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EFFECT OF SULPHUR DIOXIDE ON THE GROWTH AND YIELD OF BRASSICA CAMPESTRIS

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ABSTRACT

Experiments in the field were carried out at the Central Research Station of the Agricultural Research Institute (BARI) during the years 2005 and 2006 to determine how varying concentrations of sulphur affect the BARI Sarisha-15 rapeseed variety. According to the findings, varying dosages of sulphur exerted a substantial amount of control over a large majority of the growth metrics and yield characteristics. It was discovered that the growth parameters, yield, and yield contributing characteristics rose with increasing amounts of sulphur fertilizer up to 60 kg S/ha, but that they decreased with dosages that were higher than that. All of the growth metrics, such as plant height, leaf area, dry matter accumulation, leaf area index, crop growth rate, net assimilation rate, and relative growth rate, as well as all of the yield components, such as the number of siliquae per plant and the seeds produced per siliqua, were taken into account.

Keywords: *Sulphur Dioxide, Growth and Yield, Brassica Campestris*

INTRODUCTION

Rice (Oriza sativa) and wheat (Triticum aestivum) are the two most significant crops in India's agriculture, but they aren't the only ones. India is home to a diverse range of plant species. Farmers in India also grow medicinal plants, grains, seeds, timber, vegetables, pulses, sugar cane, and oilseeds, as well as non-food items such as tea, coffee, cotton, rubber, and jute (the fibers in these plants are used to produce ice and rope). For the sake of rice harvests in India, for example, excessive quantities of water are being allocated during times of rising water shortage and environmental crises. Rice agriculture in areas such as Punjab is suffering as a result of insufficient water usage, which has a negative impact on the fertility of the land. The ongoing drought and unfavorable weather in Asia are contributing factors in the deterioration of farming conditions. Even if a monsoon with typical rainfall were to be expected during that time, the forecast for the period was not thought to be favorable. This is owing, in part, to the rather unfavorable distribution of the rainfall, which resulted in floods in several other places.

The incorporation of new businesses and the introduction of modernisation practices in the oilseeds industry were both kicked off by the mission. There has been a notable rise in the production of oilseeds throughout the time period covered by the mission, and it has been noticed that the biggest growth has been found in the case of soybean and sunflower oilseeds. This is a result of the efforts that have been put forward. There were a total of nine different oilseed crops, and the increase of both land area and technological capabilities contributed practically equally. During the time period covered by the mission, India's primary focus was on achieving self-sufficiency, and the country imported just 6% of the total value of edible oils.The advancement of irrigation provision and the dissemination of innovative techniques both contribute to the achievement of desirable results. The entire area that was planted with oilseed crops in 1996-1997 was 19.3 million hectares, but that number expanded to 25.3 million hectares in 1998-1999. Additionally, the percentage of land that was irrigated rose from 17.4% in 1996-1997 to 24.2% in 1998-1999. The overall output over this time frame saw a considerable increase, going from 10.84 million tonnes to 0.1 million tonnes in 1996–1997.

Between the middle of the 1990s and the turn of the century, an announcement was made in the field of oil seed crop production. It is believed that the influence of TMO (Transit mail office) Peter was recorded with a negative rise on both field and production reported under oilseeds, which registered at 2.8% growth and 1.9 percent growth respectively. This would imply that the land used for growing oil seeds has been diverted to the cultivation of other crops, and that employees and farmers are experiencing less variety in their labor. The announcement was made in the field and production for a variety of reasons, some of which include low-cost production value, high risk, pests and bug assaults, climatic inclementness, and so on. The high government MSP (minimum support prices) during this time period for the crops of rice and wheat, together with substantial competition for oilseeds crops in some regions, led to expansion in the oilseed industry.

Brassicas world

Vegetables of the Brassica family are the most widely farmed vegetables in the world. It refers to a vast range of plants that are predominantly herbaceous in nature. After soybeans, the Brassica species is the second most significant and biggest oil seed crop in the world. Of the 37 species that make up the Brassica genus, oilseed crop production comes from Brassica. Brassica juncea, Brassica rapa, Brassica carinata, and Brassica napus are the four species of Brassica that are farmed the most for oilseed crop and vegetables. Other species include Brassica carinata and Brassica napus. Brassica campestris and Brassica napus are the two species most usually used to produce oleiferous brassicas. Brassica campestris is also cultivated to produce crops such as toria, quick plants, sarson, summer turnip rape, field mustard and turnip mustard, polish rape, and turnip mustard. These names are all collectively known as rape. Brassica species are extremely polymorphic, meaning they can be found in oilseed crops as well as in cultivated forms that contribute to rape seed production.

An essential crop for the production of oilseeds in India, rapeseed is a member of the Brassica family of oilseeds and is also known as raya, rai, and lahi. After groundnut, it is the second most significant crop in India for producing edible oilseeds, and it is responsible for almost 30 percent of the total oilseeds that are produced in the nation. The rapeseed-mustard family of edible oil seed crops is significant because it accounts for approximately 26.1% of the entire output of oil seeds and accounts for approximately 85% of the total rapeseed-mustard production in the country. The top place in terms of landmass and the second place in terms of production, behind China over the globe, crops of rapeseed and mustard are farmed in 53 nations, dispersed over all six continents, on a total land area of 24.2 million hectares. The percentage of the world's hectares and production that may be attributed to India is respectively 28.3 and 19.8 percent.

According to the Directorate of Economics and Statistics in the Department of Agriculture (2015), the most significant oil seed crop in India is rapeseed-mustard, which accounts for around 6.31 million tonnes of the country's total oilseed production. Nitrogen is the most essential nutrient for the mustard crop since it controls the plant's development, boosts the quantity of protein produced, and raises the overall output. Minerals such as calcium, manganese, copper, iron, selenium, and zinc are abundant in rapeseed, as are vitamins A, B, and C, as well as proteins. Mustard seed has 508 calories, 28.09 grams of carbs, 26.08 grams of proteins, 26.08 grams of total fat, and 12.2 grams of dietary fiber per one hundred grams. Nitrogen is the most essential nutrient for rapeseed crops since it influences the overall growth of the crop, as well as the total quantity of protein produced and the harvest. In the presence of nitrogen, it is well knowledge that phosphorus and potash may be utilized more effectively. It encourages blooming, the setting of siliqua, and an increase in the size of siliqua as well as the yield. Sulfur is another essential nutrient that has a significant impact on the body's physiological processes, such as the production of cystein, methionine, chlorophyll, and the oil content of oil seed crops. Sulfur also has a significant impact on the human diet.

In cruciferous vegetables, it is also accountable for the production of specific vitamins (B, biotin, and thiamine), the metabolism of carbs and proteins, and the production of oil that contains flavorful compounds. Due to the presence of glucosinolates that are rich in sulphur, Brassica has the highest sulphur requirement of any plant. One of the seventeen elements that are required for the expansion and maturation of plant life, potassium is an important contributor. Because of its influence on photosynthesis, water usage efficiency, and plant resistance to diseases, drought, and cold, it is utilized for the purpose of boosting the production and quality of various crops. Additionally, it is utilized for striking a balance between protein and carbs.

The technological mission in oilseed, which was started in 1986, prepared the path for the oilseed sector to tackle a variety of obstacles and complexity. In agroecological settings that were dominated by rainfed systems from 1950-2004, there was a fivefold rise in oilseed output. This increase occurred over the period under review. These figures were significantly greater than the proportional growth in total food grain output that took place during 2003-2004. India imported 51 lakh tons of vegetable oils despite having a record oilseed harvest of 25.1 million tons. The cost of these imports was 51 lakh tons.

The present demand for vegetable oils in the country is estimated to be 13 million tons, however this number is projected to rise to 14.8, 18.3, and 21.8 million tons by 2010, 2015, and 2020 correspondingly. Mustard has a cultivation area of 0.781 million hectares and a total annual yield of 0.957 million tons. Nearly 76 percent of oilseeds land is irrigated by rain, which means that it is frequently affected by the unpredictable monsoon. Protein makes up between 20 and 40 percent of the yellow mustard seeds, and their oil content ranges from 41 to 47 percent. Both the seed and the oil are utilized in the production of pickles and other condiments, as well as in the seasoning of curries and vegetables. The oil cake is most commonly used as a feed for cattle, while the young leaves of plants are harvested and consumed as leafy green vegetables. Because of its relatively expensive price, the amount of mustard oil that is utilized in the industrial sector is quite restricted. In addition to this, yellow mustard cake may also be utilized as an organic kind of fertilizer for the ground. During the growth season, the crop requires weather that is somewhat cold and moderate, with fair sunny conditions and a sufficient amount of moisture; during the harvest season, the crop requires weather that is dry. Above all else, the most significant reason for the poor yield is that it is typically cultivated as a mixed crop together with sugarcane and gram without the extra application of key plant nutrients such as nitrogen, phosphate, potash, and sulphur. Potatoes and sugarcane are also commonly included in this crop.

In light of the fact that there is a growing human population all over the world, there is a pressing need to boost global agricultural production in order to meet the expanding need for food that is both sufficient and highly nutritious. Altering the amount of nutrients that are supplied by the soil is one method among many others that may be used to boost crop output and productivity. Sulfur, a macronutrient that is required for plant growth and development, has also been recognized for its role in boosting crop production quality and plants' responses to abiotic stress. Therefore, for plants to have access to an appropriate amount of S throughout all stages of their growth is required in order to achieve optimal crop performance. Despite all of this, however, the S macronutrient has gotten very little attention throughout the course of many years, until very recently [This is mostly due to the fact that, in the past, it was believed that fertilizers and atmospheric deposition effectively supplied the soil with sufficient amounts of the nutrient. As a direct result of this, relatively little agricultural research on the nutrient S has been carried out, and a very limited amount of information has been reported.

However, amazing discoveries suggest that most arable soil around the globe has lacked S for more than three decades, but the adverse impacts on global agricultural output have just lately been apparent. This is because S deficiency has only recently been discovered. In recent years, decreased atmospheric S deposition as a result of stricter emission regulations, decreased use of S based fungicides, use of high analysis low S synthetic fertilizers, low S returns from farm animal derived manure, cultivation of high nutrient-demanding and high yielding crop cultivars, and intensification of agriculture have all led to widespread S shortage across the globe. This shortage has been caused by a combination of factors. Consequently, due to the significance of the sulfur nutrient in several plant processes (including the creation of sugar, the absorption of carbon dioxide, the fixation of nitrogen (N), and the construction of proteins), the significance of the sulfur nutrient is steadily growing. Notably, a growing body of studies in the field of science suggests that in order for crop producers to attain maximum yield from ever-improving high-performance genetics, they will need to begin administering the nutrient S to their fields in the form of fertilizer.

As a result, a recent increase in the demand for S can be attributed to the resurgence of interest in S. In terms of the market, the demand for sulfur fertilizers is growing at a significant rate, and the worldwide market for sulfur fertilizers now accounts for and is anticipated to reach This is mostly brought about by an increase in demand in the agricultural industry for crops that are prone to S deficit as well as a desire for improved production. In addition, the deterioration of soil quality and the rise in the amount of sulfur deficiency in the soil, the decrease in the amount of sulfur emissions, which influences the need for more sulfur, and the increase in the amount of sulfur used in fungicides and insecticides are the drivers of the expansion of the sulfur market. The elemental S sector is anticipated to see the greatest rate of growth over the course of the projected period. Elemental sulfur, in particular, is finding more and more applications as a result of its capacity to both lower the pH of soil and recover sodic soils. By crop type, the oilseeds and pulses segment—especially canola and soybean (Glycine max L.)—will dominate the high sulfur requirements. This is partly due to the fact that sulfur boosts oil synthesis and protein production in pulses. Canola and soybean (Glycine max L.) are two examples of these types of crops. Additional forecasts indicate that the Asia Pacific area will be the market that expands at the quickest rate during the forecast period of 2017–2026. This growth will be driven by the expansion in agricultural techniques and the need for high-quality agricultural output, with the Chinese fertilizer demand playing a significant role.

Because of its high nutritional potentiality for crops, its potential protective function against abiotic stressors, and its relative immobility in the soil–plants system, sulfur is now receiving the greatest attention in the field of soil science and plant nutrition. This is owing to the fact that sulfur is the nutrient that crop production focuses on the most. As a result of the need for S in the production of proteins and enzymes, it has been seen that crops are unable to attain their full potential in terms of yield, quality, or the amount of protein they contain. Furthermore, they are unable to make optimal use of the N that has been applied to them.

As a result of the enormous demand for grain and vegetable meals of the highest possible quality, S has the potential to play a pivotal role in enhancing the output, productivity, and quality of crops. In addition, in view of newly developing issues about depleted soil fertility, sulfur acquires a particular significance for crop productivity, particularly in heavily farmed areas. Therefore, in this study, we will address the function that the nutrient S plays in crop production, with a special emphasis on how it affects plant development, metabolism, and adaptation to abiotic challenges, in addition to how it might help increase agricultural yield. After that, we come to a conclusion by discussing the potential outcomes of further study on sulfur in plant crops.

OBJEACTIVES

1. The Study Sulphur Dioxide on The Growth and Yield of Brassica Campestris.
2. The Study the Increase in Farming Conditions Is an Occurring Asian Drought and Unpleasent Weather.

Sulphur in the Soil

Sulfur in the soil may be found in a variety of forms, including organic sulphur compounds, sulphide (S2), elemental sulphur (S0), and sulphate (SO42). The processes of mobilization, mineralization, immobilization, oxidation, and reduction are all involved in the process of transforming it between these forms. A heterogeneous combination of plant wastes, animal manures, and soil microorganisms make up up to 98% of the total soil sulphur, which occurs in the form of organic sulphur compounds. It is not immediately available to plants until it has been mineralized by microorganisms, at which point it will produce SO42, which may then be taken up by plants.

The parameters that influence the growth of microorganisms, such as the soil's water content, temperature, and pH, as well as the availability of other nutrients, are what affect the rates of mineralization and immobilization. As a consequence of this, the amount of sulphur that is present in the soil changes throughout the year. Proteins and amino acids are the primary sources of sulphur that may be found in microbial cells, according to research. Soil microbiological biomass S is estimated to make up between 1.5 and 5% of the total organic sulphur content of soil. In the meanwhile, microbial biomass is thought to be the most active pool for S turnover in the soil. This is despite the fact that it is rather unstable. In most cases, the addition of soil organic matter (SOM) will result in an increase in the total amount of microbiological biomass, which will include microbial S. On the other hand, in acid-sulfate soils, S2 can be the dominant species, and considerable SO42 can be found in dry soils or soils to which significant amounts of gypsum have been added. However, unless organic S or S2 is first converted to the SO42 form, plants will not be able to absorb or make use of it.

Sulphur in the Plant System

Plants have developed a network of sulfate transporters with varied affinity, localization, and regulation, which enables effective absorption and distribution of sulfate (S) from the root cells into sink organs according to the availability of sulfate (S) and the plant's requirements. Even while the aerial portions of higher plants are able to take in and make use of atmospheric SO2, the most essential source of S is the SO42- anions that come from the soil or fertilizer and are taken up by the roots. Furthermore, both the absorption and incorporation of SO42 are subject to stringent regulation at the transcriptional level. The divalent SO42 anion is taken up by root cells and subsequently transported in the xylem and phloem, with transmembrane transport steps being catalyzed by a family of SO42 transporters when the pH is in the physiological range. There has been a lot of research done on the absorption and assimilation of sulfur by plants, and various transporter genes that are involved in these acquisition and assimilation processes have been found. An increase in sulfate absorption capacity is a typical response seen in situations when sulfate availability is restricted. This increase is principally caused by transcriptional regulation of two root-localized sulfate transporters with high affinity, SULTR1 and SULTR2. As soon as S is replenished, the transcript levels of these transporters will immediately begin to decrease. This process is known as repression.

In its most basic form, the sulfate absorption route supplies plants with cys, which is subsequently used for protein synthesis and as a source of reduced S for the creation of met, GSH, coenzymes, and several secondary S compounds. The absorption of sulfur necessitates the transport of SO42 into the cell and subsequently into the organelles via SO42 transporters, the activation of sulfur by adenylation to form adenosine phosphosulfate (APS), which is catalyzed by ATP sulfurylase (ATPS), and the subsequent reduction of APS to SO32 by APS reductase (APR). Therefore, ATPS is responsible for catalyzing the first essential step in the sulfate assimilation pathway, which is the activation of sulfate prior to its reduction. This step is performed before sulfate can be reduced. In contaminated conditions, some sulfur (S) may also be taken up by leaves as gaseous sulphur dioxide (SO2) or hydrogen sulfide (H2S) and absorbed into cysteine (Cys). For sensitive plants, SO2 can be phytotoxic at very low air quantities (0.1 mg m-3).

In a more recent assessment, Kopriva et al. brought attention to the fact that the absorption of SO42 is closely controlled in response to demand. Plants will speed up their rate of SO42 reduction and SO42 transport at times when the availability of SO42 is limited. This indicates that the route is inhibited when normal amounts of external SO42 are present, but that it is activated when there is a lack of SO42 or when there is an overwhelming need for S due to growth and development. In addition, even the suppressed pathway has the potential to undergo additional suppression when the plant is provided with less sulfur. The process of SO42 absorption that occurs inside the plant system is subject to direct interference from external situations involving SO42. When decreased S compounds are provided to plants (such as Cys, GSH, SO32, or H2S), or when nitrate or carbon availability is restricted, the pathway's activity is suppressed. In addition, Giordano and Raven underlined that S absorption and primary assimilation are enhanced when there is a shortage of it, light, carbs, or amino acids, in addition to oxidative stress and other situations which generate higher demand.

S-containing metabolites can perform their functions directly as components of proteins and enzymes, or they can perform their functions indirectly as cofactors, methyl group donors, prosthetic groups, and hormone precursors. The activation of SO42 during the reaction of adenylation that is catalyzed by the ATPS enzyme is the first step in the metabolic process of SO42. Due to the fact that increased ATP expression causes plants to take in less sulfur, the absorption of sulfur is being restricted by ATP. Sulfite reductase (SiR) is responsible for the final phase in the assimilation of SO42, which is the reduction of SO32 to S2. O-acetylserine (thiol) lyase (OASTL) is the enzyme responsible for transferring S2 to activated serine, which ultimately results in the formation of Cys. In plants, the process that results in the synthesis of cys is a merger of the route that leads to the absorption of nitrogen and carbon.

After the reduced S2 is integrated into activated serine, O-acetylserine, the first organic component that is generated in the SO42 assimilatory route is cys. This links glycine-serine metabolism to S metabolism. Cys is a vital amino acid that may be found in a wide variety of proteins. It is also a precursor to a large number of molecules that are very necessary to the body, including Met, S-adenosylmethionine (SAM), S-methylmethionone, iron-S clusters, hormones, vitamins, and enzyme cofactors. The formation of disulfide bonds in proteins between the thiol groups of Cys residues is an essential step in both the formation and the preservation of the tertiary structure of proteins. Cys, in addition to its role in the production of proteins and Met derivatives, also plays an important role as a foundational component in the formation of all further derived reduced S-containing compounds, such as GSH, phytochelatines, S-methylCys, S-alkyleysteine, glucosinolates, and phytoalexins. Compounds made of organic substances that include the element sulfur are also to blame for the distinctive flavor and aroma of onions, garlic, herbs, and other beneficial vegetables that are used in cooking and traditional medicine. Cys desulfhydrase is the enzyme that catalyzes the next step in the breakdown of Cys, which leads to the synthesis of pyruvate, ammonia, and H2S. When a pathogen attacks a plant, the H2S that is produced may contribute to the plant's defensive mechanism.

CONCLUSION

Sulfur is an essential element in the fundamental metabolic processes of plants, where it performs antioxidative and protective physiological actions against a wide variety of abiotic stressors. S may play a major role, much like other macronutrients, in the sustainable maintenance of soil fertility, improving crop productivity, and promoting the production of high nutritive-value crops. Our goal is to satisfy the growing demand for food, animal feed, and biofuel caused by the ever-increasing human population. Because of this, as we move forward into the future, we need to refocus our attention on the nutrient sulfur. Greater efforts should be focused on improving our understanding of the molecular processes and dynamics of S availability and utilization in plants; deciphering the dynamics of S interactions with other nutrients; exploring the role of soil rhizospherical microbes in plant S transformations; enhancing plant phenotyping and diagnosis for nutrient deficiencies; and providing a precise estimation of crop S requirements for optimal production.

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