A REVIEW ON IMPACT OF RESOURCE AND APPLICATION TIME OF SULPHUR ON OIL CONTENT IN MUSTARD.

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Abstract

Sulphur is an important component in deciding rapeseed-mustard seed production, oil content, consistency, and tolerance to biotic and abiotic stresses. It is an essential constituent of seed protein, amino acids, various enzymes, and glucosinolate, in addition to encouraging chlorophyll formation and oil synthesis. Increased activity of an enzyme called acetyl-CoA carboxylase, which is also a precursor for oil synthesis, is related to increased oil content in mustard as a result of S use. Sulphur is beneficial to plants in another way: it reduces the adverse effects of heavy metal toxicity, such as those caused by cadmium. S has both synergistic and antagonistic interactions with other nutrients. Under the All India Coordinated Research Project on Rapeseed-Mustard, suggestions for unique S fertilization for different zones in mustard-based cropping systems have been developed. In order to improve the quality of S use, Not only must the right volume (based on soil testing) be applied in a balanced proportion with other limiting nutrient elements in the soil, but it must also be applied at the appropriate physiological level of the plant. While basal application of S is the highest, it can also be top dressed at 20-40 days of growth for a reasonable yield. The current paper examines the state of Indian soils, the response of S to rapeseed-mustard, primarily Brassica juncea, and improving S usage efficiency through advancements in techniques such as cost, process, and S sources.

Keywords: Sulphur, time of application, oil content, Indian mustard.

INTRODUCTION

Oilseeds occupy an important area in Indian agriculture due to their essential function in the sustainable profitable system of the country. Oil seed crops plays a vital role in human nutrition. As an excessive strength aspect of food, edible oil is necessary for convention the high energy requirements of human beings. Indian mustard is the essential winter oil seed crops. The production of mustard is no longer thoroughly abused due to the lack of desirable data on its food requirements. Indian rapeseed and mustard occupies about 6.18 million hectare area with a production of 7.36 mt and average production of 1190 kg ha−1. In India, Rajasthan first position in both area and production and Gujarat state has the maximum output of rapeseed and mustard. Rapeseed and mustard is grown in UP under 6.58 lakh ha area with production of 0.76 mt and yield of 1155 kg ha−1. Indian mustard significantly responded to sulphur fertilization. In oilseeds, sulphur plays an important role in the enlargement of seed and improving the quality Sulphur increases mustard consistency by increasing oil content, protein content, and fatty acid content. Sulphur is beneficial to the formation of chlorophyll and Vegetative development. It also aids in the respiration's reduction-oxidation reactions. In India, the role of micronutrients in increasing crop production has been recognised, but research has primarily focused on fruit trees and vegetable crops. Zinc is needed for proper plant growth and development in the plant system. Zinc is a key component of many enzymes that control a variety of metabolic processes in plants, as well as influencing the production of growth hormones such as IAA. In mustard seeds, zinc promotes pod setting, seed formation, and oil synthesis, among other things. Depending on the soil type and source of sulphur, oilseed crops react differently to sulphur application. Sulphur's roles in the plant are closely linked to those of nitrogen, and the two nutrients work together. Our soils have a negative sulphur balance because the addition of sulphur from different sources is much lower than the removal. In general, phosphorus and sulphur are deficient.

Sulphur (S) is an important secondary macronutrient for all plants' growth, metabolism, and development, and is appropriately referred to as "sulphur. The fourth most important nutrient for plants. S is extremely important in a variety of physiological and biochemical roles a plant Sulphur deficiency has been identified in a number of places. There are more than 70 countries in the world, including the United States. India is a country in Asia. Sulphur, in addition to being an essential component of seed protein, amino acid, and other compounds, facilitates oil synthesis. Holmes (1980) described enzymes, glucosinolate, and chlorophyll as "enzymes, glucosinolate, and chlorophyll." In rapeseed mustard, sulphur uptake and assimilation are critical for evaluating yield, oil quality, and stress resistance. Rapeseed-mustard has the highest S requirement of all the oilseed crops. In irrigated conditions, sulphur increases mustard yields by 12 to 48 percent, and in rain fed conditions, it increases yields by 17 to 124 percent (Aulakh and Pasricha, 1988). Every kilogramme of S increases mustard yield by 7.7 kg in terms of agronomic quality (Katyal et al., 1997). Rapeseed is a form of rapeseed that (Brassica compestris and Brassica rapa L.) has been found to require 3-10 times the amount of S as barley (Bole and Pitman 1984). The use of high-analysis S-free fertilisers and limited use of organic manures, combined with intensification of agriculture with high-yielding crop varieties and multiple cropping, has accelerated S shortages in arable lands. In India, the ratio of N: P_2O_5: K_2O: S has widened to 14.7:5.1:1.6:1 due to the continued use of S-free fertilisers (TSI, 2014). The adoption of advanced techniques developed for sustainable

S management is urgently needed to bring N: P2O5: K2O: S to the desired level. In India, the average rapeseed mustard productivity is only 1145 kg ha-1, and it needs to be increased to 2562 kg ha-1.by 2030 in order to ensure self-reliance in edible oil (DRMR, 2011). A systematic S management strategy could be crucial in achieving this degree of efficiency. Improved S management will boost oilseed productivity, especially for rapeseed-mustard, by addressing deficiencies with precise fertilisers.

❖ Sulphur in soil

Organic S compounds make up to 98 percent of total soil S, and they are a heterogeneous combination of plant residues, plants, and soil microorganisms. In certain ways, S behaves and reacts like nitrogen in the soil. S is a mobile nutrient, similar to N that can move quickly through the soil, particularly through sandy surface layers. Negatively charged sulphate is susceptible to leaching. Since soluble sulphates are leached into the B-horizons, they rarely accumulate in the upper soil layer (30 cm). Sulphur is commonly found in the subsoil, where it is absorbed by iron and aluminium oxides. As the acidity of the subsoil rises, so does the accumulation of sulphur. Mineralization of sulphur from organic matter to sulphate is dependent on the C: S ratio. 200-300:1 is the critical range. If the ratio is less than 200:1, net mineralization occurs, and if it is greater than 300:1, net immobilisation occurs. If the residue contains a small amount of sulphate, soil microbes may bind it (immobilise it). Under waterlogged conditions, sulphate can also volatilize as hydrogen sulphide (H2S). S from the atmosphere will contribute 5-10 kg ha-1 of S per year. The absorption and translocation of S in soil is also influenced by soil characteristics. Freundlich adsorption isotherms aid in the perception of the movement and preservation of added S in the soil during absorption studies. As gypsum and K2SO4 are used as S sources, K2SO4 migrates further than gypsum. In the 90 cm depth of the profile, about 28 to 38 percent of the added S is retained. The upper soil layer has the greatest increase in total S content as a result of S application. In the 30 to 75 cm depth range, soluble S accumulates, and the proportion of S that is sorbed increases with depth. Increase in soluble and sorbed fraction of S leads to an increase in S in the surface layer due to an increase in organic fraction in the lower layer of the profile (Saha et al. 2002). The total S content of Indian soils ranged from 10 to 6319 mg kg-1, but most agricultural soils had a mean content of 30 to 300 mg kg-1.

❖ Role of Sulphur in Mustard

In oilseed crops, sulphur plays a unique role. Cheema and Arora (1984) found that rapeseed-mustard needs 0.33 to 0.40 percent S in the leaf to produce 90 percent of its potential yield. Oilseeds (Brassica species/cultivars) differ in their susceptibility to sulphur deficiency and the amount of sulphur they need for optimal seed yield and quality (Malhi et al., 2005). For optimal growth and development, plant tissue should contain one part S for every 15-20 parts N. Its concentration varies by species and ranges between 0.1 and 0.6 percent of dry matter (De Kok et al., 1997). Plants contain a wide range of organic S compounds, such as thiol (glutathione) and secondary S compounds (allins, glucosinolate, phytochelatine, and others), that play an important role in physiology and pest resistance (De Kok et al, 1998). Sulphur deficiency induces the accumulation of amides and carbohydrates, which slows the development of chlorophyll, resulting in stunted plant growth and light green coloration of young plants. In rapeseed-mustard, as in other plants, sulphur is needed for the formation of protein, enzymes, vitamins, and chlorophyll. Proteins are made up of three S-containing amino acids: methionine (21 percent S), cysteine (26 percent S), and cystine (27 percent S). Around 90% of the total plant S is contained in these amino acids (Tandon and Messick, 2002). Plant hormones including thiamine and biotin, both of which are involved in carbohydrate metabolism, contain sulphur. The amino acid cysteine is a precursor to glutathione, a water-soluble thiol compound that protects plants from oxidative stress, heavy metal toxicity, and xenobiotic. Sulphur compounds are also crucial for food safety and efficiency, as well as the development of phytopharmaceuticals. It is a part of certain vitamins and stimulates some enzyme systems (Vitamin A). Sulphur is present in mustard oil glycoside, which gives plants like mustard their distinct odours and flavours. S is incorporated into a wide range of secondary compounds by many plant species, especially Brassicaceae crops, such as flavonol sulfation, desulfoglucosinolate, choline, and gallic acid glucoside (Leustek and Saito, 1999). Glucosinate levels in Brassicaceae vegetables change in response to S and nitrogen fertiliser treatments, according to several reports (Aires et al., 2006).

Mustard growth characters have increased, according to Chhonkar and Shroti (2011). Singh and Singh (1983) reported an increase in mustard chlorophyll synthesis, while Sah et al. (2006) reported a substantial increase in all growth attributes up to 40 kg S ha-1.

- **Sources of S fertilizer**

Since S-containing fertilisers are costly, they should be used efficiently and judiciously to reap greater benefits. The cost and ease of access of S fertilisers widely used to correct deficiency in various soils and crops influence their selection. Approaches for efficient managing of S fertilizers are listed in Table.

Table: Sulphur-carrying fertilisers and their use in various crops.

S.N.	Fertizers	Sulphur Content (%)	Management
1	Ammonium Sulphate	24	N+S application with integrated N+S, particularly for topdressing
2	Single super phosphate	16	For the basal dose, an integrated P+S application was used.
3	Potassium sulphate	18	Chloride-sensitive crops receive an integrated K+S application.
4	Elemental S	85	For calcareous soil with a fine texture. 3–4 weeks earlier to planting in the soil
5	Pyrite	22	Appropriate for Alkaline soil. Until planting, apply a thin layer to the surface.
6	Gypsum	18	For crops that need a lot of calcium.
7	Zinc sulphate	15	Depending upon the zinc requirements of the crop.

Sardana (2008) recorded an improvement in seed yield of 8.9% with foliar application of thiourea @ 0.05 percent at flower initiation to 22.2 percent with soil application of 20 kg S/ha as gypsum at sowing+ foliar application of thiourea @ 0.05 percent over control with soil application of 20 kg S/ha as gypsum at sowing+ foliar application of thiourea @ 0.05 percent With a basal application of 20 kg S ha-1 through gypsum + foliar application of thiourea (0.05 percent), net returns and B: C ratio were higher, followed by a spray of 0.15 percent Sic acid and soil application of gypsum to supply 40 kg S ha-1. When using pyrite as an S source, it should be broadcast as a fine powder on the soil surface under moist conditions 7-10 days before sowing to ensure a high conversion of unavailable S to plant usable form. Compared to gypsum and wettable S, bentonite S provided significantly better growth, yield attributes, seed yield, oil yield, nutrients (NPS) uptake, net return, B: C ratio, productivity, economics, and water use quality (Tetarwal et al., 2013). To improve the effectiveness of granular elemental S, a variety of S-bentonite fertilisers have been produced.

❖ Effect of Sulphur with other nutrients

The crop's ability to absorb S is largely determined by the balance of S and other nutrient elements within the plant as well as in the soil. With other nutrient components, S has both a synergistic and antagonistic effect. The relationship between N and S is said to be synergistic since they are both closely linked in protein metabolism. These two nutrients boosted each other's concentration and uptake in the plant. P and S have established an adversarial relationship. Several studies, however, show that there is a positive relationship between the two. At low to medium levels of P, the P and S relationship was found to be synergistic. d. The maximum increase in oil yields was obtained at 75 kg ha-1 N and 60 kg S ha-1 S, based on the results of three years of field experiments on mustard, indicating a strong positive association between them. In grains, an adequate N: S ratio of 7.5:1 has been discovered, above which S deficiency can be observed (Aulakh et al., 1980). To get the most out of your rapeseed mustard, make sure you give it enough S. Sulphur is also necessary for the absorption of phosphorus and other vital nutrients. Sulphur is on par with nitrogen in terms of crop yields and efficiency. It increases the size and weight of seed crops, as well as the efficiency with which nitrogen is used to make protein. S is a major nutrient factor that influences P: S partitioning and nitrogen accumulation in plants, especially in legumes with symbiotic nitrogen fixation (Dwiwedi et al., 2005). In oilseed Brassicas, the N and S relationships are important (Jackson, 2000). Oilseed rape seed yield and S absorption are significantly increased when mineral S fertiliser is applied (McNeill et al., 2005). Jackson (2000) looked at the four N values in conjunction with the three S rates, and found that seed yield and oil content were both closely linked to nitrogen availability.(Malhi et al. 2007) found that oilseed crops like rape and mustard are vulnerable to S and/or K deficiency. As 45 kg S ha1 is used, the oil content rises to 46.6 percent, compared to 42.8 percent when no S is used. The effect of K and S on protein content in rape and mustard showed that oil content increased significantly with each increment in K level when applied with the lowest level of S. In comparison, oil content decreased significantly with each increase in K level at the highest level of S. Protein content improved when the S rate was increased to 30 kg S ha1 and the K level was increased to 60 kg K ha1 (Amanullah et al., 2011).

❖ **Integrated use of Sulphur with Organic manure**

In many soils, organic bound S is a possible source of plant accessible S. As a result, using organic manure increases the availability of S in soils while also providing a longer-lasting residual effect. The application of 20 (kg S ha-1) + 5 t FYM to a crop has a major residual effect on the following crop, as well as increasing native S utilisation ability. When pyrite is used in conjunction with 10 t ha-1 FYM or press mud, the yield is significantly higher than when the two are used separately. In the crop rotation, a catch crop can help to avoid S deficiency and increase synchrony between plant demand and available soil S. While they cannot meet the needs of S-demanding crops, they can serve as a valuable nutrient supplement. Catch crop has the potential to minimise sulphate leaching and thus improve overall S usage performance in crop rotation. Although all crops, including leguminous, ryegrass, and other grasses, are beneficial, the best catch crop (legume on sandy soil) sequesters 10-12 kg S ha-1, while the worst catch crop sequesters just 3.0 kg S ha-1 (Erickson et al., 2000).

❖ Time of application

It is not only necessary to apply the correct amount (on a soil test basis) in a balanced proportion with other limiting nutrient elements in the soil to improve S use quality, but it is also necessary to apply it at the proper physiological stage of the plant. Since S, like nitrate, is leachable, it's best to apply it in two doses near to the time of plant uptake. This is especially true in sandier soils. Band application is preferred, but broadcasting may also be effective if there is enough rainfall or irrigation to leach the S into the root region.

To maximise seed yield while avoiding damage to mustard seedlings, side-banding is the most efficient way to apply sulphate-S fertilisers. In most years, broadcast-incorporation methods can achieve seed yields comparable to side banding in relatively moist areas (Malhi, et al., 2005). Crucifers have the highest rate of S mineralization (57-85 percent of total S added) and legumes have the lowest rate (up to 46 percent of total S added). Sulphate S fertiliser can only be applied in small quantities near the crop. The largest increase in yield and S absorption occurs when sulphate-S is applied to mustard at seeding time (Malhi et al., 2005).

Sulphate-S application during bolting can significantly improve seed yield, while application during early flowering can moderately correct S deficiency damage (Malhi, et al, 2005). Within plant components, sulphur is less mobile than nitrogen. Since the crop's S requirement is higher in the early stages of development, it should be applied prior to bud initiation or flowering to ensure higher crop yields. However, because of the essential importance of S in plants, S fertilisers should be applied. A plant tissue test for complete S deficiency in rapeseed-mustard may be used to assess S deficiency, the S given by this method can arrive too late to cure the S deficiency and restore the current crop's seed yield to optimal levels. The most reliable index of S status in plants was found to be the ratio of hydriodic acid reducible (HI-S): total S in plants at the rosette level, and a ratio of less than 0.38 may reduce seed yield due to S deficiency in canola plants (Maynard et al. 1983). S fertilisation should be performed if the N: S ratio is greater than 15:1. Histuda et al., (2005) found that tolerance to low externals (2.0 mg L1) and essential tissue S levels for S deficiency differed significantly between the oilseed Brassica species studied. If S is not applied at the time of sowing, it can be top dressed at 20-40 days of growth to get a good yield. S has a lower foliar mist. When compared to its soil application, it is more successful. Because of the crop's strong S requirement.

Conclusion

Along with N, P, and K, sulphur is now considered the fourth most important nutrient for plants. Only when there is a high yield of high-quality produce is it possible to produce a high yield of high-quality produce

Sulphur is available in an optimal amount to crops. A constituent of three major amino acids: important for cysteine, cystein, and methionine synthesis of proteins. Out of the four main nutrients needed by plants, S is the least expensive (N, P, K and S). It is less costly to apply than other nutrients, but it yields higher income. The only way to get rid of sulphur deficiency in Indian soils is to treat S in crops correctly. S not only helps to maintain high yields, but it also increases the consistency of rapeseed-mustard produce. Mustard reacts well to S concentrations of 40-60 kg/ha applied via SSP, gypsum, or betonite S. The oil content of rapeseed-mustard will rise by 3-9 percent. This is important in the sense of India, as the country is low on vegetable oils and imports a significant amount of foreign exchange. Proper steps should be taken to increase the potency of S fertilisers in order to achieve the most desired outcomes from S application to deficient soils. Strategies must be devised. Established to promote further use of S by combining a judicious combination of fertiliser S, by-product S, and organic manure to achieve a high mustard yield that can be sustained productiveness.

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