Other cultivars like brown sarson and yellow sarson are under cultivation over limited areas in the Eastern part of the country including North-Eastern States.

Indian mustard markedly responded to sulphur fertilization in oilseeds. Sulphur plays a vital role in quality and development of seed. The chemical fertilizers being used for supplementing the major nutrient are generally either deficient or low in sulphur content. The importance of sulphur fertilization for increasing yield and quality of Indian mustard is being increasingly recognized. However, the information regarding optimum level of sulphur as well as source of sulphur and its influences on seed yield and quality of mustard is meager. Mustard crop needs comparatively higher amount of sulphur for proper growth and development and higher yields. Sulphur levels significantly influenced the seed and stover yield of mustard (Sharma *et al.*, 2009).

Mustard has highest requirement of S with optimum level ranging from 20 to 60 kg S ha$^{-1}$ depending on the soil S status and yield potential (Sarmah and Debnath, 1999).

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 component of vitamin A. 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 sulphydryl (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.
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Sulphur proteins called ferredoxins. Sulphur is associated with the production of oilseed crops of superior nutritional and market quality.

Sulphur deficiencies in India are widespread and scattered. 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 provide adequate sulphur on their own to meet crop demand resulting in sulphur deficient crops and sub-optimal yields.

As crop demands for sulphur increase, deficiencies are more likely to occur on soils that inherently supply less available S within root 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. Continuous removal of S from soils by plant uptake has led to widespread S deficiency and soil S budget (Aulakh et al., 1977) all over the world.

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.

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% as compared to control (Ahmad et al., 2005). Oil content in mustard is reduced due to application of high analysis fertilizers. Use of diammonium phosphate 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 (Ahmad et al., 2005).

Beneficial effect of sulphur application on increasing yield of several oilseed, cereals, pulses and cash crops has been reported in sulphur deficient soils by several workers. The performance of various sulphur sources like gypsum (18% S), phosphogypsum (14-16% S), ammonium sulphate (24% S), single super phosphate
(12% S), pyrites (22-24 % S) and elemental sulphur (85-100% S) has been review by Sakal and Singh (1997).

Elemental S–based products are the most concentrated source of S (85 – 100% S). Upon addition to the soil, elemental S has to be oxidized to yield the SO$_4$$^{2-}$ from that can be absorbed by plants. This oxidation is accomplished by soil bacteria. The rate of oxidation depends upon the particle size of S, its degree of contact with soil, temperature, moisture, and aeration. In order to allow adequate time for transformation, it is applied 3-4 weeks ahead of planting the crop.

Taking note of the facts highlighted above, a field experiment entitled “Effect of sources and levels of sulphur on the growth, yield and quality of Indian mustard (Brassica juncea L.)” was undertaken at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh during *rabi* season of 2015-16 with following objectives.

1. To study the effect of different sources of sulphur on growth, yield and quality of Indian mustard.
2. To study the effect of different levels of sulphur on growth, yield and quality of Indian mustard.
3. To ascertain the interaction effect of sources and levels of sulphur on growth, yield and quality of Indian mustard.
4. To arrive an economically viable conclusion for Indian mustard.