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IMPACT OF SULFUR ON SUNFLOWER GROWTH AND YIELD

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Abstract
The use of Sulphur (S) is known to have a significant effect on the growth and yield components of Sunflower ('Helianthus annuus' L.). From March to May, the Kharif season from 2022 was conducted at Amir Muhammad Khan Campus, The University of Agriculture, Peshawar in order to analyses S's effects on sunflower with varying levels of Sulphur 0, 10, 20, 30 kg ha⁻¹. A randomized complete block design was followed with three replicates of sunflower crops across the region. Results showcased the best growth parameters with 30kg S ha⁻¹, early emergence on day 10 and oil content of 45.38%, seed weight oil content of 60.39g, plant height of 156.66cm. Furthermore, all 30 ha were the optimal yielding conditions with Michigan S K Port received values of grain yield and biological yield peaking at 1076 alongside 4310 Kg ha⁻¹ becoming the new regional record. Overall, S was showcased with the fullest potential regarding the sunflower yield, with 30 kg S has recommended for the Mardan region.

Keywords: *Sulphur, Sunflower, Kharif Season, Growth, Biological Yield*

Introduction

Sunflower (Helianthus annuus L) is cultivated worldwide as a major oilseed crop due to its edible oil which contains unsaturated fatty acids. This makes sunflower a healthy food oil. Sunflower is grown in various agro-climatic regions of the world and is considered a major crop. The nutritional value of oilseed sunflower makes it be adopted in different agricultural systems because of its relatively short growth cycle. Sunflower oil has a wide range of uses including cooking, margarine production, and manufacturing of biodiesel and other industrial products. Even though it is globally important, Pakistan's sunflower production faces numerous challenges that limit its yield potential. Soil infertility, imbalanced fertiliser application, and limited nutrient availability are some of the main barriers to increasing sunflower crop productivity in the country. Farmers often have to deal with soil nutrient deficiencies, especially with Sulphur, which is why the yields remain below international standards. These challenges need to be addressed to improve sunflower production's efficiency and sustainability in Pakistan.

Sulphur is necessary as a macronutrient for the growth and development of plants. Its role is highly dynamic as physiological and biochemical processes are interconnected. Sulphur is a crucial part of chlorophyll and thus plays roles in photosynthesis as well as being an integral aspect of plant metabolism. Moreover, it plays a noteworthy role with regards to the oil content of oilseed crops like sunflowers as it improves their fatty acid synthesis. Seiler (2007) states that the "spread in productivity" of oilseed crops is rightly marked with shortfalls like inadequate growth-enhancing characteristics of stems and seeds and hence, they become deficient. It's concerning that Sulphur is placed on a pedestal in modern agriculture; that is because it is now heavily lacking in soils and this nutrient deficiency is termed as starvation. This is the outcome of discounted Sulphur fertilisers faced with copious amounts of refined crops, in effect depleting soil reserves. This very much caters to the parlous risk of inflation where the dip in sunflower yield and soybean oil content is drastically enhanced, leading to the building up of deficit markers in a country like Pakistan.

According to Messick (2003), the growth and quality of sunflower crops in many regions, including Pakistan, have been adversely affected by the insufficient application of Sulphur fertilisers.

The impact of Sulphur on agricultural production, particularly on oilseed crops, has been gaining attention in the recent past. An example is how Sulphur directly impacts the quantity and quality of yields in crops like sunflowers, which are highly responsive to Sulphur. Sulphur is known to support growth and even in Pakistan's agriculture sector, a number of oil-producing sunflower crop cultivars demand significant levels of available Sulphur during their growing season. Unfortunately, mismatching supply with farmers' Sulphur fertilisation knowledge has led to unsatisfactory crop growths and lower yield oil production. The main focus of the research is to find the relationship between the different levels of Sulphur application and growth in both yield parameters and growth in oil quality produced from sunflower crops. The oil quality is further evaluated from the optimal level of Sulphur required to increase productivity. This cultivation should remove the uncertainties regarding the role of micronutrients in sunflowers and ease the improvement of Pakistan's agricultural productivity while further fortifying the efforts around smarter food security.

The goals of the study are additionally in scope with the ongoing international activities that focus on the increase of crop yields and their quality through the proper use of Sulphur and other important nutrients.

Literature Review

The contribution of Sulphur to the growth of plants has been studied as it is considered the fourth macronutrient after nitrogen, phosphorus, and potassium. Sulphur is known to have an impact on cell metabolism both directly, as in the case of chlorophyll, and indirectly by aiding in the process of enzymatic proteins, vitamins, and coenzymes of metabolism. The deficiency of Sulphur in the plant is known to lead to retarded growth or delayed maturity with lowered oil content in sunflower seeds (Najar et al. 2011).

Seiler (2007), while discussing the use of Sulphur in sunflower, noted its particular importance regarding oil quality, where he identified deficiency in fatty acid as a reason for poor oil quality. Even Messick (2003) noted that the application of Sulphur was proven to improve seed quality by enhancing the conversion of carbohydrate oil into useful oil. Ahmad et al. (2006) observed that the application of Sulphur aids in plant height, seed weight, and yield of oilseed crops, which was also supported by Wani et al. (2011), who stated that the application of Sulphur has a positive effect on the yield of sunflower achene as well as the protein content. Ravikumar et al. (2016) highlighted Sulphur's significance in the growth and yield of sunflowers in diverse Agro-climatic settings. They noted that the application of Sulphur not only enhances crop productivity but also improves soil health by stimulating microbial life. These findings support the claims made regarding the use of Sulphur in overcoming deficiencies in sunflower production.

Sulphur is crucial in forming some of the most fundamental building blocks of living forms like Coenzyme-A, ferredoxin, and glutathione, translating into assistance in various metabolic processes in a plant. These assist in cell respiration, aid in transporting electrons across membranes and act as a protective apparatus within a plant (Shivay & Shekhawat, 2009). Additionally, the proteins that facilitate plant growth and productivity are formed from plant Sulphureous acids like cysteine and methionine. Kaya and Kolarik's (2011) work demonstrates that the use of Sulphur greatly improves the concentration of chlorophyll, which significantly aids in photosynthesis, self-referring to the "Photosynthesis Efficiency Chlorophyll Index."

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Effects from not having enough Sulphur include a plant becoming chlorotic and stunted, especially the younger leaves, as Sulphur is known to have low mobility in plants. This problem is exacerbated when encountered with sandy soils having low organic substance. As Jamal et al. (2005) noted, applying Sulphur improved growth parameters, including plant height and biomass in sunflowers, thereby improving economic returns.

Besides having a direct impact on plant metabolism, Sulphur has a synergistic effect with other nutrients. For instance, Boaretto et al. (2006) noted the joint effect of Sulphur and nitrogen on amino acid production and its subsequent effects on the yields of oilseed crops. Moreover, Renukadevi et al. (2003) elucidated that Sulphur helps in enhancing the quality of seed oils by increasing the amount of unsaturated fatty acids in several oilseed crops like sunflower and soybean.

The beneficial effects of Sulphur application on soil are equally remarkable. Morris (2006) states that Sulphur compounds improve the activity of soil microorganisms and, consequently, the availability and uptake of nutrients. This nutrient helps to reduce soil pH in alkaline conditions, which is beneficial for crop growth. Kalaiyarasan et al. (2020) and sayyam et al., (2025) provided new evidence concerning the application of Sulphur and organic amendments! They reported that such practices improve not only the yield but also the quality of sunflower crops, thus revealing another dimension of sustainability in agriculture.
Materials and Methods

A field experiment was carried out at the Amir Muhammad Khan Campus Mardan during the autumn (kharif) season in 2022. The adopted design was a randomised complete block with three replicates. The treatments included four levels of Sulphur: 0, 10, 20, and 30 kg ha-1, applied as elemental Sulphur (80%) per treatment. Sunflower variety HYSUN 33 was grown in 3 m x 3 m plots. All agronomic operations such as irrigation, weeding, and pest control for treating plots were done uniformly for all the treatments.
The data collected included, but were not limited to, the following: days to emergence, plant height, seeds per head, seed weight, grain yield, biological yield, and oil content. ANOVA was conducted in R studio with a 5% significance level to evaluate the significance level of treatment impacts.

Results and Discussion

Days to Emergence

Both untreated and treated plots showed improvement in emergence over time, but the difference was more pronounced in the control plots. Here it can be stated that untreated plots emerged later than treated ones. The application of Sulphur alone had noticeable effects on the time to emergence. All plots receiving Sulphur treatment have shown a significant reduction in emergence. Treated plots with 30 kg of Sulphur per hectare had the shortest time to emergence at 10 days compared to control plots which took 12 days to emerge. The role of Sulphur in enzymatic activation and protein synthesis has been proven to shorten the time period by reducing the amount of minerals needed for the process. As support, Zahoor et al. (2005) also acknowledged that the supplementation of Sulphur within nutrition aids in faster seedling emergence. So, it can be stated that the addition of Sulphur immeasurably improves growth if applied at the starting period of life in roots enabling and fostering the important subprocesses necessary for the normal development of seedlings.

Sulphur's Effect on Plant Height

The plot with the application of 30 kg of Sulphur per hectare showed the tallest plants measuring 156.66 cm, as compared to control plots with a plant height of 145.02 cm. The control plots without Sulphur inputs only managed to attain 145.02 cm which was significantly lower compared to the other plots. The height increase is attributed to the improvement in nutrient uptake based on Sulphur application along with photosynthetic activity. Sulphur is known to be a vital nutrient as it forms amino acids and proteins, enhancing the plant's growth and development. The better nutrient uptake of Sulphur within the plants highly likely contributed to the overall plant growth by aiding the plants to efficiently access and utilise the nutrients. This is consistent with observations made by Renukadevi et al. in 2003 where they marked the physiological benefits of Sulphur on plant height including photosynthesis and nutrient absorption. This increase in height can be attributed to many reasons, one of them being Sulphur's role in optimising the growing environment on the physiological system of the plants.

Seeding Weight and Grain Yield

The application of Sulphur had powerful effects on seed weight and grain yield. In the case of 1000 seeds weighed, the control had 57.92 g and the maximum treatment in the 30 kg Sulphur per hectare plots was 60.39 g. This signifies excellent growth over the control group. Further, the grain yield was noted to increase in the undefined Sulphur treated plots up to 1076 kg per hectare, and furthermore, controlling or restraining peak yield showed marked improvement over the control region. These findings verify Rasool et al. (2013) and sayyam et al., (2025) where crop Sulphur deficiencies tended to deplete yield potential. The rise in seed weight and grain yield appears to follow directly from the increase in Sulphur application due to enhanced nutrient stress factors, accompanying Sulphur metabolism, and processes like biochemical protein construction needed for either seed, grain, or both development to be complete. Given that Sulphur metabolism is a considerable pathway of essential amino acids and protein building blocks, its use in increasing seed and grain development was consequential.

Biological Yield and Oil Content

The use of Sulphur had a significant effect on biological yield and oil content as well. The yield in the sites applied with 30 kg of Sulphur per hectare reached a biological yield of 4310 kg per hectare, which is quite high in comparison to the control. The oil content in the seeds also showed a significant increase from 40.75% in the control to 45.38% in the treated plots. This increase in oil content is related to Sulphur's contribution in fatty acid biosynthesis and in chlorophyll production, which are both very important for the growth of high-quality oilseed. It has been documented that Sulphur increases the synthesis of oils and fats in oilseed crops because it participates in the biosynthesis of some fatty acids. The increase in chlorophyll production due to the application of Sulphur will also support better photosynthetic efficiency, leading to an increase in plant productivity and yield of oil. Further, these claims are also supported by Shivay and Shekhawat (2009), which claim that the application of Sulphur improves the quality of oilseed crops by increasing their yield and oil content. So, it can be said that Sulphur improves the synthesis of fatty acids and enhances chlorophyll production; these two facts alone explain perfectly why such an increase in biological yield and oil content was observed.

Conclusion

This research highlights the critical impact that sulfur has on the growth and yield of sunflower crops, identifying the optimal sulfur application rate for effective plant sulfur and productivity stimulation at 30 kg sulfur per hectare. This study's findings demonstrate that the application of sulfur fertiliser improves several growth parameters measured, such as the days to emergence, plant height, seed weight, grain yield, biological yield, and oil content. Moreover, all the measured growth parameters were better for the sulfur-treated plots when compared to the control plots, demonstrating the role of sulfur in improving both the physiological processes and yield components of sunflowers. Considering the benefits observed, applying 30 kg S ha^{-1} for sunflower production in the Mardan region is recommended, as it not only increases productivity but also improves oil quality which enhances the economic value of sunflower crops in the region.

This study offers new perspectives on how sulfur application may increase sunflower crop productivity in areas known to have sulfur-deficient soils. On the other hand, there are clear immediate benefits tied to the application of sulfur. More research is needed, however, on the long-term implications of applying sulfur on the soil and crops. The impact of continuous infertility on the dynamics of soil nutrients, microbial life, and overall soil health will be critical to effective sustainable agriculture solutions aimed at preserving soil resources over time. Furthermore, investigating how sulfur interacts with other nutrients and their management may help answer how best sulfur should be incorporated into comprehensive farming plans. Hence, future work should focus on determining the long-term impacts of applying sulfur fertilisation over several cropping seasons to evaluate its effectiveness as a sustainable input in sunflower and other crop production.

References

Ahmad, W., Niaz, A., Kanwal, S., Rahmatullah, & Khalid, R. (2009). Role of sulfur in plant growth: A review. *Journal of Agricultural Research*, 47(3), 329.

Alam, S., Hamayun, K., & Khan, I. (2025). *Digital transformation of fashion entrepreneurship in Pakistan: AI adoption, social-commerce capability, and financial inclusion*. Policy Journal of Social Science Review, 3(9), 180–195.

Alam, S., Khan, I., & Hamayun, K. (2025). *Harnessing artificial intelligence for green business model innovation: The role of environmental awareness in Pakistani SMEs*. Annual Methodological Archive Research Review, 3(9), 29–44.

Alam, S., Majeed, R., & Rahman, R. U. (2025). *From challenge to growth: How opportunity recognition and digital adoption drive SME performance in Pakistan*. Pakistan Journal of Social Science Review, 4(4), 993–1015.

Alam, S., Majeed, R., & Shah, S. T. H. (2025). Unlocking Startup Intentions: How Self-Efficacy Mediates Education and Incubation within Pakistan's Entrepreneurial Ecosystem. *Bulletin of Management Review*, *2*(2), 738-763.

Kastori, R., Plesnicar, M., Pankovic, D., & Sakac, Z. (2015). Photosynthesis and chlorophyll fluorescence in sunflower as affected by sulfur deficiency. *Journal of Plant Nutrition*, 18, 1751-1763.

Messick, D. L. (2003). Sulfur fertilizers: A global perspective. Proceedings of TSI-FAI-IFA Workshop, 1-7.

Najar, G. R., Singh, S. R., Akhtar, F., & Hakeem, S. A. (2011). Influence of sulfur on sunflower yield. *Indian Journal of Agricultural Science*, 81(4), 340-343.

Rasool, F. U., Hassan, B., & Jahangir, A. (2013). Growth and yield of sunflower as influenced by sulfur and farmyard manure. *Journal of Agricultural Sciences*, 11(1), 81-89.

Renukadevi, A., Savithri, P., & Andi, K. (2003). Boron and sulfur application and its impact on sunflower yield. *Madras Agricultural Journal*, 91, 74-96.

Seiler, G. J. (2007). Wild annual sunflower for improving oil content and quality. *Industrial Crops and Products*, 25, 95-100.

Shivay, Y. S., & Shekhawat, K. (2009). Effect of nitrogen sources, sulfur, and boron on growth parameters and productivity of sunflower. *Indian Journal of Plant Physiology*, 14(3), 290-298.

Wani, S. A., Lone, F. A., & Mehraj, S. (2011). Effect of sulfur fertilization on oilseed crops. *International Journal of Agricultural Research*, 6(2), 100-110.

Zahoor, A., Mir, S. A., & Wani, F. U. (2005). Role of sulfur in oilseed crop productivity. *Advances in Agronomy*, 88, 215-244.