Original Research Article

Effect of Phosphorus and Sulphur on growth and yield of Wheat (*Triticum aestivum* L.)

Abstract

A field experiment was conducted during *Rabi* (2021-2022) at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, prayagraj, and Uttar Pradesh, India. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36 %), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). P1 (40 kg/ha), P2 (60 kg/ha), P3 (80 kg/ha) were 3 different phosphorus levels, and S1 (20 kg/ha), S2 (30 kg/ha), S3 (40 kg/ha) were 3 different levels of sulphur. The experiment was conducted in Randomized Block Design with nine treatments and was repeated three times. The result displayed the application of Phosphorus 80 kg/ha + Sulphur 40 kg/ha was recorded topmost Plant height (96.47 cm) recorded in research, Number of Tillers/hill (10.47), Plant dry weight (18.54 g/plant), Grains/spike (47.36), Test weight (38.59 g), Grain yield (6.25 t/ha), Straw yield (9.54 t/ha), and Harvest index (39.58 %), also recorded in treatment 9 with apply Phosphorus 80 kg/ha + Sulphur 40 kg/ha as compared to other treatments. Phosphorus is the second most essential plant nutrient which plays a major role for achieving the maximum crop production. It plays a vital role in several physiological processes viz. photosynthesis, respiration, energy storage and cell division/ enlargement. In the cereal crops, sulphur contain in the ranges from 0.16-0.20%. Sulphur performs many physiological functions like synthesis of sulphur containing amino acids which have positive role in improving quality of grain.

Key words: Wheat, Phosphorus, Sulphur, growth, yield.

Comment [G1]: Please arrange the manuscript according to the journal's instructions for authors.

Comment [G2]: the experimental

Comment [G3]: in

Comment [G4]: Delete ~~the~~

Comment [G5]: What is intended by this sentence?

Comment [G6]: Sulphur-containing

Comment [G7]: the quality

Introduction

Wheat (*Triticum aestivum* L.), which triggered green revolution in the Indian subcontinent, is an important food grain providing nourishment nearly to 35 per cent people of the world. On global scale, the crop is grown over an area of 220 million hectare with a production of 763.06 million tonnes (Anonymous, 2019-2020). India is the second largest

producer of wheat in the world next only to China and the crop has provided the fastest pace of growth to Indian agriculture. Among cereals, wheat is next to rice in area (24.23 million ha) and production (75.6 million tonnes) **(Jagshoran *et al.*, 2004).** Wheat contributes about 60 per cent of daily protein requirement and more calories to world diet than any other food crop **(Mattern *et al.*, 1970).** As main staple food, wheat continues to assume greater significance in the years to come both from grain productivity as well as quality point of view. Wheat is one of the most important cereal crops of India with diverse uses. Intensive cultivation has resulted in depletion of soil nutrients to a great extent thus nutrients requirement of crops has increased considerably during the last few years.

Phosphorus is the second most essential plant nutrient which plays a major role for achieving the maximum crop production. It plays a vital role in several physiological processes *viz*. photosynthesis, respiration, energy storage and cell division/ enlargement. It is also an important structural component of many biochemicals viz. nucleic acid (DNA and RNA enzymes and co-enzymes) and also stimulates root growth and associated with early maturity of crops **(Khan *et al.*, 2007).**

Sulphur is another one of the essential nutrients in all plant nutrients and component of amino acids which are the building block of protein. In the cereal crops, sulphur contain in the ranges from 0.16-0.20%. Sulphur performs many physiological functions like synthesis of sulphur containing amino acids which have positive role in improving quality of grain **(Chaudhary *et al.*, 2003).** Sulphur is a structural constituent of organic compounds, some of which are uniquely synthesized by plants, providing human and animals with essential amino acids (methionine cystine and cysteine). It is involved in chlorophyll formation, activation of enzymes and is a part of vitamins biotin and thiamine (B1) **(Hegde and Sudhakara babu, 2007).** Sulphur deficiency in crops is gradually becoming widespread due to continuous use of sulphur free fertilizers, high yielding crop varieties, intensive multiple cropping systems coupled with higher productivity.

Comment [G8]: the depletion

Comment [G9]: Delete ~~the~~

Comment [G10]: Sulphur-containing

Comment [G11]: a positive

Comment [G12]: the quality

Comment [G13]: In the references

Hegde D. M., Babu S. N. 2007

Comment [G14]: the continuous

Comment [G15]: sulphur-free

Materials and Methods

The experiment was carried out during *Rabi* season of 2021 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (Allahabad) which is located at 25o 24' 42" N latitude, 81o50' 56" E longitude and 98 m altitude above the mean sea level. The experiment laid out in Randomized Block Design which consisting of nine treatments with T_1: Phosphorus 40 kg/ha + Sulphur 20 kg/ha, T_2: Phosphorus 40 kg/ha +

Comment [G16]: Kindly, add the number of replicates here.

Sulphur 30 kg/ha, T_3: Phosphorus 40 kg/ha + Sulphur 40 kg/ha, T_4: Phosphorus 60 kg/ha + Sulphur 20 kg/ha, T_5: Phosphorus 60 kg/ha + Sulphur 30 kg/ha, T_6: Phosphorus 60 kg/ha + Sulphur 40 kg/ha, T_7: Phosphorus 80 kg/ha + Sulphur 20 kg/ha, T_8: Phosphorus 80 kg/ha + Sulphur 30 kg/ha, T_9: Phosphorus 80 kg/ha + Sulphur 40 kg/ha are used. plant height (cm), number of tillers per hill, plant dry weight(g/plant), number of grains per spike, test weight(g), grain yield(t/ha), stover yield(t/ha) and harvest index (%) observation were recorded on different growth parameters at harvest time.

Comment [G17]: Kindly, mention the initial soil properties of the experimental field.

Results and Discussion

Comment [G18]: The discussion is very brief.

Growth attributes

Plant height

Comment [G19]: Please add Table No. 1 and 2 for each studied trait.

Significant plant height (96.47 cm) was reported in treatment of Phosphorus 80 kg / ha + Sulfur 40 kg / ha as compared to all other treatments. However, treatment using phosphorus 60 kg / ha + sulfur 40 kg / ha (96.02 cm) and phosphorus 80 kg / ha + sulfur 30 kg / ha (96.28 cm) was found to be equivalent to Phosphorus 80 kg / ha + Sulfur 40 kg / ha.

Application of 90 kg P2O5 per ha was helped in obtaining the maximum plant height. Phosphorus encourages formation of new cells, promote plant vigour and hastens leaf development, which help in harvesting more solar energy and better utilization of nitrogen, which help towards higher growth attributes. The results were in accordance to **Noonari *et al.*, (2016).**

Comment [G20]: P_2O_5

Comment [G21]: Delete ~~was~~

Comment [G22]: the formation

Comment [G23]: promotes

Comment [G24]: with

Number of tillers/plants

Phosphorus 80 kg / ha + Sulfur 40 kg / ha Treatment the highest tiller / hill (10.47) was reported to be significantly higher than all treatments. However, treatment with phosphorus 60 kg / ha + sulfur 40 kg / ha (10.25) and phosphorus 80 kg / ha + sulfur 30 kg / ha (10.36) which was found to be statistically equivalent to phosphorus 80 kg / ha + sulfur 40 kg / ha

Application of 90 kg P2O5 per ha was helped in obtaining the maximum tillers/plant. The number of tillers were increased due to the greater availability of nutrients in soil due to increasing application of phosphorus doses might have enhanced multiplication and elongation of cells leading to increased number of tillers as reported by **Sharma *et al.* (2011)**.

Comment [G25]: was

Comment [G26]: the soil

Plant dry weight (g/plant)

Treatment with Phosphorus 80 kg/ha + Sulphur 40 kg/ha was recorded with significantly maximum dry weight (18.54 g/plant) over all the treatments. However, the treatments Phosphorus 60 kg/ha + Sulphur 40 kg/ha (18.14 g/plant) and Phosphorus 80 kg/ha

+ Sulphur 30 kg/ha (18.36 g/plant) which were found to be statistically at par with Phosphorus 80 kg/ha + Sulphur 40 kg/ha.

The application of Phosphorus 80 kg/ha to wheat significantly increased dry matter production. The plants attained more vigour with phosphorus, due to adequate supply and availability of nitrogen, phosphorus, potassium and spacing in balanced combination, resulting in increased dry weight of the plant. The results were found to be similar with **Khan *et al*., (2017).**

Comment [G27]: a balanced

Comment [G28]: to

Comment [G29]: In the references

Khan, W. and Singh, V. 2017

Yield attributes and Yield

Number of grains/spikes

Significant number of grains / spikes (47.36) were reported using phosphorus 80 kg / ha + sulfur 40 kg / ha on all treatments. However, phosphorus 60 kg / ha + sulfur 40 kg / ha (46.89) and phosphorus 80 kg / ha + sulfur 30 kg / ha (47.15) treatment which was found to be statistically equal to phosphorus 80 kg / ha + sulfur 40. Kg / ha.

Application of Phosphorus 90kg/ha increased the number of grains/spikes might be due to the enhanced early vegetative growth in terms of higher leaf area, dry matter accumulation and vigorous root system resulted in more tillers which consequently increased the number of grains bearing tillers significantly. Similar findings were observed by **Islam *et al.*, (2017).**

Test weight (g)

Significantly higher test weight (38.59 g) was reported using phosphorus 80 kg / ha + sulfur 40 kg / ha on all treatments. However, phosphorus 60 kg / ha + sulfur 40 kg / ha (38.15 g) and phosphorus 80 kg / ha + sulfur 30 kg / ha (38.40 g) treatment which was found to be statistically equal to phosphorus 80 kg / ha +. Sulfur 40 kg / ha.

Application of 75 kg P2O5 per ha was helped in obtaining the maximum test weight **Yadav et al., (2017).**

Comment [G30]: P_2O_5

Grain yield (t/ha)

Significantly higher grain yield (6.25 ton / ha) was reported using phosphorus 80 kg / ha + sulfur 40 kg / ha in all treatments. However, in phosphorus (6.02 ton / ha) 60 kg / ha + sulfur

40 kg / ha and in (6.18 ton / ha) phosphorus 80 kg / ha + sulfur 30 kg / ha was found to be - statistically treated. Phosphorus 80 kg / ha + Sulfur 40 kg / ha.

Application of 90kg P2O5 per ha was helped in obtaining the maximum grain yield. **Khan *et.al*., (2007)**

Stover yield (t/ha)

Significantly higher straw yield (9.54 ton / ha) was reported using phosphorus 80 kg / ha + sulfur 40 kg / ha on all treatments. However, treatment with phosphorus (9.22 t / ha) 60 kg / ha + sulfur 40 kg / ha and (9.44 t / ha) phosphorus 80 kg / ha + sulfur 30 kg / ha which was found on statistical level. Phosphorus 80 kg / ha + Sulfur 40 kg / ha. The results were in accordance with **Sharma *et al*., (2011).**

Harvest index (%)

Significantly highest yield index (39.58%) was reported using phosphorus 80 kg / ha + sulfur 40 kg / ha. However, phosphorus 60 kg / ha + sulfur 30 kg / ha (39.10%), phosphorus 60 kg / ha + sulfur 40 kg / ha (39.49%) and phosphorus 80 kg / ha + sulfur 30 kg / ha (39.56%) Which was found to be statistically equal to 80 kg / ha + sulfur 40 kg / ha)

Application of 90 kg P2O5 per ha was helped in obtaining the maximum harvest index. **Obaid *et al*., (2019**

CONCLUSION

On the basis of one season experimentation it can be concluded that with the application of Phosphorus 80 kg/ha + Sulphur 40 kg/ha was found significantly superior in plant height (96.47cm), tillers/hill (10.47), dry weight (18.54 g/plant), grains/spike (47.36), Test weight (38.59 g), Grain yield (6.25 t/ha), Stover yield (9.54t/ha) and harvest index (39.58 %) so this treatment is viable for farmers.

REFERENCES

1. Chaudhary, P. D.; Jat, R. S. And Sharma, H. S. (2003). Interaction effect of phosphorus, sulphur and PSB inoculation on growth, yield and nutrient uptake of wheat. Annals of Agricultural Research; **24**(1):12-16.

2. Hegde D. M., Babu S. N. 2007. Correcting Sulphur deficiencies in soils and crops.

Comment [G31]: P_2O_5

Comment [G32]: Delete ~~was~~

Comment [G33]: Delete was

Comment [G34]: of experimentation

Comment [G35]: Delete ~~with~~

Indian J. Fert.; **3**(1):65-79.

3. Islam, S., Ullah, S., Anjum, M.M., Ali, N., Ahmad, B. and Ahmad, S. 2017. Impact of wheat various levels of Phosphorus on Wheat. *International Journal of Environmental Sciences and Natural Resources.* **6**(5)2572-1119.

4. Jagshoran, Sharma R. K, Tripathi S. C. 2004. New varieties and production. The Hindu, Survey of Indian Agriculture. 33-35.

5. Khan, W. and Singh, V. 2017. Response of phosophorus application on growth and yield attributes of sweet corn *(Zea mays* L. *saccharaata)* varieties. *Journal of Pharmacognosy and Phytochemistry*, **6** (5): 2205-2208.

6. Khan, R., Gurmani, A. R., Gurmani, A. H. and Zia, M. S. 2007. Effect of phosphorus application on wheat and rice yield under wheat- rice system. *Sarhad J. Agric.* **23**(4): 851-856.

7. Mattern P. P. J., Schmidt J. W., Johnson V. A. 1970. Screening forhigh lysine content in wheat. Cereal Sci. Today.15:409.

8. Noonari, S., Ali, K. S., Ali, A., Amanullah, M., Raza, S., Munnesr, A., Fayaz, A. S. S., Ullah, B. S. (2016). Effect of Different levels of Phosphorus and Method of Application on Growth and Yield of Wheat. *Natural Science*. Vol. 8, pp:305-314.

9. Obaid, H., Khalili, A., Sharifi, S. and Shiva Dhar**. (2019)** Effect of different levels of phosphorus on growth and yield of wheat(Triticum aestivum L.) in Kandahar region of Afghanistan. *Annals of Agricultural Research.* **40** (1): 1-5

10. Sharma, A., Rawat, U.S., Yadav, B.K. 2011. Influence of Phosphorus Levels and Phosphorus Solubilizing Fungi on Yield and Nutrient Uptake by Wheat under Sub-Humid

Region of Rajasthan. *International Scholarity Research Network*. Volume 2012, Article ID 234656, 9 pages

11. Yadav, S. K., Singh, G., Kumar, R., Kumar, P. and Mohan, B. 2017. Effect of Phosphorus, Sulphur and Zinc on Growth, Yield and Yield Attributes of Wheat (*Triticum aestivum*). *Int.J.Curr.Microbiol.App.Sci*, **6**(8): 2581-2584.

Table 1: Effect of Phosphorus and Sulphur on Growth attributes of Wheat

Sr.No	Treatments	Plant height (cm)	No.of Tillers/hill	Dry weight (g/plant)
1.	Phosphorus 40 kg/ha + Sulphur 20 kg/ha	94.51	9.55	16.63
2.	Phosphorus 40 kg/ha + Sulphur 30 kg/ha	94.66	9.66	16.84
3.	Phosphorus 40 kg/ha + Sulphur 40 kg/ha	95.47	10.02	17.47
4.	Phosphorus 60 kg/ha + Sulphur 20 kg/ha	94.92	9.84	17.02
5.	Phosphorus 60 kg/ha + Sulphur 30 kg/ha	95.74	10.12	17.90
6.	Phosphorus 60 kg/ha + Sulphur 40 kg/ha	96.02	10.25	18.14
7.	Phosphorus 80 kg/ha + Sulphur 20 kg/ha	95.27	9.96	17.24
8.	Phosphorus 80 kg/ha + Sulphur 30 kg/ha	96.28	10.36	18.36
9.	Phosphorus 80 kg/ha + Sulphur 40 kg/ha	96.47	10.47	18.54
	SEm (±)	0.19	0.11	0.18
	CD (P = 0.05)	0.57	0.33	0.54

Comment [G36]: Significant, highly significant and non-significant should be added to show the effect of the treatments on each trait.

Table 2. Effect of Phosphorus and Sulphur on Yield attributes and Yield of Wheat

Sr.No	Treatments	Grains/spike	Test Weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
1.	Phosphorus 40 kg/ha + Sulphur 20 kg/ha	45.17	36.81	5.23	8.39	38.38
2.	Phosphorus 40 kg/ha + Sulphur 30 kg/ha	45.43	37.05	5.35	8.54	38.50
3.	Phosphorus 40 kg/ha + Sulphur 40 kg/ha	46.28	37.76	5.63	8.91	38.70
4.	Phosphorus 60 kg/ha + Sulphur 20 kg/ha	45.60	37.37	5.47	8.65	38.71
5.	Phosphorus 60 kg/ha + Sulphur 30 kg/ha	46.54	38.02	5.80	9.04	39.10
6.	Phosphorus 60 kg/ha + Sulphur 40 kg/ha	46.89	38.15	6.02	9.22	39.49
7.	Phosphorus 80 kg/ha + Sulphur 20 kg/ha	45.89	37.52	5.53	8.74	38.72
8.	Phosphorus 80 kg/ha + Sulphur 30 kg/ha	47.15	38.40	6.18	9.44	39.56
9.	Phosphorus 80 kg/ha + Sulphur 40 kg/ha	47.36	38.59	6.25	9.54	39.58
	SEm (±)	0.18	0.18	0.11	0.07	0.28
	CD (P = 0.05)	0.53	0.54	0.32	0.21	0.8

Comment [G37]: Significant, highly significant and non-significant should be added to show the effect of the treatments on each trait.