Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2582-2845.9033

ISSN: 2582 – 2845

Ind. J. Pure App. Biosci. (2023) *11*(6), 46-52

Indian Journal of Pure & Applied Biosciences

Peer-Reviewed, Refereed, Open Access Journal

Research Article

Effect of Various Levels of Sulphur and Zinc on Growth and Yield of Late-Sown Wheat (*Triticum aestivum* L.)

Ritesh Yadav[1] and Deepali Joshi[2*]

[1]M.Sc Student, Department of Agriculture, Agronomy, Dehradun, Uttarakhand, India

[2]Principal, Himalayan Institute of Technology, Dehradun, Uttarakhand, India

*Corresponding Author E-mail: deepaliaswal21@gmail.com

Received: 12.09.2023 | Revised: 19.11.2023 | Accepted: 3.12.2023

ABSTRACT

The present study was conducted at the Crop Research Farm of the Institute of Agriculture Training and Research, Prem Nagar, Dehradun, Uttarakhand, India, during the 2022-23 year. The experimental design employed was a Factorial Randomized Block Design (RBD), comprising nine treatments each replicated three times. These treatments involved varying level of (Sulphur- 20kg, 25kg, 30kg/ha, Zinc- 20kg, 30kg, 40kg/ha) arranged in an RBD Factorial with plot size 2m×2m varying. The primary objective of this study was to assess the response of wheat crops to different levels of sulphur and zinc fertilization. The results indicated that both nutrients played crucial roles in enhancing late-sown wheat productivity and may offer valuable insights into sustainable crop management practices. Data analysis revealed that the most effective treatment for increasing the Quality characters and Yield is 30 kg Sulphur ha^{-1} + 40 kg Zinc ha^{-1} under agro-ecological conditions of Dehradun. This finding has the potential to guide farmers and agriculture practioners in optimizing crop yields and quality in similar environments.

Keywords: *Sulphur, Zinc, Late Sown Wheat.*

INTRODUCTION

Wheat (*Triticum aestivum* L.) is a world staple food and belongs to family Poaceae (Gramineae). It has been described as the 'King of cereals' because of its acreage and high productivity, which also occupies a prominent position in the international food grain trade. Wheat ranks first in the world among cereals both with respect to area (221.68 million hectares) and production (757.92 million metric tonnes), with productivity of wheat at 3.29 tonnes per hectare (FAS/USDA 2016-17). In India, the total production of the wheat crop was 86.53 metric tonnes from a covered area of 30.23 million hectares during the past 2015-2016 rabi season and accounted for 38% 4th Advance estimate.

Cite this article: Yadav, R., & Joshi, D. (2023). Effect of Various Levels of Sulphur and Zinc on Growth and Yield of Late-Sown Wheat (*Triticum aestivum L.*), *Ind. J. Pure App. Biosci. 11*(6), 46-52. doi: http://dx.doi.org/10.18782/2582-2845.9033

Wheat provides nearly 55% of the carbohydrates and 20% of the food calories that are consumed by two billion people (36% of the world's population) as staple food. It is said that wheat is more nutritive than other cereals. It has a good nutrition profile with 12.1 per cent protein, 1.8 per cent lipids, 1.8 per cent ash, 2.0 per cent reducing sugars, 6.7 per cent pentose, and provides 314 Kcal/100g of food. Wheat is also a good source of minerals and vitamins *viz*., calcium (37 mg/100g), iron (4.1 mg/100g), thiamine (0.45mg/100g), riboflavin (0.13mg/100g) and nicotinic acid (5.4mg/100mg). Unlike other cereals, wheat contains a high amount of gluten, the protein that provides the elasticity necessary for excellent bread making. Hard wheat is high in protein (10-17%) and yields a flour rich in gluten, making it particularly suitable for yeast breads. The objectives of the present study was to find out the effect of different levels of Sulphur and zinc on growth and yield of wheat.

MATERIALS AND METHODS

The experiment was conducted in *rabi* Season of 2022-23 at the Institute of Agriculture Training and Research, Prem Nagar, Dehradun, Uttarakhand, India. The city is located at 25.28° N latitude and 81.54° E longitude. 410 m above mean sea level. All necessary facilities required for crop cultivation were available at the institute.

- Data Collection:

Data was collected on various parameters related to crop growth yield including plant height, leaf area index (LAI), number of tillers per plant, number of leaves, dry matter etc. and yield components such as spike length, grain weight per spike, grain yield and 1000-grain weight.

The experiment involved two factors in a randomized block design (factorial), comprising 9 treatment combinations, each replicated thrice. Treatments were randomly arranged in each replication and divided into 27 plots. The treatments combine specifications of the layout, *etc*., are given below.

Details of Treatment

A) Sulphur level

S_1: 20 kg Sulphur ha^{-1}

S_2: 25 kg Sulphur ha^{-1}

S_3: 30 kg Sulphur ha^{-1}

B) Zinc level

Z_1: 20 kg Zinc ha^{-1}

Z_2: 30 kg Zinc ha^{-1}

Z_3: 40 kg Zinc ha^{-1}

Table 1: Treatment combinations

Sl. No	Treatment No.	Treatment combination	Treatment Description
1.	T_1	S_1Z_1	20 kg Sulphur ha^{-1} + 20 kg Zinc ha^{-1}
2.	T_2	S_2Z_1	25 kg Sulphur ha^{-1} + 20 kg Zinc ha^{-1}
3.	T_3	S_3Z_1	30 kg Sulphur ha^{-1} + 20 kg Zinc ha^{-1}
4.	T_4	S_1Z_2	20 kg Sulphur ha^{-1} + 30 kg Zinc ha^{-1}
5.	T_5	S_2Z_2	25 kg Sulphur ha^{-1} + 30 kg Zinc ha^{-1}
6.	T_6	S_3Z_2	30 kg Sulphur ha^{-1} + 30 kg Zinc ha^{-1}
7.	T_7	S_1Z_3	20 kg Sulphur ha^{-1} + 40 kg Zinc ha^{-1}
8.	T_8	S_2Z_3	25 kg Sulphur ha^{-1} + 40 kg Zinc ha^{-1}
9.	T_9	S_3Z_3	30 kg Sulphur ha^{-1} + 40 kg Zinc ha^{-1}

Agronomic practices followed in crop cultivation

The first step involved was through land preparation was prepared thoroughly to obtain fine soil tilth.the field was cleared with weeds.

Approx. 15 days before the sowing of the experimental crop, the field was irrigated. The pre-sowing irrigation helped maintain the soil's moisture and prepare the soil for planting.

The seed sowing was carried out on 22dec, 2022 using seed drill maintaining a Row-to-Row distance of 25cm and Plant to Plant distance of 10cm at a depth of around 5cm.

Fertilizers were applied as a basal dose at the time of sowing. Nitrogen was applied as per treatment through urea. However, 60 kg P_2O_5 ha^{-1} through SSP and 40 kg K_2O ha^{-1} through muriate of potash was applied at the time of sowing as a basal dose.

The crop was allowed to grow and its progress was monitored. Visual observation were used to determine the proper stage of maturity. Harvesting took place on April 20, 2023 at the stage of maturity determined through visual observaed.

Half-meter lengths on both ends of each plot and two border rows from each side of the field were removed before harvest to minimise errors.

The harvested produce was tied in bundles and weighed to determine biomass yield.

Lastly, a thresher is used to separate seed or grain from the rest of the plant material. Pullman thresher was used for this purpose.

RESULTS

- Plant height (cm)

Maximum plant height was observed with treatment by S_3 (30 kg Sulphur ha^{-1}). Further, data analysis revealed that S_2 (25 kg Sulphur ha^{-1}) was at par with S_3 (30 kg Sulphur ha^{-1}). In case of zinc treatments the highest plant height was recorded by treatment Z_3 (40 kg Zinc ha^{-1}). However, analysis of the data revealed that Z_2 (30 kg Zinc ha^{-1}) had a similar effect on plant height as Z_3 (40 kg Zinc ha^{-1}).

- Leaf area index (%)

The Maximum leaf area index was recorded by S_3 (30 kg Sulphur ha^{-1}). Further, data analysis revealed that S_2 (25 kg Sulphur ha^{-1}) was at par with S_3 (30 kg Sulphur ha^{-1}). In the case of zinc treatments, the highest leaf area index was observed by treatment Z_3 (40 kg Zinc ha^{-1}). Treatment Z_2 (30 kg Zinc ha^{-1}) had a similar effect in leaf area index with Z_3 (40 kg Zinc ha^{-1}).

- Plant dry weight (g)

The Maximum plant dry weight was recorded by S_3 (30 kg Sulphur ha^{-1}). Further, data analysis revealed that S_2 (25 kg Sulphur ha^{-1}) was at par with S_3 (30 kg Sulphur ha^{-1}). In case of zinc treatments highest plant dry weight was recorded by treatment Z_3 (40 kg Zinc ha^{-1}). However, data analysis revealed that Z_2 (30 kg Zinc ha^{-1}) was at par with Z_3 (40 kg Zinc ha^{-1}).

Table 2: Effect of different treatments on growth components

Treatment	30 DAS			60 DAS			90 DAS		
	Plant height	Leaf Area Index	Dry weight	Plant height	Leaf Area Index	Dry weight	Plant height	Leaf Area Index	Dry weight
Zinc level									
Z_1	21.74	1.88	16.78	75.53	2.87	81.51	95.22	2.51	148.50
Z_2	22.28	1.91	17.22	77.14	2.92	83.31	97.17	2.56	151.65
Z_3	24.08	2.07	18.61	83.36	3.16	90.04	105.01	2.77	163.89
F test	S	S	S	S	S	S	S	S	S
SEd±	0.73	0.06	0.58	2.50	0.09	2.71	3.14	0.08	4.91
C.D. (P=0.05)	1.50	0.13	1.18	5.10	0.19	5.53	6.41	0.17	10.03
Sulphur level									
S_1	21.82	1.88	16.84	75.80	2.88	81.81	95.57	2.52	149.04
S_2	22.46	1.93	17.37	77.78	2.95	84.01	97.98	2.58	152.91
S_3	23.81	2.04	18.41	82.45	3.12	89.05	103.86	2.74	162.09
F test	S	S	S	S	S	S	S	S	S
SEd±	0.70	0.06	0.55	2.37	0.09	2.57	2.98	0.08	4.66
C.D. (P=0.05)	1.42	0.12	1.12	4.84	0.18	5.25	6.08	0.16	9.52

- Grain yield (q ha^{-1})

Data on harvest stages of crop plants were collected in terms of grain yield are presented below.

Maximum grain yield was recorded by S_3 (30 kg Sulphur ha^{-1}). In the case of zinc treatments, the highest grain yield was recorded by treatment Z_3 (40 kg Zinc ha^{-1}).

- Test weight (g)

Maximum test weight was recorded by S_3 (30 kg Sulphur ha^{-1}). In the case of zinc treatments, the highest test weight was recorded by treatment Z_3 (40 kg Zinc ha^{-1}).

Table 3: Effect of different treatments on yield components

Treatment	Test weight (g)	Grain yield (q ha^{-1})
Zinc level		
Z_1	44.26	38.75
Z_2	45.12	39.50
Z_3	48.76	42.69
F test	S	S
SEd±	1.45	1.27
C.D. (P=0.05)	2.96	2.59
Sulphur level		
S_1	44.42	38.89
S_2	45.50	39.83
S_3	48.23	42.22
F test	S	S
SEd±	1.38	1.20
C.D. (P=0.05)	2.81	2.46

DISCUSSION

Plant height, number of leaves and leaf area increased with increasing levels of Sulphur up to 30 kg ha^{-1}. Sulphur had a beneficial effect on wheat, accelerating the rate of photosynthesis, assimilation, cell division and vegetative growth. The sulphur application stimulated cell division, elongation and enlargement. Similar findings were also reported by Senapati et al. (2007) and Das & Borkotoki (2011). Plant height, number of leaves and leaf area increased with increasing zinc levels. Zinc plays a role in the metabolism of growing plants and is essential for several enzyme systems which regulate the various metabolic activities of the wheat plants. Similar effects were also reported by Slaton et al. (2005) and Pooniya & Shivay (2011).

The yield of grain and straw increased with increasing application of Sulphur up to 30 kg ha^{-1}. Yield was the resultant of co-ordinate effect of growth and yield attributing parameters. The variation in yield of grain and straw, as well as harvest index by sulphur application, might be attributed to the pivotal role of Sulphur in improving growth and development activities. The application of Sulphur also produced more grains per plant and test weight. These ultimately result in higher grain and straw yields as well as a higher harvest index. The findings are in accordance to Singh &Singh (2004) and Senapati et al. (2007).

Application of zinc 40 kg ha^{-1} brought a conspicuous effect on grain and straw yield. However, harvest index vary at all. The yield and harvest index might have increased due to good improvement in growth and yield attributes by the application of zinc. Similar findings were also reported by De et al. (2003) and Maiti & Das (2007).

CONCLUSIONS

This study suggests that a combination of overall (30 kg Sulphur ha^{-1}) has a significantly positive effect on wheat growth, yield attributes and yield of wheat plants. In the case of zinc treatments, the highest growth, yield attributes, and yield were recorded by treatment Z_3 (40 kg Zinc ha^{-1}). The highest gross return and net return was also recorded by the combination of S_3Z_3 (30 kg Sulphur ha^{-1} + 40 kg Zinc ha^{-1}) and B: C ratio was recorded to be the highest in S_3Z_1 (30 kg Sulphur ha^{-1} + 20 kg Zinc ha^{-1}. It is concluded that wheat crops should preferably be grown with 30 kg Sulphur ha^{-1} + 40 kg Zinc ha^{-1} under agroecological conditions of Dehradun.

Acknowledgement:
I would like to sincerely thank my co-authors for their support and kind gesture to complete this manuscript in time.

Funding: NIL.

Conflict of Interest:
There is no such evidence of conflict of interest.

Author Contribution
All authors have participated in critically revising the entire manuscript and approving the final manuscript.

REFERENCES

Anonymous (2015). Ministry of Agriculture & Cooperation, GOI Agriculture statistics at a glance.

Anonymous (2018). Ministry of Agriculture & Cooperation, GOI Agriculture statistics at a glance.

Chandel, R.S., Kalyan, S., Singh, A.K., & Sudhakar, P. C. (2003). Effect of sulphur nutrition in rice (*Oryza sativa* L.) and mustard (*Brassica juncea* L. Czern and Coss.) grown in sequence. *Indian Journal of Plant Physiology*, *8*(2), 89-93.

Chandrapala, A. G., Yakadri, M., Kumar, R. M., & Bhupal Raj, G. (2010). Productivity and economics of rice (*Oryza sativa*)–maize (*Zea mays*) as influenced by methods of crop establishment, Zn and S application in rice. *Indian Journal of Agronomy 55*(3), 65-68.

Cochran, W. G., & Cox, G. M. (1970). Experimental design Indian first Edition.

Das, K. N., & Borkotoki, B. B. (2011). Interrelationship of forms of Sulphur with its availability indices and soil properties in entisols of Assam. *Journal of the Indian Society of Soil Science 59*(2), 45-47.

De, O. S., & Cristina Gomes, C. M. (2003). Response of two rice cultivars to rates of zinc applied as oxysulfate. *Pesquisa Agropecuária Brasileira* 38(3), 387-396.

Fang, Yong, Lin, W., Xin, Zhihong, Zhao, Liyan, Xinxin, An & Qiuhui, Hu (2008). Effect of foliar application of zinc, selenium, and iron fertilizers on nutrients concentration and yield of rice grain in China. *Journal of Agricultural and Food Chemistry* 56(6), 2079-2084.

FAO, (2002). Statistical data base on agriculture http.apps F.A.O.org

Hossain, M. A., Jahiruddin, M., Islam, M. R., & Mian, M. H. (2008). The requirement of zinc for improvement of crop yield and mineral nutrition in the maize-moogbean-rice system. *Plant and Soil 306*(1-2), 13-22.

Jena, D., Sahoo, R., Sarangi, D. R., & Singh, M. V. (2006). Effect of different sources and levels of Sulphur on yield and nutrient uptake by groundnut-rice cropping system in an inceptisol of Orissa. *Journal of the Indian Society of Soil Science*, *54*(1), 43-47.

Jackson, M. L. (1973). Soil chemical analysis. Prentice hall of India, Pvt. Ltd., NewDelhi: 151-408.

Kulandaivel, S., Mishra, B. N., & Mishra, P. K. (2004). Effect of levels of zinc and iron and their chelation on yield and soil micronutrient status in rice-wheat cropping system in semi-arid condition. *Indian J. of Agronomy*. *49*(2), 80-83.

Kumar, R. (2007). Statistical investigation on use of application of micro nutrients in rice-wheat cropping system. *Bhartiya Krishi Anusandhan Patrika 22*(2), 67-68.

Lindsay, W. l., & Norvel, W. A. (1978). Development of DTPA test for Zn, Fe, Mn and Co. *Soil Sci. Soc. Amer. J*. 421-428.

Maiti, D. K., & Das, Kumar, D. (2007). Evaluation of different analytical methods for the estimation of available N, P, K and Zn in soil .*Archives of Agronomy and Soil Science 53*(1), 89-94.

Mandal, Latika, Maiti, D., & Bandyopadhyay, P. (2009). Response of zinc in transplanted rice under integrated nutrient management in new alluvial zone of West Bengal. *International Journal on Rice 46*(2), 76-79.

Mishra, Peeyush; Singh, Room; Srivastva, P. C., & Bali, R. (2009). Effect of continuous cropping and fertilization on zinc fractions and their contribution to plant uptake under rice-wheat system. *Journal of the Indian Society of Soil Science 57*(2), 54-56.

Naik, Kumar, S., & Das, Kumar, D. (2007). Effect of split application of zinc on yield of rice (*Oryza Sativa* L.) in an inceptisol. *Archives of Agronomy and Soil Sci. 53*(3), 305-313.

Naik, Kumar, S., & Das, Kumar, D. (2008). Relative performance of chelated zinc and zinc sulphate for lowland rice (Oryza *sativa* L.). *Nutrient Cycling in Agroecosystems*, *81*(3), 219-227.

Oliveira, S. C., Costa, M. C. G., Chamas, R. C., Cabaral, C. P., & Malavolta, E. (2003). Response of rice to rate of sulphur application as oxysulphate. *Pesquisa Agropecuaria Brasibira*. *38*(3), 387-396.

Olsen, S. R., Cole, V. V., Watanabe, F. S., & Dean, L. A. (1954). Estimation of available phosphorus by extraction with sodium bicarbonate, USDA cire. 939.

Pandian, P. S. (2010). Kinetics of desorption of native Sulphur in soil in a long-term fertilizer experiment on rice. *Madras Agricultural Journal*, *97*(10-12), 360-364.

Pathak, P. K., & Pal, R. B. (2003). Improvement of protein content by application of zinc. *Indian Journal of Agronomy*. *63*, 420-421

Pooniya, Vijay & Shivay, Y. S. (2011). Effect of green manuring and zinc fertilization on productivity and nutrient uptake in basmati rice (*Oryza Sativa* L.)-wheat (*Triticum aestivum* L.) cropping system. *Indian Journal of Agronomy 56*(1), 78-80.

Prasad, R. K., Kumar, Vipin; Prasad, B., & Singh, A.P. (2010). Long-term effect of crop residues and zinc fertilizer on crop yield, nutrient uptake and fertility build-up under rice-wheat cropping system in calciorthents. *Journal of the Indian Society of Soil Science 58*(2), 67-69.

Rahman, M. T., Jahiruddin, M., Humauan, M. R., Alamand, M. J., & Khan, A. A. (2008). Effect of Sulphur and zinc on growth, yield and nutrient uptake of boro rice (cv.BRRI Dhan-29). *Journal Soil Nature*. *2*(3), 10-15.

Rahman, M. S., Ahmed, M. U., Rahman, M. M., Islam, M. R., & Zafar, A. (2009). Effect of different levels of Sulphur on the growth and yield of BRRI Dhan-1. *Bangladesh research Publication Journal*. *3*(1), 846-852.

Raju, R. A., & Reddy, M. N. (2001). Response of hybrid and conventional rice to gliricidia lopping, Sulphur and zinc application.*Fertilizer News*, *46*(1), 61-62.

Ramkala; Dahiya, R. R., Dahiya, S. S., & Dalel, S. (2008). Evaluation of N.P.Zn. (10: 50: 1.5) complex fertilizer in rice -wheat cropping System. *Indian Journal of Agricultural Research 42*(4), 78-81.

Saha, P. K., Ishaque, M., Saleque, M. A., Miah, M. A. M., Panaullah, G. M., & Bhuiyan, N. I. (2007). Long-term integrated nutrient management for rice-based cropping pattern: Effect on growth, yield, nutrient uptake, nutrient balance sheet, and soil fertility. *Communications in Soil Science and Plant Analysis*, *38*(5 -6), 579-610.

Sarkar, A. K., Singh, S., & Saha, P. B. (2000). Sulphur in balanced fertilization in red and lateritic soil in Chloranazapur Plateau of Bihar. Workshop on Sulphur in balanced fertilization. *Proc.* ISI/FAI/IFA workshop held on 7-8 2000, New Delhi, 65-72.

Senapati, H. K., Dash, A. K., & Mohanty, B. (2007). Effect of long term fertilizer use on sulphur availability to rice in an inceptisol .*Madras Agricultural Journa*l *94*(7-12), 205-211.

Shanti, M., Babu, B., Prasad, P., Rajendra, B., & Minhas, P. S. (2008). Effect of zinc on blackgram in rice-blackgram cropping system of coastal saline soils. *Legume Research, 31*(2), 55-57.

Shivay, Y. S., Dinesh, K., & Prasad, R. (2008). Relative efficiency of zinc sulfate and zinc oxide-coated urea in rice-wheat cropping system .*Communications in*

Soil Science and Plant Analysis 39(7-8), 1154-1167.

Shivay, Y. S., Dinesh, K., Prasad, R., & Ahlawat, I. P. S. (2008). Relative yield and zinc uptake by rice from zinc sulphate and zinc oxide coatings onto urea. *Nutrient Cycling in Agro ecosystems, 80*(2), 181-188.

Singh, H. P., & Singh, T. N. (2004). Effect of sources and levels of zinc on growth, yield and mineral composition of rice in alkali. *Soil Indian Journal of Plant Physiology 9*(4), 65-67.

Singh, H. P., & Singh, T. N. (2006). Metabolic variation in rice cultivars of contrasting salt tolerance and its improvement by zinc in sodic soil. *Journal of Environmental Biology, 27*(3), 36-38.

Singh, A. P., Sinha, R. P., & Bhogal, N. S. (1990) Am. Agric. Res., *11*(89).

Slaton, Nathan, A., Edward, Gbur, E., Wilson, Charles, E., & Norman, Richard, J. (2005). Rice response to granular zinc sources varying in water-soluble zinc. *Soil Science Society of America Journal, 69*(2), 443-452.

Slaton, Nathan, A., Wilson, Charles, E., & Norman, Richard, J. (2005). Effect of zinc source and application time on zinc uptake and grain yield of flood-irrigated rice *Agronomy Journal, 97*(1), 272-278.

Srivastava, P. C., Ghosh, D., & Singh, V. P. (1999). Evaluation of different zinc sources for lowland rice production .*Biology and Fertility of Soils* 30(1-2), 168-172.

Subbiah, B. V., & Asija, G. L. (1956). A rapid procedure for the determination of available nitrogen in soil. *Curr.Sci. 25*, 259-260.

Tondon, H. L. S. (1991). Sulphur research and Agricultural production in India, third edition. The sulphur institute Washington, DC. USA, 112-113.

Varghese, Mercy; Varghese, Kins & Singh, S. S. (2006). Effect of different levels and sources of Sulphur on growth, yield and grain quality of basmati rice (*Oryza Sativa* L.) Cv. Pusa Basmati-2. *Agricultural Science Digest, 26*(1), 45-49.

Varshney, Poonam; Singh, S. K., & Srivastava, P.C. (2008). Frequency and rates of zinc application under hybrid rice – wheat sequence in a mollisol of Uttarakhand . *Journal of the Indian Society of Soil Science 56*(1), 67-71.

Walkley, A., & Black, J. A. (1934). An examination method for determination of soil organic matter and proposed modification of chromic acid titration method. *Soil sci. Soc. 37*, 29-38.

Williams, C. H., & Sterinbergs, A. (1959). Soil sulphur fraction as chemical indices of available Sulphur in some Australian soil. *Aust. J. Agric. R*es *10*(1), 340-352.