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Effect of sulphur and magnesium application on growth and yield attributes of wheat crop under central plains zone of U.P.

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ABSTRACT

A field experiment was conducted during the *Rabi* seasons, on the effects of Sulphur and Magnesium on the yield and yield attributes of wheat crops in the central plains zone of UP. The result showed that the application of sulphur and magnesium with the recommended dose of fertilizer (RDF) increased the growth parameters i.e. plant height, number of tillers, number of ear plant$^{-1,}$ and number of ear lengths. The yield and yield attributes, viz., ear weight (g), number of grain spike^{-1}, test weight (g), grain yield (q ha^{-1}), and straw yield (q ha^{-1}). The highest plant height at 30, 60, and 90 DAS was 15.38, 62.74, and 87.71 cm respectively, the number of tillers plant-1 was highest in T_9 (6.83), the number of ears plant-1 was highest in T_9 (6.03), ear length highest in T_9 (10.25 cm) and lowest in (T_1) control plot. The maximum test weight in T_9 (39.38 g), grain, and straw yield were recorded as significantly higher in T_9 (45.96 q ha-1), (72.95 q ha^{-1}) and lowest in the (T_1) control plot (29.75 q ha^{-1}), (62.40 q ha^{-1}).

Keywords: *RDF, Sulphur, Magnesium, Growth and Yield.*

Introduction

Wheat is a staple crop in the Indian subcontinent. It has many usages, including bread, biscuits, semolina, and pasta. Although Punjab and Haryana are the major wheat-producing states UP state has the largest contribution to the national food basket in terms of total wheat production amounting to more than 30% alone. The wheat area and production trend in each state show that Uttar Pradesh, Punjab, Madhya Pradesh, and Haryana are the largest contributors to national wheat production.

Wheat production is faced with manifold productivity constraints. The growing demand along with increasing population compounded with climate change is a serious concern (Sendhil *et al.*, 2018). The use of RDFin soil ensured the highest growth parameters, yield components, and productivity of the wheat crop in comparison to all the treatments (Chandra *et al.,* 2023). Modern agriculture relies on classic mineral fertilizers, along with oligo and microelements while helping in further absorption and utilization of macronutrients. Although sulphur presence in earth's crust ranks 13th for plant growth

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and development role it is placed 4thSulphur, which is a component of vitamins and amino acids (Cysteine, Cystine, and Methionine), and thus of proteins. The presence of sulphur is essential for the biosynthesis of protein in the seeds. It positively affects not only the quantity but also the quality of crude protein in the harvested crop (G³owacka *et al.,* 2023).

Sulphur participates in the metabolism of potassium and nitrogen in plants, increasing their effectiveness. Cereals are the best example of the complex relationships between magnesium fertilization, nitrogen uptake, development of yield components, and increase in final grain yield. Experiments with foliar application of cereals with magnesium sulphate showed a significant increase in magnesium and nitrogen accumulation in plants at harvest (Grzebisz, 2013). It is an essential element for both plants and people, and it is mostly found in the aminoacids cysteine and methionine, which contain sulphur. All of the methionine, which is necessary because humans are unable to synthesize it, and most of the cysteine, which is semi-essential since people can synthesize some of it, must come from plant or animal meals. A lack of sulphur can cause a range of illnesses, such as arthritis and joint stiffness. Humans require 1.1 g of (sulphur-containing amino acids) SAAs per kilogram for 70 kg body weight (Rose and Wixom, 1955). Although they can produce both of these SAAs, plants should be able to obtain enough sulphate of sulphur from the soil. For optimal S nutrition in plants and people, soils must be properly fertilized with sulphur. The sheer ignorance and lack of interest in secondary elements for plant nutrition is overwhelming.

Despite having so many vital roles these elements have compelled us to assess the role of sulphur and magnesium on growth, yield-defining parameters, and nutrient uptake in wheat crops. Magnesium has a diverse role in plant physiology which directly and indirectly affects the growth, yield, and seed quality. One of the well-known roles of magnesium is in the photosynthetic role along with the transportation of photosynthate to sink organs. Magnesium deficiency also reduces phloem loading and allocation of amino acids within plants (Cakmak *et al.,* 1994). The decrease in the assimilate transit from source leaves was attributed to either decreased sink demand for assimilates or impaired sucrose phloem loading (Cakmak and Kirkby, 2008; Verbruggen and Hermans, 2013; Mengutay *et al.,* 2013). Due to magnesium deficiency,the starch accumulation in wheat crops was hampered which caused deformed seed size and seed filling (Ceylan *et al.,* 2013).

Methods and Materials

Experimental Site

The study was performed in the rabi season of the year 2020-21 at the agricultural farm of Chandra Shekhar Azad University of Agriculture and Technology (CSAU&T), Kanpur, Uttar Pradesh, India (N 25° 26' and 26° 58' and E 79° 31' and 80° 34'). It is characterized bya subtropical zone having a semi-arid climate and average annual rainfall is 700 mm, with a mean sea level of 126 m a major portion of which is received during the monsoon season from the last week of June to the first week of October.

Experimental layout

They comprised nine treatments in a randomized block design. The plot size was 1×1 m^2 size with a plant-to-plant spacing of 22.5 cm. Three combinations of sulphur and magnesium were applied in the treatments. The sulphur three doses were S_0 (0 kg S ha^{-1}), S_1(20 kg S ha^{-1}) and S_3 (40 kg S ha^{-1}) soil application. The three levels of magnesium were M_0 (0 kg Mg ha^{-1}), M_1 (5 kg Mg ha^{-1}) and M_3 (10 kg Mg ha^{-1}). Through these three combinations, nine treatments were made with randomized block design (RBD). For nitrogen application urea and DAP (46 &18%) were used for phosphorus DAP (46%) applied, for potassium MOP (60%) was applied for sulphur elemental sulphur (60%) was used, and for magnesium $MgCl_2$ (12%) were used as a source of fertilizers. The basal doses of P& K were applied and three split applications of N were applied at basal, tillering, and jointing stages.

Soil samples collection, processing, and analysis

Initial soil samples were taken before initiation of the experiment. Soils were randomly collected using a sampler triplicate from each plot and made into a composite sample. The soil samples were air-dried well processed using a wooden hammer sieved through a 2mm sieve, and utilized to analyze the soil parameters. The soil was characterized by a sandy loam texture with soil pH 7.6,electrical conductivity (EC) 0.36 dSm^{-1}, organic carbon (Walkey and Black) 3.2 g kg^{-1},Available Nitrogen 169.4 kg ha^{-1}, available phosphorus 16.3 kg $ha^{-1}$and available potassium was 154.7 kg ha^{-1}.

Statistical analysis

Data were analyzed by using the statistical analysis system (SAS Institute Inc, 2002) customized by the Indian Agricultural Statistics Research Institute (IASRI), New Delhi, for split-plot design (Gomez and Gomez 1984). Pooled analysis was performed to study the effect of variations between the years and achieve consistency and homogeneity in the values. The least significant difference test was used at a 5% level of significance (*P*=.05) (Rangaswamy, 2018).

Results and Discussion

Growth parameters

Plant height being a key morphological characteristic reflects the interaction among the plant's genetic make-up, seedling vigour, and the environment in which it is grown. The growth parameters like plant height, number of tillers, number of ear plant$^{-1,}$ and ear length were all recorded as highest in the T_9 treatment. Control plots showed the lowest all the growth parameters in given treatments. The data about periodical plant height revealed that the highest doses of sulphur and magnesium resulted in the highest plant height at 30, 60, and 90 DAS with 15.38, 62.74, and 87.71 cm respectively. Treatment T_9 recorded staticallythe highest plant height followed by T_5 and the lowest plant height at 30, 60, and 90 DAS with 9.81, 38.81, and 66.31 cm was seen in the control plot (T_1) where only the recommended dose of NPK was applied. The number of tillers plant^{-1}highest in T_9 (6.83) followed by T_5 (5.84) and lowest in T_1 (Control) was (4.41), number of ears plant^{-1}highest in T_9 (6.03) followed by T_5 (5.97) and lowest in T_1 (Control) was (4.14) and ear length highest in T_9 (10.25 cm) followed by T_5 (9.75 cm) and lowest in T_1 (Control) was (7.13 cm).

Table 1. Effect of different doses of sulphur and magnesium on growth parameters in wheat crop

Treatment details		Plant height (cm) 30 DAS	60 DAS	90 DAS	No. of tillers	No. of ears/ Plant	Ear length (cm)
T_1	S_0Mg_0	9.81	38.81	66.31	4.41	4.14	7.13
T_2	S_1Mg_0	12.15	40.12	82.40	4.71	5.30	9.46
T_3	S_2Mg_0	12.75	43.56	84.30	4.95	5.46	9.56
T_4	S_0 Mg_1	13.40	45.68	84.46	5.81	5.50	9.51
T_5	S_1 Mg_1	14.23	58.46	86.71	5.84	5.97	9.75
T_6	S_2 Mg_1	13.64	48.62	84.63	5.66	5.62	9.60
T_7	S_0 Mg_2	13.83	50.23	85.73	5.73	5.70	9.63
T_8	S_1 Mg_2	14.05	53.78	85.75	5.73	5.74	9.66
T_9	S_2 Mg_2	15.38	62.74	87.71	6.83	6.03	10.25
SE (d)	0.062	0.56	0.084	0.022	0.012	0.019	
C.D. (P=.05)	0.132	1.24	0.180	0.482	0.026	0.041	

(S_0- 0 kg ha^{-1}, S_1- 20 kg ha^{-1}, S_2- 40 kg ha^{-1}, Mg_0- 0 kg ha^{-1}, Mg_1- 5 kg ha^{-1}, Mg_2-10 kg ha^{-1})

Table 2. Effect of sulphur and magnesium on yield and yield attributing characters in wheat crop

Treatment details		Ear weight (g)	No grain/ spike	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1	S_0 Mg_0	2.65	45.47	36.84	29.75	62.40
T_2	S_1 Mg_0	3.57	51.26	37.26	40.46	67.40
T_3	S_2 Mg_0	3.66	52.14	38.26	41.16	69.41
T_4	S_0 Mg_1	3.79	52.21	38.33	42.18	70.93
T_5	S_1 Mg_1	3.89	54.79	38.67	43.85	72.21
T_6	S_2 Mg_1	3.78	52.30	38.34	42.20	71.04
T_7	S_0 Mg_2	3.80	53.35	38.35	42.67	71.81
T_8	S_1 Mg_2	3.81	53.21	38.61	43.60	71.91
T_9	S_2 Mg_2	4.04	55.73	39.38	45.96	72.95
SE (d)	0.010	0.285	0.018	0.006	0.435	
C.D. (P=0.05)	0.022	0.609	0.039	0.013	0.931	

Yield attributing characters

Among the given treatments, the highest dose of sulphur and magnesium recorded maximum ear weight in T_9 (4.04 g) followed by T_5 (3.89 g) and minimum in T_1 (2.65 g).The number of grain spike^{-1} maximumin T_9(55.73) followed by T_5 (52.79) and minimum in T_1 (45.47). There was significant variation in test weight (g) among the treatments, the maximum test weight in T_9 (39.38 g) was followed by T_5 (38.67 g), and the minimum in T_1 (36.84 g) was recorded. The grain and straw yield were recorded significantly higher in T_9 (45.96 q ha^{-1}), (72.95 q ha^{-1}) followed by T_5 (42.20 q ha^{-1}), (71.40 q ha^{-1}) and lowest in the (T_1) control plot (29.75 q ha^{-1}), (62.40 q ha^{-1}).

Conclusion

This significantly increases the growth and yield of crops due to the combined effect of RDF and sulphur and magnesium. The synthesis of essential amino acids and proteins depends on sulphur, which also improves grain quality and plant health overall. On the other hand, magnesium plays a crucial role in photosynthesis and chlorophyll development, which affects the ability of plants to absorb solar radiation and convert it into energy. Understanding and implementing effective sulphur and magnesium management practices are integral components of a comprehensive strategy for maximizing wheat crop productivity, ensuring food security, and promoting sustainable agricultural practices.

Conflict of Interest: None

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