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Characteristics of Shallots (*Allium ascalonicum* L) Influenced by Sulfur Application in Floating Cultivation

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Abstract

Floating agricultural cultivation presents a viable solution for cultivating in water-rich regions. Among the crops suitable for this system is shallot (Allium ascalonicum L.). This study aimed to assess the effectiveness of sulfur application on shallot plant characteristics (Allium ascalonicum L.) in floating cultivation. Conducted in May 2023 at the Faculty of Agriculture's research pond, Sriwijaya University, the research employed a completely randomized design with sulfur applications (S1: 0 kg ha-1, S2: 30 kg ha-1, S3: 60 kg ha-1, S4: 120 kg ha-1, S5: 240 kg ha-1). Results revealed that tuber diameter exhibited strong determination values (R2: 75%), leaf length, number of leaves, and number of tillers exhibited moderate determination values (R2: 51%, 57% and 56%, respectively), while the relative growth rate showed a weak determination value (R2: 40%). The 60 kg ha-1 sulfur treatment demonstrated the highest chlorophyll content.

Keywords : Floating culture; Shallot; Sulfur

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1. Introduction

Floating agricultural cultivation provides a viable solution for farming in swamp areas. Unlike traditional cultivation, where plants require watering, floating cultivation ensures a constant water supply, eliminating the need for additional irrigation [1]. This system not only supports plant growth but also contributes to the local economy [2]. As suggested by [3], floating cultivation serves as a proactive measure during flood periods. Shallots are among the crops well-suited for development in floating cultivation.

Shallots (*Allium ascalonicum* L.) is a horticultural plants that is classified spice vegetables which are widely consumed or needed by the community [4]. Shallots are consumed as a flavor enhancer and flavoring agent in food and as a herbal medicine that has a pharmacological effect on body health [5]. As suggested by [6] The nutritional content and compounds contained in shallots have a preventive function if used as a food ingredient and a curative function if used as herbal medicine. Consumption of shallots has increased every year from year to year [7].

Sulfur serves as a crucial nutrient for shallot growth, facilitating the formation of essential amino acids like cystine, cysteine, and methionine, which contribute to protein formation [8]. As outlined by [9], sulfur assumes a crucial part in the union of key amino acids, aids in bulb enlargement, and imparts the distinct aroma and pungency to shallots through sulfoxide compounds. Despite its significance, sulfur nutrient application in shallot cultivation has received limited attention [10]. This research aims to assess the impact of sulfur provision on shallot plant characteristics in floating cultivation, specifically focusing on effectiveness.

2. Materials and Methods

2.1 Place and Time

This research began in May 2023, taking place at the research lake of the Faculty of Agriculture, Sriwijaya University, Indralaya District, Ogan Ilir Regency, South Sumatra Province at a height of 10 meters above sea level at coordinates 3°13'30.2"S 104°38'56.2"E.

2.2 Procedure

The raft is made from 100 bottles of 1.5 L mineral water per raft. Making the raft begins with calculating the buoyancy of the raft against the load of the polybag using Archimedes' law, namely with the formula:

$$\textbf{Volume of bottle} \times \textbf{Density of Water} \times$$

$$\textbf{Gravity} > \textbf{Mass} \times \textbf{Gravity}$$

Shallot bulbs are planted by cutting them first by about 1/3, this is done to accelerate shoot growth and stimulate the growth of side bulbs [11]. Next, the shallot bulbs are soaked in a dethane fungicide solution containing the active ingredient Mancozeb 80% at a dose of 3 g L-1 water for 5 minutes. Planting is done by inserting the shallot bulb into the planting hole with a movement like turning a screw so that the tip of the seed bulb appears flush with the surface of the soil. [12].

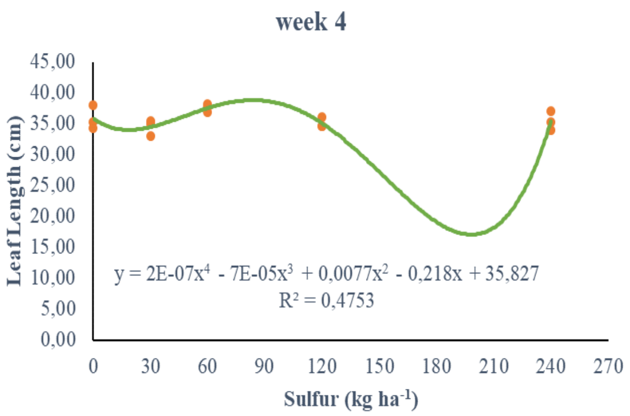
2.3 Research Methods

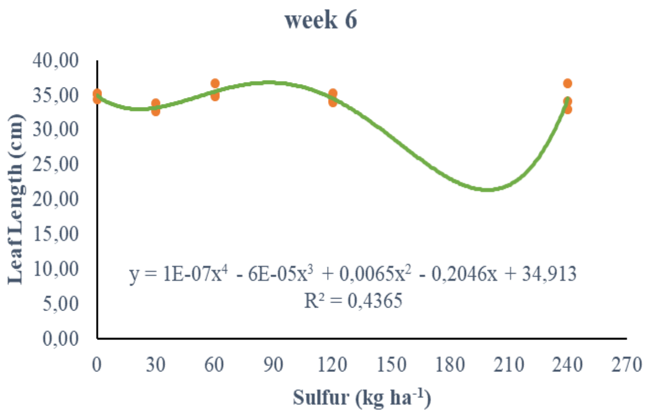
The This research employed a completely randomized design with five treatments and three replications, resulting in 15 treatment units, each comprising 10 plants for a total of 150 plants. The five applied treatments were S1 (0 kg ha-1), S2 (30 kg ha-1), S3 (60 kg ha-1), S4 (120 kg ha-1), and S5 (240 kg ha-1). Treatments were administered twice: 7 days and 25 days after planting. Research data underwent analysis using or-thogonal polynomial regression through the R studio application. Variables observed en-compassed leaf length, number of leaves, number of tillers, tuber diameter, relative growth rate, and chlorophyll analysis.

3. Results and Discussion

3.1 Results

Leaf Length (cm)





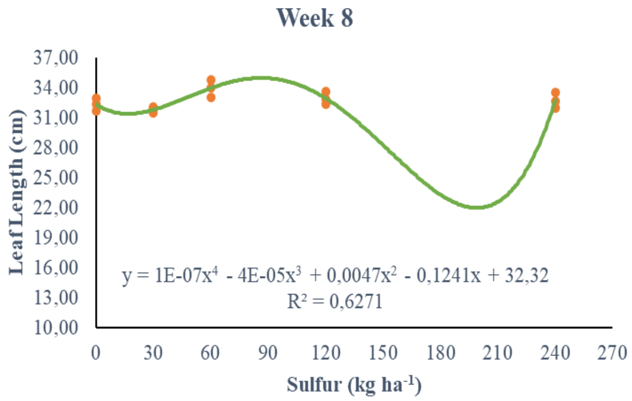


Figure 1. Results of orthogonal polynomial regression test for leaf length at week 4, week 6 and week 8.

Polynomial regression test results (Figure 1), leaf length in the week 4 obtained a determinant coefficient (R2), namely 0.4753, which is in the weak category where leaf length is influenced by 48% by the application of sulfur. The results of further tests in the 6th week showed that the determinant coefficient (R2) was 0.4365, which was in the weak category, where leaf length was influenced by 44% by the application of sulfur. The results of further tests in the 8th week showed that the determinant coefficient (R2) was 0.6271, which was in the moderate category, where leaf length was influenced by 63% by the application of sulfur. Regression tests at the week 4, week 6, and week 8 also obtained an optimum sulfur value of 86.7 kg ha-1 with an optimum leaf length of 36 cm.

Polynomial regression test results (Figure 2), the determinant coefficient (R2) for week 4 leaf length was 0.7312, including in the medium category where leaf length was influenced by the application of sulfur by 73%. The results of further testing at week 6 showed that the determinant coefficient (R2) was 0.6187, which was included in the medium category, where leaf length was influenced by the application of sulfur by 62%. The results of follow-up testing at week 8 showed a determinant coefficient (R2) of 0.3719, which was included in the medium category, where leaf length was influenced by the application of sulfur by 37%. Regression tests at week 4, week 6, week 7, and week 8 also obtained an optimum sulfur value of 87.7 kg ha-1 with an optimum leaf length of 27.4 strands.

Number of Leaves (strands)

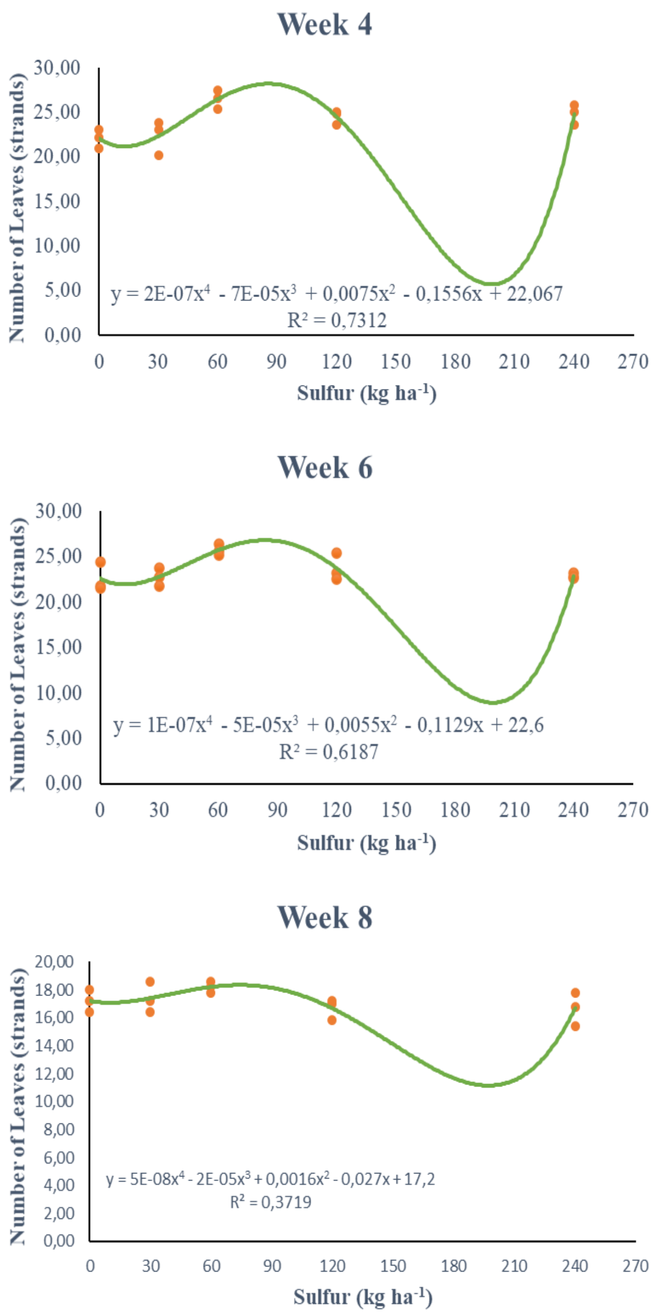


Figure 2. Results of the orthogonal polynomial regression test for the number of leaves at week 4, week 6 and week 8.

Polynomial regression test results (Figure 3), the number of leaves in the 4th week obtained a determinant coefficient (R2), namely 0.4068, which is in the weak category where leaf length is influenced by 41% by the application of sulfur. The results of further tests in the 6th week showed that the determinant coefficient (R2) was 0.6279, which was in the moderate category, where leaf length was influenced by 62% by the application of sulfur. The results of further tests in the 8th week showed that the determinant coefficient (R2) was 0.6543, which was in the moderate category, where leaf length was influenced by 65% by the application of sulfur. Regression tests on the 4th week, 6th week, and 8th week also obtained an optimum sulfur value of 85.3 kg ha-1 with an optimum leaf length of 6.4 clumps.

Number of Clumps (clumps)

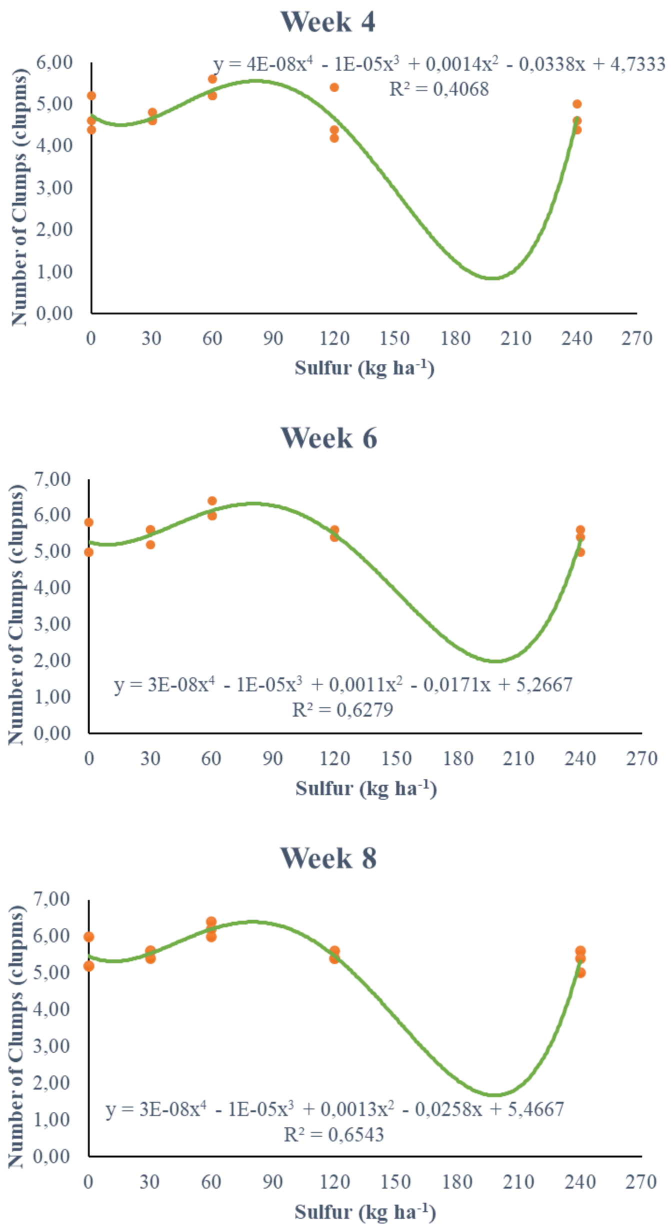
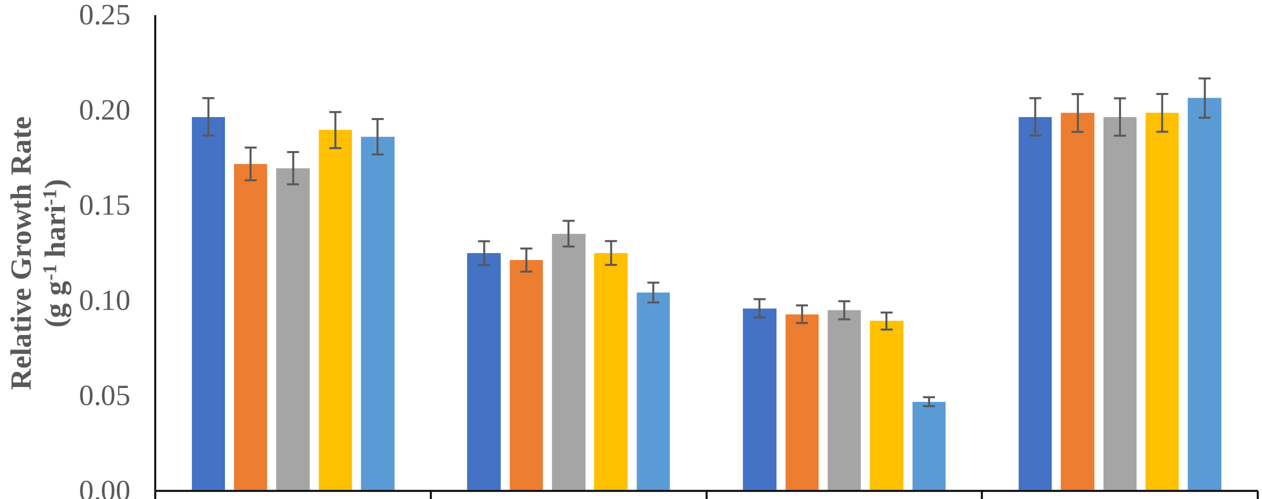


Figure 3. Orthogonal polynomial regression test results for the number of offspring at week 4, week 6 and week 8.

Polynomial regression test results in quartic order (Figure 4), we get the equation y = 1E-07x4 - 5E-05x3 + 0.0051x2 - 0.132x + 30.02. The results of this equation show that x is optimal or giving sulfur of 93 kg ha-1 can produce a tuber diameter of 30.73 mm. The regression results obtained a determinant coefficient (R2) of 0.7566 in the strong category where tuber diameter was influenced by 76% by the application of sulfur.

Relative Growht Rate (g g^{-1}hari^{-1})



	Week 3-2	Week 4-3	Week 5-4	Week 6-5
S1	0.20	0.12	0.10	0.20
S2	0.17	0.12	0.09	0.20
S3	0.17	0.14	0.09	0.20
S4	0.19	0.13	0.09	0.20
S5	0.19	0.10	0.05	0.21

Figure 5. Average relative growth rate (g g^{-1} day^{-1}) week 3-2, week 4-3, week 5-4, week 6-5.

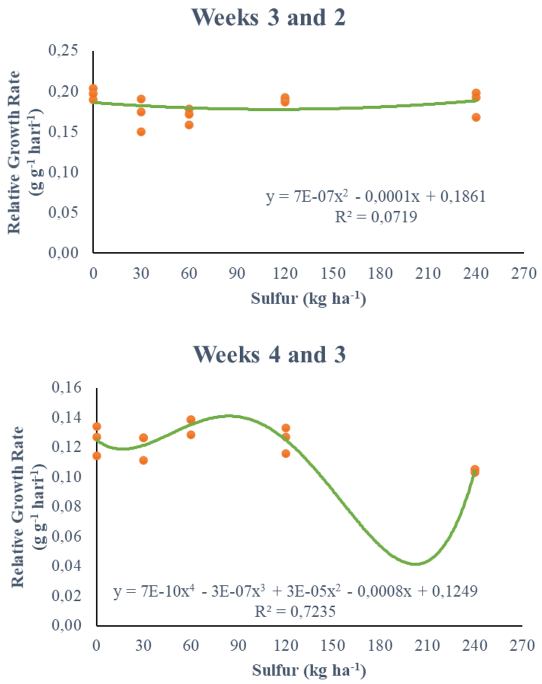
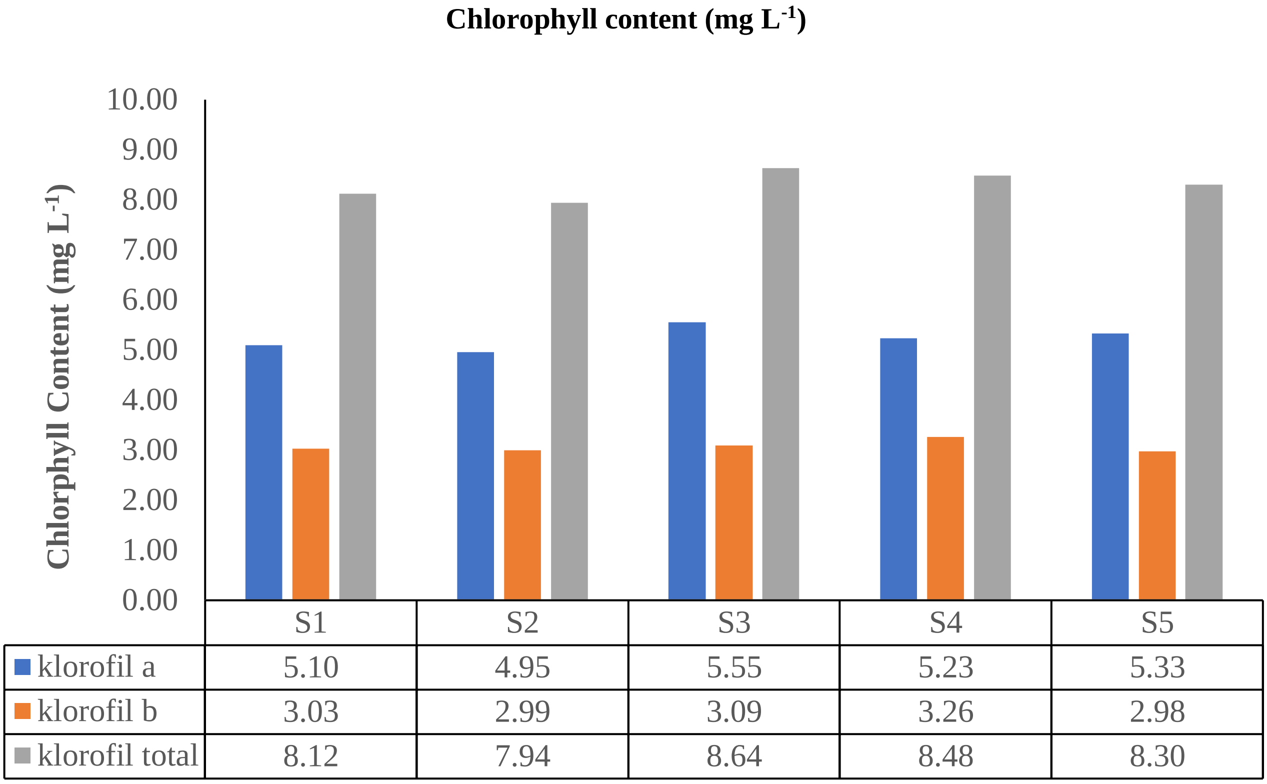


Figure 6. orthogonal polynomial regression test results of relative growth rates at weeks 3-2 and weeks 4-3.

Polynomial regression test results (Figure 6), the relative growth rate in weeks 3-2 obtained a determinant coefficient (R2), namely 0.0719, which is in the weak category where leaf length is influenced by 7% by the application of sulfur. The results of further tests in weeks 4-3 showed that the determinant coefficient (R2) was 0.7235, which was in the moderate category, where leaf length was influenced by 72% by the application of sulfur. Regression tests at week 3-2 and week 4-3 also obtained an optimum sulfur value of 88.3 kg ha-1 with a relative optimum growth rate of 0.145 g g^{-1} day^{-1}.

The consequences of chlorophyll examination in shallot plants showed that the most noteworthy chlorophyll a was gotten in treatment S3 with an average of 5.55 mg L^{-1}, the highest chlorophyll b was obtained in treatment S4 with an average of 3.26 mg L^{-1} and the highest total chlorophyll was obtained in treatment S3 with an average of 8.64 mg L^{-1} (figure 7).



	S1	S2	S3	S4	S5
klorofil a	5.10	4.95	5.55	5.23	5.33
klorofil b	3.03	2.99	3.09	3.26	2.98
klorofil total	8.12	7.94	8.64	8.48	8.30

Figure 7. Average content of chlorophyll a, chlorophyll b and total chlorophyll.

Discussion

Sulfur significantly influences plant growth and development, playing a crucial role in compounds such as glutathione, coenzymes, vitamins, and phytohormones, thereby impacting plant strength and growth [8]. Elemental sulfur, as highlighted by [13] enhances plant vegetative growth by serving as a vital component of ferredoxin, a complex compound in chloroplasts essential for carbohydrate catabolism. Optimal sulfur availability, as emphasized by [14], enhances the absorption of nitrogen (N) elements, as sulfur and nitrogen synergistically influence each other, thereby promoting plant growth. Proper sulfur application can also impact soil quantity and quality, leading to increased metabolic processes in plants [15].

According to [8] sulfur application has the most significant impact on leaf count, highlighting sulfur's crucial role in chlorophyll formation closely tied to photosynthesis and essential for plant growth[13]. Sulfur is involved in photosynthesis, electron transport systems, and acts as a coenzyme and prosthetic group, such as ferredoxin, vital for nitrogen assimilation [16]. Plants need balanced fertilization in the vegetative phase [17]. Sulfur is an important element in providing other nutrients, especially in plant N fixation [18]. According to [19] sulfur can increase immunity against pathogens that damage plant growth. Sulfur is also a nutrient that can prevent stress in plants, especially stress in water conditions [20].

Sulfur is an element that plays a role in composing cell protoplasm and is needed in the photosynthesis process [16]. Increased photosynthesis in the generative phase is aimed at forming and filling tubers [8]. ulfur significantly influences many aspects of plant quality, including vegetative and generative development, and modification of plant chemical composition, and has protective activities as well as multifunctional roles of sulfur, ranging from nutrition to protection [21]. The increase in tuber diameter will be greater if sulfur is used more effectively [22].

The quantity of plant chlorophyll is correlated with the availability of sulfur to plants, this occurs because sulfur is an essential nutrient needed by plants in the form of sulfihydryl groups (-SH) which are absorbed as reduced sulfate ions [23]. According to [24] he use of sulfur causes an increase in photosynthetic pigments in plants. The use of sulfur can increase environmental toxicity by increasing photosynthetic pigments, this is because sulfur helps increase the activity of glutathione reductase and glutathione peroxidase which are enzymes that increase photosynthetic pigments in plants [25]. as emphasized by [26] A deficiency or excess of one nutrient will affect all other nutrient elements so photosynthetic pigments will be affected.

Supplying plants with sulfur enhances its absorption, leading to increased and more robust leaf growth. This results in upright and sturdy leaves, optimizing sunlight absorption and improving the photosynthesis process, generating optimal photosynthate to bolster plant growth [8]. Research by [27] indicates that sulfur application at optimal concentrations synergistically enhances the availability and uptake of other nutrients. Sulfur supplementation is beneficial for plants experiencing environmental stress, whether abiotic or biotic. As highlighted by [19], Sulfur either directly or indirectly helps to lessen the negative effects of a variety of biotic and abiotic stressors. sulfur is a component of amino acids, vitamins, coenzymes, the thioredoxin system, glutathione, lipoic acid, and glucosinolates.

4. Conclusion

The conclusion from the research results was that the application of sulfur affected the tuber diameter with a strong determination value (R2: 75%), leaf length, number of leaves, and number of tillers exhibited moderate determination values (R2: 51%, 57% and 56%, respectively), while the relative growth rate showed a weak determination value (R2: 40%). The 60 kg ha-1 sulfur treatment demonstrated the highest chlorophyll content.

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