



Sulfur Synergy: Improving Black Soybean (*Glycine max* (L.) Merrill) Yields with Varied Sources and Levels

Anki Mibang ^{a*}, Kasinam Doruk ^a, Sanchung Lida ^a,
Karge Basar ^a, Nabam Akli ^a and Karthikeyan M ^b

^a Himalayan University, Jollang, Itanagar, Arunachal Pradesh, India.

^b Mother Teresa College of Agriculture, Illupur, Tamil Nadu, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/acri/2024/v24i6791>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/119842>

Original Research Article

Received: 21/05/2024

Accepted: 24/07/2024

Published: 26/07/2024

ABSTRACT

Field experiment was laid out at agriculture field of Himalayan university, Jollang during Kharif season 2023-2024 to study the response of black soybean to levels and sources of sulphur under mid - hill conditions of Arunachal Pradesh. The treatments comprising of all possible combinations of three levels of sulphur viz. 15, 30 and 45 kg /ha and four sources of sulphur viz. Iron pyrite, Gypsum, Epsom salt and Sphalerite. The result revealed that yield attributes viz. number of pods per plant, number of seeds per pod, seed weight, seed yield, biological yield and harvest index of black soybean increased with the application of S upto 45 kg/ha. Higher dose of sulphur significantly influence yield attributes of black soybean. The response per kg S apply was 14.5 kg of soybean grain. Among the sources of sulphur gypsum gave the better response in terms

*Corresponding author: Email: ankimibang2069@gmail.com; anki2069@gmail.com;

Cite as: Mibang, Anki, Kasinam Doruk, Sanchung Lida, Karge Basar, Nabam Akli, and Karthikeyan M. 2024. "Sulfur Synergy: Improving Black Soybean (*Glycine Max* (L.) Merrill) Yields With Varied Sources and Levels". *Archives of Current Research International* 24 (6):335-42. <https://doi.org/10.9734/acri/2024/v24i6791>.

of yield attributes and seed and straw yield of soybean over the other sources. Gross returns (27322 ₹/ha), net returns (12552 ₹/ha) and B: C (1.84) ratio was significantly higher at Gypsum 45 kg S/ha.

Keywords: Sulphur; growth; yield attributes yields; economics; black soybean.

1. INTRODUCTION

Sulphur is an essential nutrient for plant growth and development, playing a crucial role in various physiological processes in crops like black soybeans. The availability of sulphur in the soil directly impacts the yield of black soybeans, making it vital to understand the effects of different sources and levels of sulphur on crop productivity. In recent years, research has focused on optimizing sulphur management practices to maximize yields while ensuring sustainable agricultural production [1].

The introduction of different sources and levels of sulphur can significantly influence the yield of black soybeans. Sulphur is involved in the synthesis of amino acids and proteins, critical components for plant growth and reproductive processes. Insufficient sulphur levels can lead to reduced chlorophyll production, poor nitrogen utilization, and decreased photosynthetic efficiency, ultimately affecting the overall yield potential of black soybeans. Therefore, the proper management of sulphur is essential for ensuring optimal crop performance and achieving high yields [2].

The choice of sulphur sources, such as elemental sulphur, sulphate-based fertilizers, or organic amendments, can impact the availability and uptake of sulphur by black soybeans. Each source has unique characteristics that influence its solubility, release rate, and interaction with soil microbes. Understanding the dynamics of sulphur sources is crucial for designing effective fertilization strategies that meet the nutritional requirements of black soybeans throughout the growing season [3].

Additionally, the levels of sulphur applied to black soybeans can have varying effects on plant growth and yield. While sulphur is considered a secondary nutrient, its importance in optimizing crop productivity should not be overlooked. Excessive sulphur application can lead to nutrient imbalances and potential toxicity, negatively impacting the physiological processes of black soybeans. Conversely, inadequate sulphur levels can result in nutrient deficiencies and limit the ability of plants to reach their full yield potential [4].

By exploring the effects of different sulphur sources and levels on the yield of black soybeans, researchers and farmers can gain valuable insights into optimizing sulphur management practices for sustainable crop production. This introduction sets the stage for a comprehensive analysis of the interactions between sulphur availability, plant nutrition, and yield outcomes in black soybeans. Understanding the complexities of sulphur dynamics in agricultural systems is essential for enhancing crop performance, improving resource efficiency, and meeting the demands of global food security [5].

2. MATERIALS AND METHODS

A field experiment was conducted during the kharif season of 2023 at Jollang, Himalayan University 27.14 'N latitude, 93.62 ' E longitude and 320 meters above sea level. Temperature during the cropping period ranged between 15 to 26 °C, the humidity 70 % to 89 % with 8.0 hours day length and a moderate to high rainfall. The soil of the experimental site was silty clay loam in texture with pH 4.2, organic carbon 1.59 %, total nitrogen 613 (kg/ha), available phosphorus 4.86 kg/ha, sulphur 5.25 kg/ha and potassium 218 kg/ha. Three levels viz., S₁=15 kg S/ha, S₂=30 kg S/ha, S₃=45 kg S/ha and 4 sources of sulphur viz., 1. Gypsum (CaSO₄.2H₂O) (18.62% S), 2. Iron Pyrite (FeS₂) (53.3 % S) 3. Epsom Salt (MgSO₄) (13% S) 4. Sphalerite (Zn, Fe) (33.06 % S) and recommended practice are evaluated in FRBD with three replications. VL Bhat a variety of black soybean was sown in lines with a spacing of row to row 45 cm and plant to plant 5 to 7.5 cm. Recommended doses of N, P and K, in the form of urea, DAP and MOP, were applied. All other recommended agronomic practices were followed during the period of crop growth. The crop was harvested from a net plot of size 9 m² on 22 Nov., 2023. The data on yield parameters were recorded periodically and analyzed statistically to find out the treatment difference and the mean differences were compared using CD values [6].

The experiment constituted of 9 treatment combinations was laid out in Factorial Randomized block design. The details of treatments are given below:

A: Sources

S₁ = Gypsum / Calcium Sulphate
 S₂ = Iron Pyrite / Ferrous Sulfide
 S₃ = Epsomite+ Sphalerite

B: Levels

L₁ = 15 kg Sulphur ha⁻¹
 L₂ = 30 kg Sulphur ha⁻¹
 L₃ = 45 kg Sulphur ha⁻¹

Treatment Combination: (3×3=9)

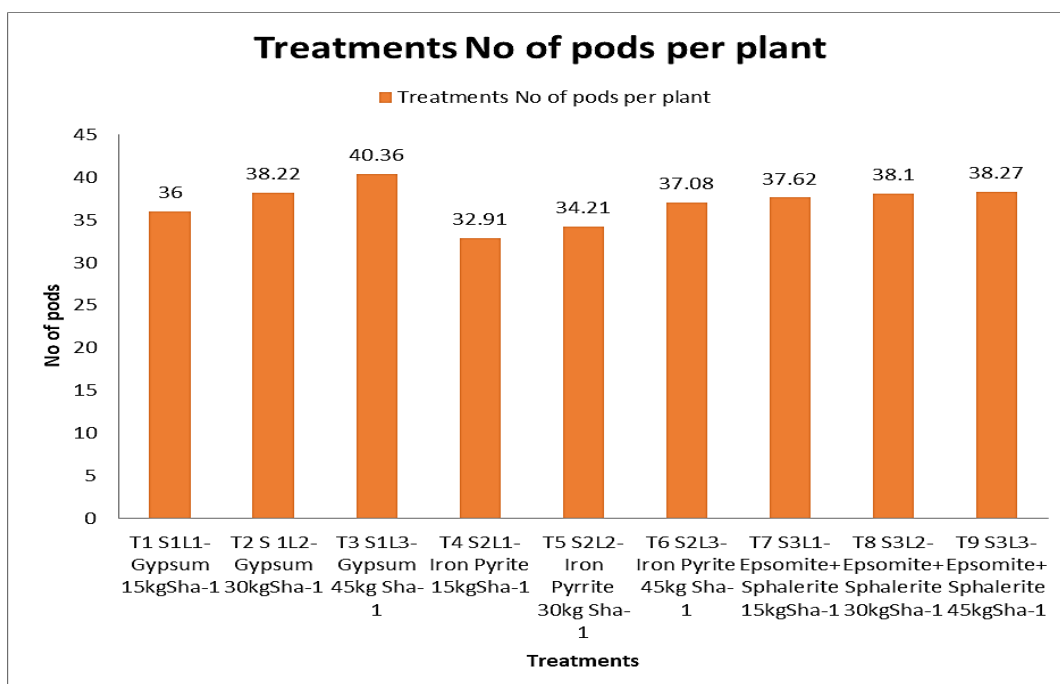
Treatment	Treatment Combination
T ₁ (S ₁ L ₁)	Gypsum at 15 kg S ha ⁻¹
T ₂ (S ₁ L ₂)	Gypsum at 30 kg S ha ⁻¹
T ₃ (S ₁ L ₃)	Gypsum at 45 kg S ha ⁻¹
T ₄ (S ₂ L ₁)	Iron Pyrite at 15 kg S ha ⁻¹
T ₅ (S ₂ L ₂)	Iron Pyrite at 30 kg S ha ⁻¹
T ₆ (S ₂ L ₃)	Iron Pyrite at 45 kg S ha ⁻¹
T ₇ (S ₃ L ₁)	Epsomite + Sphalerite at 15 kg S ha ⁻¹
T ₈ (S ₃ L ₂)	Epsomite + Sphalerite at 30 kg S ha ⁻¹
T ₉ (S ₃ L ₃)	Epsomite + Sphalerite at 45 kg S ha ⁻¹

3. RESULTS AND DISCUSSION

3.1 Yield Attributes

The growth of the crop was appeared to be reflected in the yield attributes of soybean. Levels of sulphur brought about significance variation in all the yield attributes of soybean. Like growth parameters yield attributes viz.

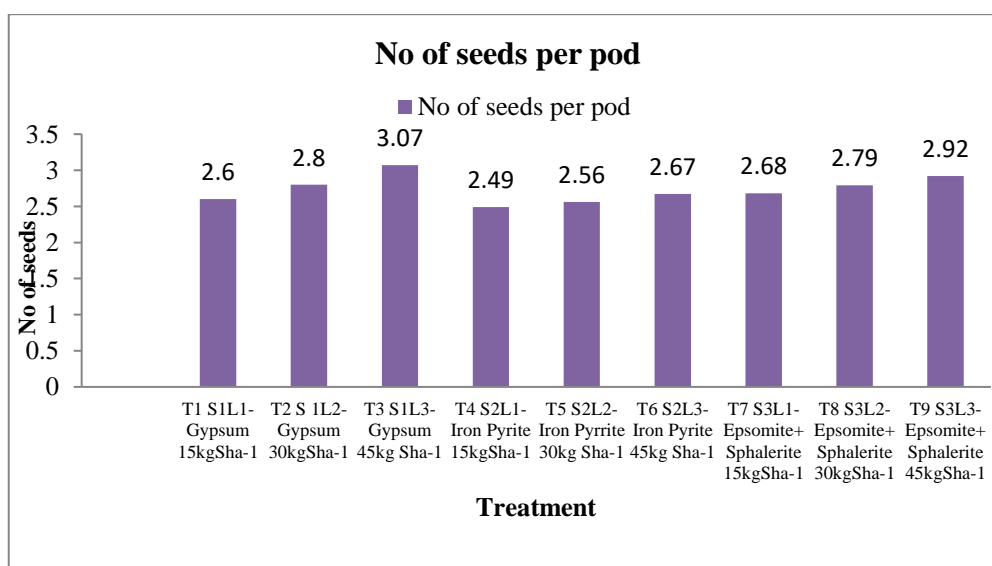
number of pods per plant, number of seeds per pod, 100 seed weight, seed yield, straw yield, biological yield and harvest index increased with increase in level of sulphur up to 45 kg S/ha. Improvement in pods/plant, seeds/pod and 100-seed weight with the application of S have been also reported [7,8]. Source of sulphur also significantly influenced number of pods/plant, seeds/pod and 100-seed weight. Among the source of sulphur, (T₃ S₁L₃- Gypsum 45 kg S ha⁻¹) excelled all the other in terms of pods/plant, seeds/pod and 100- seed weight, seed yield, straw yield, biological yield and harvest index. The superiority of gypsum in influencing yield attributes in soybean [9] and other legumes [10] have been amply documented. However, (T₉S₃L₃ Epsomite+ Sphalerite 45 kg S ha⁻¹) was statistically at par with gypsum in influencing pods/plant, seeds/pod, 100-seed weight, seed yield, straw yield, biological yield and harvest index. Sphalerite, Epsom salt and Iron pyrite were comparable to each other in influencing the seeds/pod and 100-seed weight. The overall effects of sulphur application were found to be significantly superior. Sulphur applications increased pods/plant, seeds/pod ,100-seed weight, seed yield, straw yield, biological yield and harvest index by about 40.36, 3.07, 10.35 g ,1.90 t/ha, 3.59 t/ha, 5.49 t/ha, 34.62 % respectively.



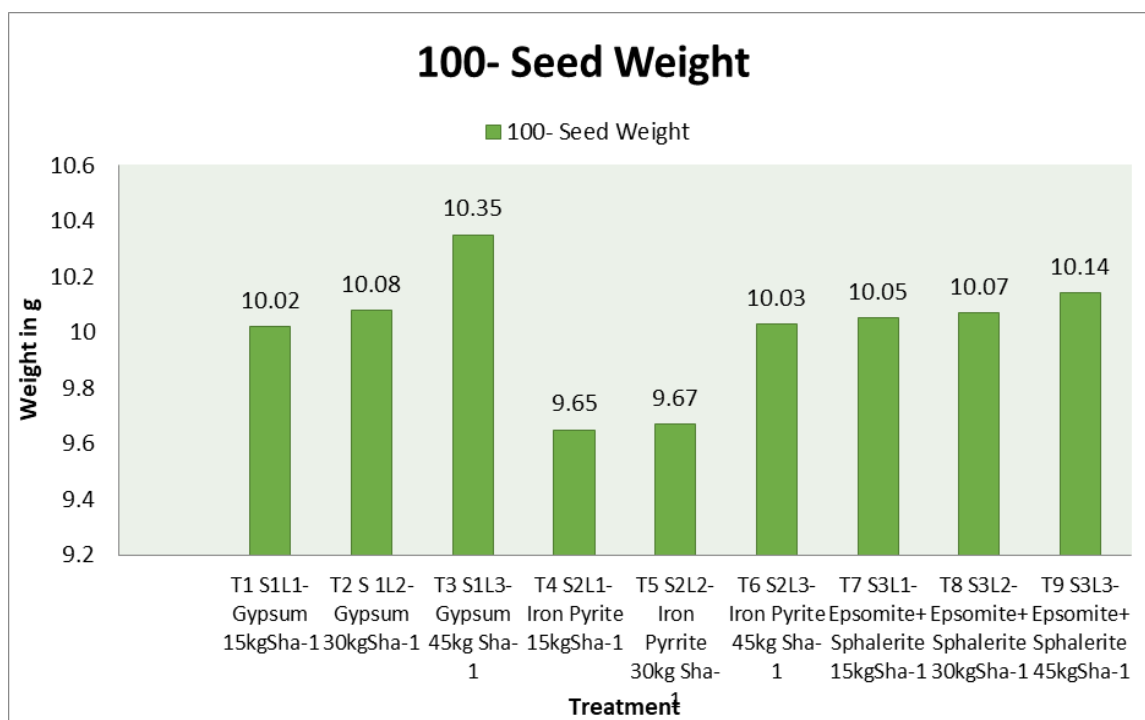
Graph 1. Effect of different sources and levels of sulphur on no. of pods per plant of black soybean

Table 1. Effect of levels and sources of sulphur on number of pods per plant, number of seeds per pod, 100 seed weight, seed yield, straw yield, biological yield and harvest index of black soybean

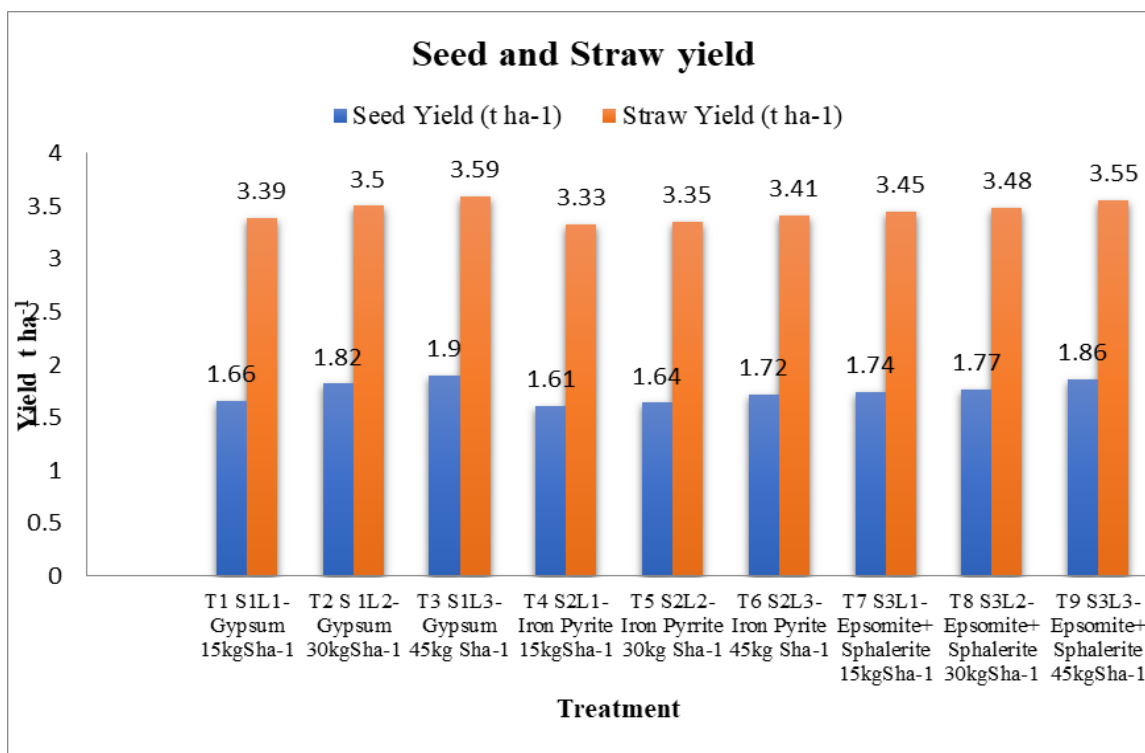
Treatments	Number of pods per plant	Number of seeds per pod	100 Seed weight (g)	Seed yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
T ₁ S ₁ L ₁ -Gypsum 15 kg S ha ⁻¹	36.00	2.60	10.02	1.66	3.39	5.06	33.00
T ₂ S ₁ L ₂ -Gypsum 30 kg S ha ⁻¹	38.22	2.80	10.08	1.82	3.50	5.31	34.04
T ₃ S ₁ L ₃ -Gypsum 45 kg S ha ⁻¹	40.36	3.07	10.35	1.90	3.59	5.494	34.62
T ₄ S ₂ L ₁ - Iron Pyrite 15 kg S ha ⁻¹	32.91	2.49	9.65	1.61	3.33	4.94	32.61
T ₅ S ₂ L ₂ - Iron Pyrite 30 kg S ha ⁻¹	34.21	2.56	9.67	1.64	3.35	4.99	32.90
T ₆ S ₂ L ₃ - Iron Pyrite 45 kg S ha ⁻¹	37.08	2.67	10.03	1.72	3.41	5.14	33.57
T ₇ S ₃ L ₁ - Epsomite + Sphalerite 15 kg S ha ⁻¹	37.62	2.68	10.05	1.74	3.45	5.20	33.52
T ₈ S ₃ L ₂ - Epsomite + Sphalerite 30 kg S ha ⁻¹	38.10	2.79	10.07	1.771	3.48	5.25	33.79
T ₉ S ₃ L ₃ - Epsomite+ Sphalerite 45 kg S ha ⁻¹	38.27	2.92	10.14	1.86	3.55	5.42	34.47
F test	S	S	S	S	S	S	S
SEm±	0.27	0.051	0.034	0.008	0.019	0.023	0.13
CD (P=0.05)	0.59	0.10936	0.073	0.018	0.041	0.050	0.27



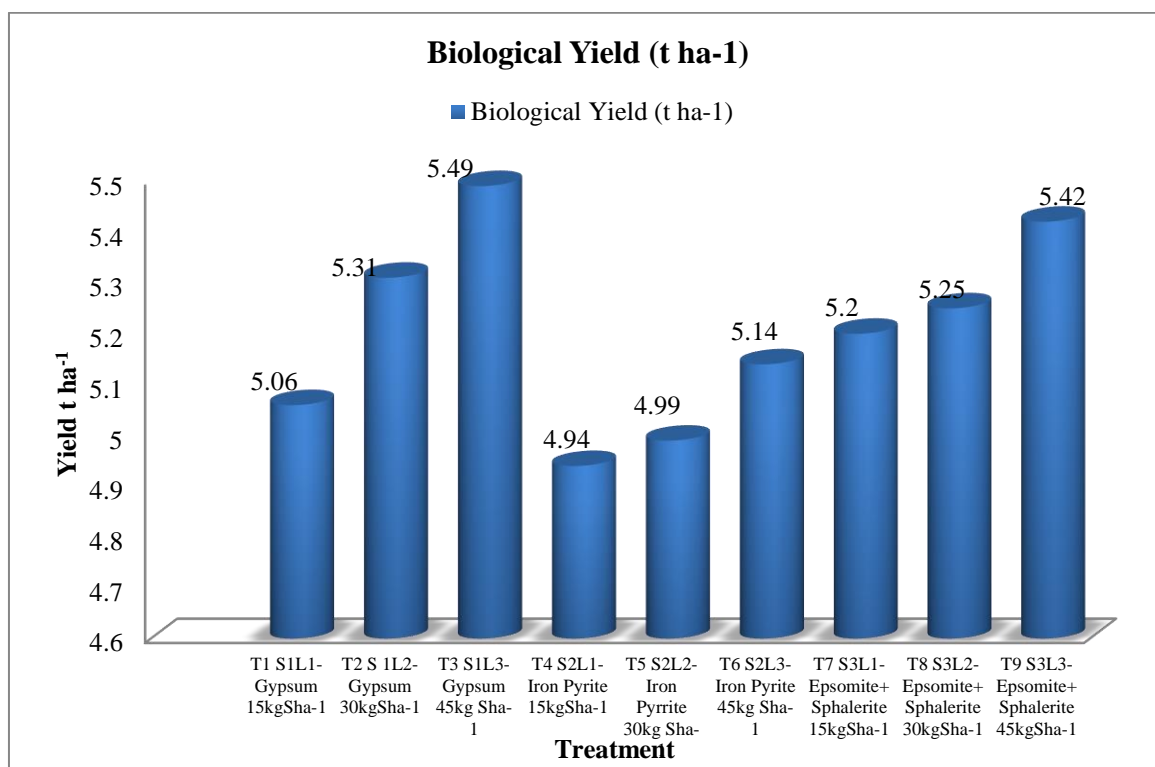
Graph 2. Effect of different sources and levels of sulphur on no. of seed per pod of black soybean



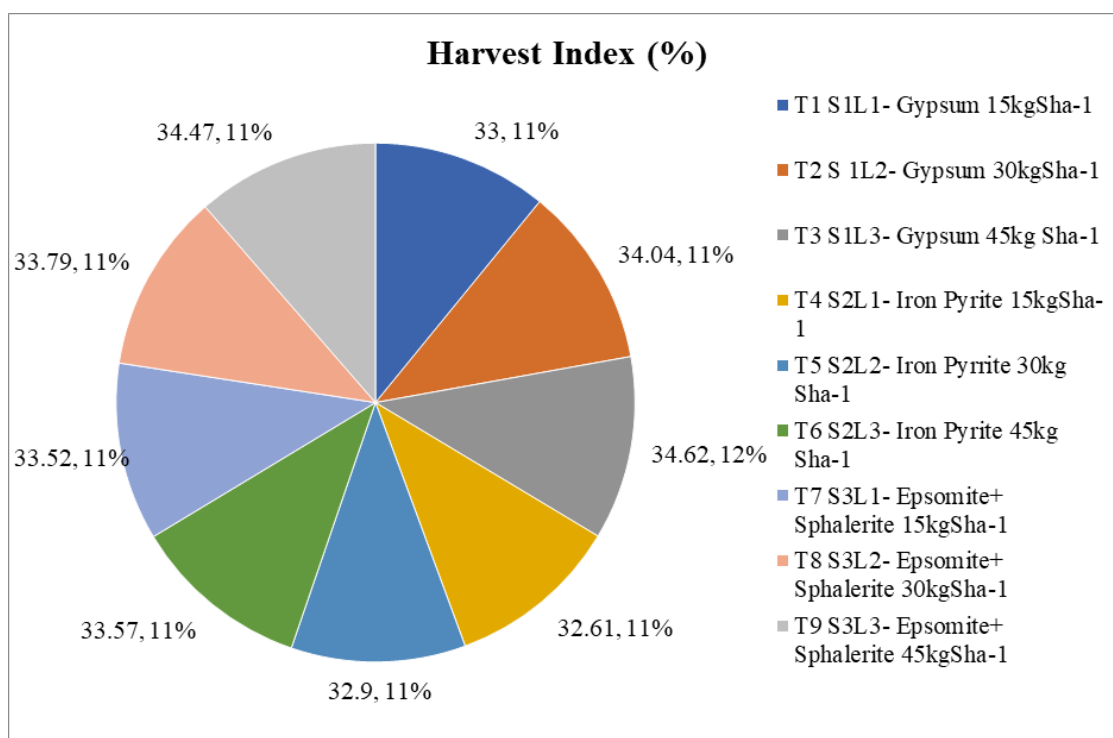
Graph 3. Effect of different sources and levels of sulphur on seed weight of black soybean



Graph 4. Effect of different sources and levels of sulphur on seed yield and straw yield of black soybean



Graph 5. Effect of different sources and levels of sulphur on biological yield of black soybean



Graph 6. Effect of different sources and level of sulphur on Harvest Index

4. CONCLUSION

The study investigating the impact of different sources and levels of sulfur on yield parameters of black soybean cultivation, specifically focusing on the T₁S₁L₁ treatment (Gypsum 45 kg S ha⁻¹), has provided significant insights. The application of gypsum at 45 kg S ha⁻¹ in the T₁S₁L₁ treatment demonstrated compelling results across multiple aspects of black soybean production.

Firstly, the increased number of pods observed in the T₁S₁L₁ treatment signifies the positive influence of sulfur supplementation on plant reproductive development. Sulfur is essential for flower and pod formation, and the enhanced pod count indicates improved flowering and successful pod setting in black soybean plants under this treatment.

Furthermore, the higher number of pods per plant in the T₁S₁L₁ treatment suggests effective utilization of sulfur by the soybean crop, leading to increased pod development on individual plants. This indicates better plant health, nutrient uptake, and overall productivity in the presence of adequate sulfur levels provided by gypsum application.

The significant increase in 100-seed weight associated with the T₁S₁L₁ treatment indicates improved seed filling and quality. Sulfur plays a critical role in protein synthesis and seed development, leading to heavier seeds with superior nutritional value. This observation highlights the positive impact of sulfur supplementation on seed characteristics in black soybean cultivation.

Moreover, the elevated seed yield in the T₁S₁L₁ treatment underscores the importance of sulfur in enhancing overall crop productivity. Sulfur is known to stimulate enzyme activity, improve nutrient uptake, and enhance metabolic processes crucial for seed formation. The higher seed yield in this treatment reflects the optimized utilization of sulfur for maximizing soybean production.

The increased straw yield in the T₁S₁L₁ treatment further supports the notion that sulfur application positively influences plant biomass production. Sulfur is essential for chlorophyll synthesis, photosynthesis, and overall plant growth. The higher straw yield indicates improved vegetative growth and biomass accumulation, contributing

to enhanced crop performance under sulfur-enriched conditions.

Additionally, the rise in biological yield and harvest index associated with the T₁S₁L₁ treatment signifies the overall improvement in crop productivity and efficiency. Sulfur availability has a direct impact on plant metabolism, nutrient assimilation, and yield components, leading to increased biological yield and harvest index. This outcome reflects the positive response of black soybean plants to sulfur supplementation through gypsum application.

In conclusion, the T₁S₁L₁ treatment involving the application of gypsum at 45 kg S ha⁻¹ has demonstrated favorable effects on the number of pods, number of pods per plant, 100-seed weight, seed yield, straw yield, biological yield, and harvest index of black soybean cultivation. The results indicate that sulfur plays a crucial role in enhancing various yield parameters and overall crop performance in black soybean production systems, emphasizing the importance of sulfur management for sustainable and optimized soybean cultivation practices.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that no generative technologies such as Large Language Models and text to image generators have been used during writing or editing of manuscript.

ACKNOWLEDGEMENT

The authors are heartily thankful to Department of Agricultural Sciences, College of Himalayan University, Jollang, Arunachal Pradesh for providing instrumental facilities and necessary facilities during the course of investigation and also to the thesis advisor for their invaluable guidance, support, and mentorship throughout this research journey.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Singh G, Pathania P, Rana SS, Kumar S, Sharma VK. Response of soybean to levels and sources of sulphur on growth and yield under mid - hill conditions of Himachal. International Journal of Chemical Studies. 2018;6(6):2903- 2907.

2. Layek J, Shivakumar BG, Rana DS, Gangaiah B, Lakshman K, Paramanik B. Growth, nodulation, physiological indices and yield of soybean as influenced by sulphur nutrition. *An International Quarterly Journal of Life Science*. 2014;9(4):1389-1393.
3. Lakshman K, Vyas A, Shivakumar B, Rana D. Effect of levels and time of sulphur application on growth, yield and quality of soybean (*Glycine max*). *Indian Journal of Agronomy*. 2018;60(1):121-125.
4. Kumar V, Tyagi S, Choudhary SK. Growth, yield and quality of Indian mustard (*Brassica juncea* L.) with doses and different sources of sulphur. *Indian Journal of Economics*. 2017;44:422–26.
5. Sharma S, Singh R. Growth, yield, and quality responses of soybean (*Glycine max* L.) to different sources and levels of sulfur. *Journal of Pharmacognosy and Phytochemistry*. 2019;8(2):2560-2564.
6. Gomez KA, Gomez AA. *Statistical Procedures for Agricultural Research*, Second Edition, John Wiley and Sons, New York. 1984;680.
7. Shivran RK, Rokadia P, Kumar R. Phosphorus and sulphur nutrition with P-solubilizing Bacterial inoculation enhanced the quality and yield of soybean (Cultivar JS-335). *Madras Agriculture Journal*. 2012;99:68-72.
8. Devi KN, Singh LNK, Singh MS, Singh SB, Singh KK. Influence of sulphur and boron fertilization on yield, quality, nutrient uptake and economics of soybean (*Glycine max*) under upland conditions. *Journal of Agricultural Science*. 2012;4;1-10.
9. Mamatha N, Chandra K, Padmaja G, Reddy MM. Influence of nitrogen and sulphur application on yield and quality of soybean (*Glycine max* L.). *International Journal of Current Microbiology and Applied Sciences*. 2018;7(12):3452-3457.
10. Yatheesh G, Gurumurthy KT, Sridhara CJ, Prakasha HC. Effect of different sources and levels of sulphur on growth and yield of soybean (*Glycine max* L.). *Mysore Journal of Agricultural Sciences*. 2013; 47(3):592-595.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<https://www.sdiarticle5.com/review-history/119842>