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Role of Sulphur for Bread Wheat (*Triticum aestivum*) Production

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Abstract: Sulphur is an essential Key macronutrient among others for plant growth, quality and crop production for many cereals. It has great role for the primary structure of proteins and functioning of enzymes, by being a constituent of the amino acids cysteine (Cys) and methionine (Met). It also important for sugar production, carbon dioxide assimilation and fixation of other nutrients in plant function. There for Sulphur fertilizer should be apply adequate amount for different crop specie. The rate of Sulphur fertilizer may vary from crop to crop and depending on the amount of nitrogen fertilizer. The N: S ratio is determined the application rate of Sulphur. This review of the literature focuses on the function, importance and management of Sulphur (S) for wheat production. These information sources are selected to assist advisers and growers to improve their understanding of S to provide the basis for improved decision making for managing S nutrition. The selected research and extension literature focuses at the basic universal principles of S nutrition provided by cornerstone journal articles and texts. Literature may be in the form of conference papers, fact sheets, and technical reports. Based on this reviewed sulphur fertilizer application is recommended for wheat production the rate of 15-20 kg/ha for nitosol and vertisol area while on saline-sodic soil 50 kg/ha is recommended.

Keywords: Bread Wheat, Quality, Rate of Sulphur

1. Introduction

In Ethiopia Bread wheat (*Triticum aesativum* L.) is the most top vital cereal crops handed and consumed. It stands third among cereals in respect of cultivated area and next in the perspective of grain product followed to maize [16]. Generally, wheat grains are utilized to get local bread, kolo, genfo, kinche, tela, borde, Enjera and other types of food. It's also handled in product lines to deliver flour for marketable product of bread for buyers in metropolises and municipalities [11]. Inspiteof its significance and developing request for bread wheat in Ethiopia, its product and productivity are veritably low. The current average yield of wheat is below 3tha^{-1} [16]. However, it's potential yields greater than 5tha^{-1} based on Abdulkadir research report [1]. According to Minot report that the nation imports much quantity (30–50% of total yearly request) wheat grains each year from overseas to fulfil home consumption [37].

In Ethiopia the production of bread wheat is very low due to reduction of soil fertility through time reported by Chapman [10, 15]. There are many factors for reduction of soil fertility which are erosion, deforestation, unbalanced nutrient management, mono cropping system, abnormal tillage practices are the many problems for whole production and productivity in Ethiopia referred by Abdulkadir [1].

According to Abdulkadir reported that Loss of soil fertility is extremely expanded through time that is becoming burning issue and required highly attention [1, 11]. In Ethiopia, most of the time DAP (di ammonium phosphate) and Urea were applying the only fertilizer source for nitrogen and phosphorus. However, unbalanced fertilizer application did not bring significant effect on bread wheat production and cannot assure food security in the country reported by Rashid [33, 41]. Nowadays, Sulphur is a most important nutrient for bread wheat production to improve protein content of different cereals. Sulphur is an essential element of grain proteins and amino acids which are important in forming the high-quality glutenins and gliadins reported by Gupta and Zhao [22, 52].

Deficiency of S in agricultural crops, especially wheat, was reported as rare reported by Withers [50]. This is due largely to the belief that the S requirement of crops is satisfied from S deposited from wet deposition of S compounds and release from organic matter. On average, 10–12 kg ha^{-1} of sulfate-S is obtained from rainfall, which is slightly less than the wheat crop requirement of 15–20 kg ha^{-1} recommended by Zhao [3, 52]. While demand for Sulphur depends on plant species, the amount and rate of Sulphur uptake from the nutrient solution depends on many factors, including pH, temperature, access to energy, sulphate concentration and the presence of other ions reported by Ali and Withers. [3, 9, 50]. with the increase in sulphate ions accumulation in the nutrient solution, their uptake by plants increases. Having reached a certain level, various for different plant species, further increase of concentration does not affect the uptake any longer. However, high sulphate concentrations may affect plant development and crop yield showed by Withers [50]. Wheat requires a relatively high amount of supplemental S due to incompatibility of conditions with its period of most rapid growth during early spring, when the rate of S release from soil organic matter is quite slow found by Johansson [29].

2. Methodology

Commencing of this review was collected from different available research findings from different research journals. References were also made to documents of national statistics and progress reports of research centers. Then, a detailed literature search was carried out using web of science, Google scholars and open access journals search. Papers selection was made through specific searches for appropriate articles on soil fertility studies in the world.

2.1. Sulfur in the Soil and Its Availability to Plants

Sulfur in soils is present both in organic and inorganic forms. While inorganic forms are important because most of the S is taken up by plants as $SO4^{2-}$ (sulfate), organic forms are important because they often make up the bulk of soil S. Because S is an integral part of soil organic matter, total S is generally greater in fine-textured than in coarse-textured soils [3]. In general, soils containing greater amounts of organic matter contain a larger fraction of their S in organic form [6, 14, 44]. Soil sulphur exists as organic sulphur compounds, sulphide (S^{2-}), elemental sulphur (S^0), and sulphate (SO_4^{2-}) [14, 26].

Organic Sulphur is changed among the forms of different processes which are mobilization, mineralization, immobilization, oxidation, and reduction. Up to 98% of the total soil sulphur occurs in form of organic sulphur compounds, and comprises a heterogeneous mixture of plant residues, animal manures, and soil microbes [6, 26, 38, 39]. It is not directly accessible to plants until it undergoes mineralisation by micro-organisms to release SO_4^{2-} for plant uptake [13, 17, 18]. The rates of these process are determined by different factors that direct micro-organisms growth, including soil water, temperature, pH, and availability of other nutrients [31, 47]. As such, available soil sulphur varies throughout the year [17, 43].

Soil organic S is divided in two main groups: the first group contains S atom in the oxidized state and the other group contains S atom in the reduced state. According to results of Sevenson between 1 and 3% of the soil organic S can be accounted for the part of microbiological biomass [29], while more recent investigations suggest that the soil microbiological biomass S generally accounts for 1.5 -5% of total soil organic S stated by Wani [48]. Sulphate is an inorganic S, categorized into soil SO_4^{2-}, adsorbed SO_4^{2-} and mineral S [17]. Inorganic S is usually much less (10% or less of total soil S) abundant in most of the agricultural soils than is organically bound S [8]. In soil solution, SO_4^{2-} is highly mobile and only weakly held on colloidal particles; it is easily leached out of the crop rhizospheres and pastures, and huge losses of up to 100 kg S ha^{-1} per year have been recorded in Southern England [17, 32].

2.2. Effect of Sulphur for Bread Wheat Growth, Yield and Quality

Sulphur is one of the fourth important macronutrient among eighteen essential nutrients for plant growth and development particularly the formation of amino acids and proteins [4, 7, 8]. The results by Mail showed an evident 10 kgha^{-1} sulphur application has significantly increased on plant growth parameters which were number of ears by 14 up to 23%, 1000-grain weight by 12.8%, number of grains per ear by 7.7 up to 18.6% and 22 up to 23% grain yield compare to the control on pseudopodzolic soil [25]. A previous study by Tao reported that S fertilization at 45 kg S /ha, 200 kg N/ha, 183 kg P/ ha, and 163 kg K/ ha significantly ($p < 0.05$) increased kernel weight in both (GY2018 and ZM8) cultivars by 30.2% in GY2018 and 14.2% in ZM8 compared to the control (no S applied) [53]. Application of Sulphur fertilizers may actually decrease 1000-kernel weight of wheat have been documented by several studies including Zhao and Khan [46, 52].

The author, Menna who reported that the highest rate (20 kg/ha) of S application showed that significantly yield increment on Kekeba bread wheat variety on vertisol of central high land of Ethiopia [34-36]. Furthermore, the authors Assefa showed that the rate of Sulphur application under balanced fertilization of digelu variety of bread wheat 20-30kg/ha S on cambisol, 30-40kg/ha S on vertisol and 15kg/ha S combined with 22kg/haP of menze bread wheat Varity on vertisol of north central highland of Ethiopia were recommended [5, 36].

Similarly, Assefa who reported that application of P and S at higher rate (44 kg P and 30kg S ha/1) showed reduction in wheat yields [5]. The reason should be imbalanced ratios of macronutrients (S-N-P) have been created in the soil solution. In soil solution, SO_4^{2-} is highly mobile and only weakly held on colloidal particles; it is easily volatilized and leached out of the crop rhizospheres and pastures, and huge losses of up to 100 kg S ha^{-1} per year have been recorded in Southern England [17].

According to Hanna et. al application of 50kg/ha S fertilizer increased spring bread wheat grain yield by 3.58% on Cambisols in southeastern Poland [30]. Moreover, According to Habtegebria and Singh Maximum yield of grain for 'Shehan' and 'Enkoy' cultivar were found at the combined application of 180 kg /ha N and 60 kg/ha S on Andisols and Cambisols in northern Ethiopia [23, 24].

2.3. Integration of Sulfur with Nitrogen

Soil nutrient interaction in different crop species is probably one of the most important factors affecting yields of annual crops [21]. Imbalanced nutrients interaction affects their availability to crops as on overabundance one may result in deficiency of another nutrient [20, 27, 47, 48]. According to Xie, Jamal and Salvagiotti Combination of S and N have also been established in terms of dry matter accumulation and yield in different crop species [10, 13, 45, 51]. In addition to this Ali also was observed that Grain yield ha^{-1} can be significantly enhanced by applying N and S [2], while at the whole plant level, the requirement for matching N and S supply to corresponding demand arise from the close link between the uptake of SO_4^{2-} and NO_3^-[12].

In addition, Assefa reported that on 15kg/ha S recommended integrated with 22kg/ha of P on heavy vertisol [5]. In agreement with this withers reported significant yield responses of wheat to S, particularly in areas of low S deposition and with light-textured or shallow calcareous soils in England [50, 54].

2.4. Sulphur Role on Protein Formation

Sulphur is the most important for protein formation associated with nitrogen. Many research confirmed that the results of increased grain protein content of wheat with increased S fertilization rates were also reported by several researchers [28, 40, 42, 49, 53]. Furthermore, the authors Jamal confirmed that In plants, S and N play a synergistically central role in the synthesis of proteins, and the supplies of N and S nutrients in plants are highly inter-related [26, 27, 33].

Similar results were also reported by several researchers including Fisme reported that N and S have exhibited strong interdependence on effecting significant yield and protein synthesis in wheat, the ratio of total N to total S in plant tissue can reflect the ability of N and S in protein synthesis [19]. Therefore, an altered ratio of reduced N to reduced S, an acceptable way to reflect the amount of amino acids S, may reveal significant protein metabolism alterations that may have important implications for protein quality. S deficiency can reduce the utilization of available soil N, leading to increased nitrate leaching and that N deficiency can also reduce S use efficiency. Furthermore result Assefa also reported that the synergistic effect of S and P on availability of P was increased at lower rate of S but decreased at higher rates [5].

3. Conclusions and Recommendation

Based on the presented research and the literature, it can be said that sulphur fertilization should be applied on vertisol and saline-sodic area in the analyzed region. It has multi vital relation with micro and macro nutrients for enhance uptake efficiency of the crops through improve soil physical and chemical properties. Sulphur also has built up Protein and enzyme synthesis as well it is a constituent of the amino acids methionine and cysteine. Research experiment showed that 15-20 kg/ha of Sulphur obtained better bread wheat yield than control under vertisol area while on saline-sodic soil 50 kg/ha of Sulphur application showed positively influenced on wheat growth and yield which is 26% higher than control treatment. Nutrient application rate determined on soil type, season, climate, and weather, application methods, time of application, crop type, cultivars and source of fertilizer.

Conflict of Interests

The authors declare that they have no competing interest.

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