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Response of Wheat (*Triticum aestivum* L.) to Phosphorus and Sulphur Fertilization

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ABSTRACT

A field experiment was conducted on calcareous clayey soil at Junagadh (Gujarat) during rabi season of 2016-17 to study the effect of phosphate and sulphur fertilization on growth and yield of Wheat (Triticum aestivum L.). The experimental results revealed that application of 90 kg P_2O_5 ha^{-1} (P_3) recorded significant maximum plant height (85.2 cm) at harvest, effective tillers (85.7) and grain yield (4451 kg ha^{-1}) and straw yield (6886 kg ha^{-1}), which was found at par with P_2 (i.e. 60 kg P_2O_5 ha^{-1}). Application of 40 kg S ha^{-1} and it was found at par 20 kg S ha^{-1} and significantly increased grain yield by 28.13 and 15.95% and straw yield by 11.13 and 03.37% over the control (S_0). Significantly the maximum grain yield 4937 kg ha^{-1} was produced when wheat crop was fertilized with 90 kg P_2O_5 ha^{-1} + 40 kg S ha^{-1} (P_3S_2) which was remained statistically at par with treatment combinations of P_3S_1, P_2S_1, P_1S_2, and P_0S_2.

Key words: *Yield, Phosphorus, Sulphur, Interaction effect.*

INTRODUCTION

Globally, demand for wheat by the year 2020 is forecast at around 950 million tonns per year. This target will be achieved only, if global wheat production is increased approximately by 2.5 per cent per annum[1].

In India, it occupied an area of 300 lakh ha and production of 93.50 million tonnes and productivity of 3117 kg ha^{-1}. India will have to produce 105 million tonnes of wheat by 2020. In Gujarat, wheat is grown on an area of 10.24 lakh ha with total production of 29.44 lakh tons and productivity 2803 kg ha^{-1} [2]. In India, The highest productivity of wheat is recorded in Punjab, whereas Gujarat stands 6th rank with productivity of 2.8 t ha^{-1} [2]. Thus, wheat today has become not only the stable food of a large population of India but has also become the rays of hope for wardening off extensive starvation.

In Saurashtra region of Gujarat, most soil is medium black calcareous soil, having poor N and S status. Maneuvering the application of different fertilizers could increase the productivity of the wheat crop and the protein content. Comparatively lower productivity in Gujarat due to several constraints like lack of irrigation facilities, imbalanced use of fertilizers and lack of knowledge of modern agro techniques such as suitable genotypes, proper sowing time, seed rate, spacing, weed control, fertilization, plant protection measures *etc*.

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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. Sulphur is another one of the essential nutrient 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%. The critical limit of sulphur in plant is 0.20 - 0.25% where crop show sulphur deficiency and response to sulphur application. Element sulphur is not available to plants. Element sulphur oxidized in the form sulphate by soil micro-organisms, make available to the plant. Therefore, keeping these considerations in view, this experiment was undertaken.

MATERIAL AND METHODS

The present study was conducted throughout *rabi* season of 2016-17 at the College Farm, College of Agriculture, Junagadh Agricultural University, Junagadh to study Response of Wheat (*Triticum aestivum* L.**)** to of Phosphorus and Sulphur Fertilization on the Yield and Economics. The soil of the experimental plot was Silty Loam in texture and slightly alkaline in reaction with pH 8.10 and EC of 0.36 dS m^{-1}. The soil was low in available nitrogen (242 kg ha^{-1}), medium in available phosphorus (39.20 kg ha^{-1}), high in available potash (292 kg ha^{-1}) and medium in available sulphur (19.05 ppm).

The experiment was conducted in factorial randomized block design with total 12 treatment combination consisting of 4 levels of phosphorus *viz*., 0.00 kg ha^{-1} (P_0), 30.00 kg ha^{-1} (P_1), 60.00 kg ha^{-1} (P_2) and 90.00 kg ha^{-1} (P_3) and 3 levels of sulphur (0.00, 20.00 and 40.00 kg ha^{-1} as S_0, S_1 and S_2, respectively). These treatments were replicated three times. Recommended dose of nitrogen, phosphorus and potassium (N: P_2O_5: K_2O @ 120:60:60 kg ha^{-1} in the form of urea (46 % N), di-ammonium phosphate (46% P_2O_5 and 18% N) and muriate of potash (60% K_2O), 60 kg ha^{-1} nitrogen and full dose of P (as per treatments) and K were applied as basal application and rest 60 kg ha^{-1} nitrogen was applied at 30 days after sowing. Sulphur in form of Cosavet (90% S) was applied as per treatments.

RESULTS AND DISCUSSION

EFFECT OF PHOSPHORUS

The results revealed that different treatments of P manifested significant influence on growth and yield of wheat (Table 1). Application of 90 kg P_2O_5 ha^{-1} (P_3) recorded significant maximum plant height of 85.2 cm at harvest, which was found at par with P_2 (*i.e.* 60 kg P_2O_5 ha^{-1}). Yield attributes *viz*., number of effective tillers 11.15%, 7.9% and ultimately increased grain yield by 22.29 and 10.30% and straw yield by 14.46 and 08.85%, respectively by 90 kg P_2O_5 ha^{-1} (P_3) and P_2 (*i.e.* 60 kg P_2O_5 ha^{-1}) over the control (P_0). This might be due to higher amount of phosphorus application resulted in mobilization of native phosphorus to the extent that plant utilized more phosphorus from the native source. It is also fact that phosphorus involves in organic compound and essential in nitrogen metabolism resulting in higher utilization of nitrogen. Phosphorus attributed to the promoting effect of phosphorus in formation of lateral and fibrous roots which increase root proliferation and absorbing surface nutrients like N, P, K and S. This higher absorption capacity of nutrients tends to improve the content and uptake of nutrient in grain and straw. More protein synthesis in presence of phosphorus and formation of some stable phospho- protein compounds is responsible for higher protein content with phosphorus application; secondly the increase in protein content under these levels was going to higher N uptake by grain which resulted in higher protein content. These finding are in accordance with those reported by Laghari *et al*.[3], Paswan *et al.*[4], Saha *et al*.[5], Kumar *et al*.[6] and Chauhan *et al*.[7] in wheat crop.

EFFECT OF SULPHUR

Sulphur fertilization did influence growth and yield of wheat (Table 1). Significantly higher values of growth and yield attributes *viz*., plant height at harvest (85.0 cm), number of effective tillers (84.6 meter row length) and were registered with application of 40 kg S ha^{-1} and it was found at par 20 kg S ha^{-1} and significantly increased grain yield by 28.13 and 15.95% and straw yield by 11.13 and 03.37% over the control (S_0). An increase in different yield attributes and yields might be due to with sulphur application might be due to sulphur is a part of essential amino acid which helps in chlorophyll formation, photosynthetic process and activation of enzyme and seed formation. The greater photosynthetic activity and chlorophyll synthesis due to fertilization seemed to have promoted vegetative growth and ultimately higher yield. These result are in close conformity with those reported by Ganeshamurty *et al*.[8], Vyas *et al*.[9], Orman and Ok[10], Singh and Bhadoria[11], Khan *et al*.[12] and Kharub and Dhillon[13] in wheat crop.

INTERACTION EFFECT OF PHOSPHORUS AND SULPHUR

The interaction effect between phosphorus and sulphur levels found significant for grain yield (Table 2). Significantly the maximum grain yield 4937 kg ha^{-1} was produced when wheat crop was fertilized with 90 kg P_2O_5 ha^{-1} + 40 kg S ha^{-1} (P_3S_2) which was remained statistically at par with treatment combinations of P_3S_1, P_2S_1, P_1S_2, and P_0S_2. Significantly the lower grain yield of 2711 kg ha^{-1} was recorded under control treatment (*i.e.* P_0S_0). The results collaborate with the findings of Marok and Dev[14], Randhawa and Arora[15], Islam *et al*.[16] and Abdallah *et al*.[17] in wheat crop.

Table 1: Effect of phosphorus and sulphur on growth and yields of wheat

Treatments	Plant height at (cm) At harvest	Number of effective tillers (Meter row length)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Phosphorus (P_2O_5 kg ha^{-1})				
P_0- 0	76.8	77.1	3521	6016
P_1-30	78.7	78.6	3623	6242
P_2- 60	83.7	83.2	3994	6549
P_3- 90	85.2	85.7	4451	6886
S. Em. ±	2.17	2.28	163	216
C. D. (P = 0.05)	6.37	6.69	478	635
Sulphur (S kg ha^{-1})				
S_0- 0	77.2	77.0	3398	6127
S_1- 20	81.1	81.8	3940	6334
S_1- 40	85.0	84.6	4354	6809
S. Em. ±	1.88	1.98	141	187
C. D. (P = 0.05)	5.52	5.80	414	550

Table 2: Interaction effect of phosphorus and sulphur on grain yield

Levels of phosphorus	Levels of sulphur		
	S_0- 0	S_1- 20	S_2- 40
P_0- 0	2711	3574	4276
P_1-30	3287	3160	4422
P_2- 60	3881	4321	3779
P_3- 90	3711	4703	4937
S. Em. ±	282		
C. D. (P = 0.05)	828		

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