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

Abstract

A field experiment was conducted during *Rabi* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the 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). The experiment was laid out on Randomized Block Design with nine treatments; each replicated thrice ~~on the basis of~~based on~~one~~ one-year experimentation. The treatments which are T_1: Nitrogen 80 kg/ha + Sulphur 15 kg/ha, T_2: Nitrogen 80 kg/ha + Sulphur 30 kg/ha, T_3: Nitrogen 80 kg/ha + Sulphur 45 kg/ha, T4: Nitrogen 100 kg/ha + Sulphur 15 kg/ha, T_5: Nitrogen 100 kg/ha + Sulphur 30 kg/ha, T_6: Nitrogen 100 kg/ha + Sulphur 45 kg/ha, T_7: Nitrogen 120 kg/ha + Sulphur 15 kg/ha, T_8: Nitrogen 120 kg/ha + Sulphur 30 kg/ha,T_9: Nitrogen 120 kg/ha + Sulphur 45 kg/ha are used. The results showed that application of Nitrogen 120 kg/ha + Sulphur 45 kg/ha was recorded to significantly higher Plant height (98.13 cm), No. of Tillers/hill (10.71), Plant dry weight (17.83 g/plant), whereas significantly highest Crop growth rate (7.47 g/m^2/day) was recorded with the treatment Nitrogen 80 kg/ha + Sulphur 15 kg/ha. However, significantly maximum No. of Grains/spike (47.34), Test weight (38.30 g), Grain yield (6.14 t/ha), and Straw yield (9.52 t/ha)was obtained in the treatment of Nitrogen 120 kg/ha + Sulphur 45 kg/ha as compared to other treatments.

Keywords: Nitrogen,Sulphur, Wheat, Growth and yield.

Introduction

Wheat (Triticum aestivum L.), which triggered the Green revolution in the Indian subcontinent, is an important food grain providing nourishment ~~nearly to~~to nearly 35 per cent of people ~~of~~ worldwide~~the world~~. On a global scale, the crop is grown over an area of 211.06 million ha with a production of 566.8million tonnes. India is the second largest ~~producer of wheat in the world next only to China and the crop has provided the fastest pace of~~wheat producer in the world, next only to China and the crop has provided the fastest growth to Indian agriculture. Among cereals, wheat is next to rice in the 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 the world diet than any other food crop**.** As the main staple food, wheat continues to assume greater significance in the years to come both from grain productivity as well asnd quality points of view. Wheat is one of the most important cereal crops of IndiaIndia's most important cereal crops with diverse uses. Intensive cultivation has resulted in the depletion of soil nutrients to a great extent; thus,the nutrients requirement of crops has increased considerably during the last few years.

The most important crucialrole of N in the plant is its presences in the structure of the protein, the mostimportant building substances from which the living material or protoplasm of every cell ismade. In addition, nitrogen is also found in chlorophyll, the green colouring matter of leaves.Nitrogen occupies a conspicuous place in plant metabolism. All vital processes in the plant areassociated with protein, of which nitrogen is an essential constituent. Although greater N application has produced higher yields, this is not a linear relationship(seebelow),andthereisaneconomicoptimumoptimum economicapplicationoffsettingincrementalyieldincrease against the cost of additional N inputs, which needs to be determined for individualcultivars **(King et al., 2003).** Availability Of N has impacts throughoutcrop development, affecting seedling establishment, tillering, canopy development as well asgrain filling, all of which have the potential to Effect final yield and together determine the Nrequirementsofthecropimpacts crop development, affecting seedling establishment, tillering, canopy development as well as grain filling, all of which have the potential to affect final yield and determine the crop requirements.

Sulphur is another one of the essential nutrient in all plant nutrients and a 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 synthesizing sulphur-containing amino acids, which positively improve grain qualitysynthesis 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 humanuniquely synthesized by plants, providing humans and animals with essential amino acids(methionine cystine and cysteine). It is involved in chlorophyll formation,and activation ofng enzymes and is a part of vitamins biotin and thiamine (B1) **(Hegde and Sudhakarababu Babu, 2007).** Sulphur deficiency in crops is gradually becoming widespread due to the continuous use of sulphur- sulphur-free fertilizers, high- high-yielding crop varieties, intensive multiple cropping systems- coupled with, and higher productivity.

Materials and Methods

The present examination was carried out during *Rabi* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which isonducted during Rabi 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, located at 25.28^{o}N latitude, 81.54^{o}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: Nitrogen 80 kg/ha + Sulphur 15 kg/ha, T_2: Nitrogen 80 kg/ha + Sulphur 30 kg/ha, T_3: Nitrogen 80 kg/ha + Sulphur 45 kg/ha, T4: Nitrogen 100 kg/ha + Sulphur 15 kg/ha, T_5: Nitrogen 100 kg/ha + Sulphur 30 kg/ha, T_6: Nitrogen 100 kg/ha + Sulphur 45 kg/ha, T_7: Nitrogen 120 kg/ha + Sulphur 15 kg/ha, T_8: Nitrogen 120 kg/ha + Sulphur 30 kg/ha,T_9: Nitrogen 120 kg/ha + Sulphur 45 kg/ha are used. The experimental site was uniform in topography and sandy loam in texture, nearly neutral in soil reaction (P^H 7.1), low in Organic carbon (0.38%), medium available N (225 kg ha^{-1}), higher available P (19.50 kg ha^{-1}) and medium available K (213.7 kg ha^{-1}). In the period from germination to harvest, several plant growth parameters were recorded at frequent intervals;along with it after harvest several yield parameters were recordedseveral yield parameters were recorded after harvest t. Ghose parameters are growth parameters, plant height, and plant dry weight are recorded. The yield parameters likeSeeds/spikes, Test weight, Grain yield and stover yield were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez K.A. and Gomez A.A. 1984).

Results and Discussion

Growth attributes

Plant height

Significantly highest plant height (98.13 cm) was recorded in the treatment with Nitrogen 120 kg/ha + Sulphur 45 kg/ha over all the other treatments. However, the treatments with application of Nitrogen 100 kg/ha + Sulphur 45 kg/ha (97.27 cm) and Nitrogen 120 kg/ha + Sulphur 30 kg/ha (97.72 cm) which were found to be at par with treatment Nitrogen 120 kg/ha + Sulphur 45 kg/ha as compared to all the treatments.

The significant increase in plant height was due to increasing levels of nitrogen fertilizer throughout the measurement period. The increase in plant height in response to ~~application of~~ N fertilizers is probably due to the enhanced availability of nitrogen (**Indra ~~chaturvedi~~Chaturvedi, 2006**).

Sulphurplays a~~nimportant~~ vitalrole inthe biosynthesisofIndole 3aceticacid.These increases in growth attributes and ~~beneficial effect of sulphur onvarious metabolic activities and also because of~~the beneficial effect of sulphur on various metabolic activities and its important role in cell division. Therefore, anincreasein plant height dueto the applicationofsulphurwasalso observed by**Degra*etal*.(2008).**

Tillers/hill

treatment with Nitrogen 120 kg/ha + Sulphur 45 kg/ha was recorded with significantly highest No. of Tillers/hill (10.71) over all the treatments. However, the treatments with Nitrogen 100 kg/ha + Sulphur 45 kg/ha (10.47) and Nitrogen 120 kg/ha + Sulphur 30 kg/ha (10.56) which were found to be statistically at par with Nitrogen 120 kg/ha + Sulphur 45 kg/ha.

The number of tillers ~~were~~ wasincreased due to the greater availability of nutrients in the soil due to increasing application of Nitrogen doses might have enhanced the multiplication and elongation of cells leading to the increased number of tillers reported by **Maurya *et al*., (2019).**

Plant dry weight (g/plant)

Treatment with Nitrogen 120 kg/ha + Sulphur 45 kg/ha was recorded with significantly maximum dry weight (17.83 g/plant) over all the treatments. However, the treatments Nitrogen 100 kg/ha + Sulphur 45 kg/ha (17.22 g/plant) andNitrogen 120 kg/ha + Sulphur 30 kg/ha (17.64 g/plant) which were found to be statistically at par with Nitrogen 120 kg/ha + Sulphur 45 kg/ha.

The significant increase in dry weight might be due to an adequate supply of ~~Nitrogen~~ nitrogen allowed the plant tissue to grow large and increase the chlorophyll formation, and ~~stimulated~~ stimulatingrapid rate of photosynthetic activity, consequently ~~recorded~~ recordingmore dry matter accumulation in comparison to its lower level as stated by **Singh *et al.*, (2019)**.Sulphur in this application plays plant metabolic activity, which may lead to ~~the~~anincreasein photosynthesis. ~~Thes~~Similar results wereobservedby **Dadhich *et al.* (2004).**

Yield parameters

Grains/spike

Significantly Maximum Number of Grains/spike (47.34) was recorded with ~~the treatment of application of~~ Nitrogen 120 kg/ha + Sulphur 45 kg/ha over all the treatments. However, the treatments Nitrogen 100 kg/ha + Sulphur 45 kg/ha (46.61) and Nitrogen 120 kg/ha + Sulphur 30 kg/ha (47.03) which were found to be statistically at par with Nitrogen 120 kg/ha + Sulphur 45 kg/ha.

~~Significant~~ A significant increase in the number of grains /spike is due to the ri~~increa~~se in higher doses of ~~Nitrogen~~ nitrogen. M~~by which m~~ore spikelets are produced due to increased rates of spikelets primordial production~~, s~~. Similar results were found by **Bhatta *et al.*, (2020).**

Test weight

Significantly highest Test weight (38.30 g) was recorded with ~~the treatment of application of N~~nitrogen 120 kg/ha + Sulphur 45 kg/ha over all the treatments. However, the treatments Nitrogen 100 kg/ha + Sulphur 45 kg/ha (37.67 g) and Nitrogen 120 kg/ha + Sulphur 30 kg/ha (38.00 g) which were found to be statistically at par with Nitrogen 120 kg/ha + Sulphur 45 kg/ha.

~~Increase~~ An increase in the value of yield contributing characters with higher doses of sulphur was ~~due to the facts that~~because~~the~~ adequate sulphur was available during the entire period of crop growth for better vegetative growth and development of wheat. The results were found to be similar ~~with~~to**Sharma *et al.* (2003).**

Test weight, a~~n import~~ significant yield determining component, is a genetic character and is least influenced by the environment. This ~~was~~ might be due to the higher conservation of light energy into chemical energy and its subsequent translocation from source to sink. Similar findings were observed **by Saha*et al*., (2017).**

Grain yield (t/ha)

Significantly highest Grain yield (6.14 t/ha) was recorded with the treatment application of Nitrogen 120 kg/ha + Sulphur 45 kg/ha over all the treatments. However, the treatments with (5.96 t/ha) in Nitrogen 100 kg/ha + Sulphur 45 kg/ha and with (6.05 t/ha) in Nitrogen 120 kg/ha + Sulphur 30 kg/ha which were found to be statistically at par with Nitrogen 120 kg/ha + Sulphur 45 kg/ha.

Grain yield was increased due to the application of higher doses of nitrogen, which increases the photosynthetic activity and might have increased vegetative growth and yield attributes~~ also improved ultimately increas~~, which ultimately improved grain yield. Similar findings have been observed by **Pandey *et al.*, (2018).**

The increment in the number of grains/spike with an increasing dose of sulphur application might be better for root growth, cell multiplication, elongation, and cell expansion in the plant body by ~~higher dose of sulphur application, which~~a higher amount of sulphur application ultimately ~~increased~~ increase the grain yield. The results were found to be similar ~~with~~to**Yadav *et al.* (2004).**

Stover yield (t/ha)

Significantly highest Straw yield (9.52 t/ha) was recorded with the treatment application of Nitrogen 120 kg/ha + Sulphur 45 kg/ha over all the treatments. However, the treatments with (9.23 t/ha) in Nitrogen 100 kg/ha + Sulphur 45 kg/ha and with (9.34 t/ha) in Nitrogen 120 kg/ha + Sulphur 30 kg/ha which were found to be statistically at par with Nitrogen 120 kg/ha + Sulphur 45 kg/ha.

Adequate availability of nutrients resulted in enhanced growth attributes and yield attributes. ~~Incorporation of biofertilizer not only increased the growth and yield attributing characters but also increased the straw yields of wheat, reported by **Kaur *et al*., (2018)**~~As reported by Kaur et al., (2018), the incorporation of biofertilizer increased the growth and yield attributing characters and the straw yields of wheat**.**

Straw yield ~~is dependent on vegetative growth as~~ depends on vegetative growth as using balanced, optimum~~use of balanced and optimum use of~~ fertilizer increased plant height, green leaves per hill, and dry matter production, ~~which finally resulted~~resulting in higher straw yield. The results were in accordance with **Sharma*etal.*(2011).**

Harvest index (%)

There was no significant difference ~~among~~ betweenthe treatments. However, ~~highest harvest index (39.30 %) was recorded with the treatment application of Nitrogen 120 kg/ha + Sulphur 45 kg/ha, whereas,~~the highest harvest index (39.30 %) was recorded with the treatment application of Nitrogen 120 kg/ha + Sulphur 45 kg/ha. In contrast, the lowest harvest index (38.19 %) was recorded with ~~the application of N~~nitrogen 80 kg/ha + Sulphur 15 kg/ha.

~~Highest~~ The highest harvest index was observed due to improved cell activities, enhanced cell multiplication and enlargement and luxuriant growth and yield attributes of the crops, probably due to more absorption and utilization of available nutrients leading to the

overall improvement of crop growth reflected ~~to~~ inthe source-sink relationship, which in turn enhanced the yield attributes that ultimately more yield which was reported by **Singh *et al.*, (2019)**.

CONCLUSION

It is concluded that the application of ~~treatment Nitrogen 120 kg/ha + Sulphur 45 kg/ha was recorded significantly higher Grain yield (6.14 t/ha), as~~Nitrogen 120 kg/ha + Sulphur 45 kg/ha recorded a significantly higher Grain yield (6.14 t/ha) compared to other treatments~~. S~~ since~~,~~ the findings are based on the research done in one season.

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Table 1: Effect of~~Nitrogen~~ nitrogen and~~Sulphur~~ sulphur on growth attributes of ~~Wheat~~wheat

Treatments	Plant height (cm)	Tillers/hill	Dry weight (g/plant)
1. Nitrogen 80 kg/ha + Sulphur 15 kg/ha	94.33	9.55	15.74
2. Nitrogen 80 kg/ha + Sulphur 30 kg/ha	94.62	9.76	15.89
3. Nitrogen 80 kg/ha + Sulphur 45 kg/ha	95.85	9.97	16.64
4. Nitrogen 100 kg/ha + Sulphur 15 kg/ha	95.17	9.83	16.12
5. Nitrogen 100 kg/ha + Sulphur 30 kg/ha	96.77	10.24	16.88
6. Nitrogen 100 kg/ha + Sulphur 45 kg/ha	97.27	10.47	17.22
7. Nitrogen 120 kg/ha + Sulphur 15 kg/ha	96.29	10.10	16.37
8. Nitrogen 120 kg/ha + Sulphur 30 kg/ha	97.72	10.56	17.64
9. Nitrogen 120 kg/ha + Sulphur 45 kg/ha	98.13	10.71	17.83
F- test	S	S	S
S. EM (±)	0.31	0.11	0.20
C. D. (P = 0.05)	0.94	0.33	0.61

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Table 2.Effect of ~~Nitrogen~~ nitrogen and ~~Sulphur~~sulphur on ~~Yield~~ yield attributes and ~~Yield~~ yield of ~~Wheat~~wheat

Treatments	Grains/spike	Test Weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
1. Nitrogen 80 kg/ha + Sulphur 15 kg/ha	44.56	35.75	5.04	8.16	38.19
2. Nitrogen 80 kg/ha + Sulphur 30 kg/ha	44.87	36.05	5.17	8.33	38.30
3. Nitrogen 80 kg/ha + Sulphur 45 kg/ha	45.73	36.63	5.52	8.78	38.62
4. Nitrogen 100 kg/ha + Sulphur 15 kg/ha	45.16	36.26	5.35	8.54	38.49
5. Nitrogen 100 kg/ha + Sulphur 30 kg/ha	46.37	37.32	5.82	9.17	38.84
6. Nitrogen 100 kg/ha + Sulphur 45 kg/ha	46.61	37.67	5.96	9.23	39.24
7. Nitrogen 120 kg/ha + Sulphur 15 kg/ha	45.96	37.05	5.66	8.89	38.87
8. Nitrogen 120 kg/ha + Sulphur 30 kg/ha	47.03	38.00	6.05	9.34	39.30
9. Nitrogen 120 kg/ha + Sulphur 45 kg/ha	47.34	38.30	6.14	9.52	39.21
F test	**S**	**S**	**S**	**S**	**NS**
S. EM (±)	0.25	0.26	0.07	0.10	0.29
CD (P = 0.05)	0.75	0.76	0.21	0.31	-

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