

Original Research Article

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## Effect of Phosphorus and Sulphur Fertilization on Yield and Quality of Wheat (*Triticum aestivum* L.)

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### ABSTRACT

#### Keywords

Yield, Quality, Phosphorus, Sulphur, Interaction effect, Wheat

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A field experiment was conducted on calcareous clayey soil at Junagadh (Gujarat) during rabi season, 2015-16 to study the effect of phosphorus and sulphur fertilization on yield and quality of Wheat (*Triticum aestivum* L.). The experimental results revealed that application of 90 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> (P<sub>3</sub>) recorded maximum No. of tillers (89.9), No. of grain spike<sup>-1</sup> (44.8), test weight (46.18 g), grain yield (4451 kg ha<sup>-1</sup>), straw yield (6886 kg ha<sup>-1</sup>) and protein content in grain (12.69 %) which was found at par with P<sub>2</sub> (60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>). Application of 40 kg S ha<sup>-1</sup> was found at par 20 kg S ha<sup>-1</sup> and significantly increased No. of tillers (88.6), No. of grain spike<sup>-1</sup> (43.1), test weight (45.78 g), grain yield (4354 kg ha<sup>-1</sup>), straw yield (6809 kg ha<sup>-1</sup>) and protein content in grain (12.08%). Combined application of 90 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> + 40 kg S ha<sup>-1</sup> (P<sub>3</sub>S<sub>2</sub>) recorded significantly maximum number of grains spike<sup>-1</sup> (47.33), test weight of (46.77 g) and grain yield (4937 kg ha<sup>-1</sup>) than the control (P<sub>0</sub>S<sub>0</sub>).

### Introduction

Globally, demand for wheat by the year 2020 is forecasted at around 950 million tonnes per year. This target will be achieved only, if global wheat production is increased approximately by 2.5 per cent per annum (Patel *et al.*, 2015)<sup>1</sup>. In India, it occupied an area of 300 lakh ha and production of 93.50 million tonnes and productivity of 3117 kg ha<sup>-1</sup>. 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<sup>-1</sup> (Anon., 2013)<sup>2</sup>. In

India, The highest productivity of wheat is recorded in Punjab, whereas Gujarat stands 6<sup>th</sup> rank with productivity of 2.8 t ha<sup>-1</sup> (Anon. 2013)<sup>2</sup>. Thus, today wheat has become not only the staple 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 is 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.

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. Element sulphur is not available to plants. Element sulphur is oxidized in the form sulphate by soil micro-organisms, make available to the plant. Therefore, keeping these considerations in view, this experiment was undertaken.

## Materials and Methods

The present study was conducted throughout *rabi* season of 2015-16 at the College Farm, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat) to study the Effect of Phosphorus and Sulphur Fertilization on Yield and Quality of Wheat (*Triticum aestivum* L.). 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<sup>-1</sup>. The soil was low in available nitrogen (242 kg ha<sup>-1</sup>), medium in available phosphorus (39.20 kg ha<sup>-1</sup>), high in

available potash (292 kg ha<sup>-1</sup>) 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<sup>-1</sup> (P<sub>0</sub>), 30.00 kg ha<sup>-1</sup> (P<sub>1</sub>), 60.00 kg ha<sup>-1</sup> (P<sub>2</sub>) and 90.00 kg ha<sup>-1</sup> (P<sub>3</sub>) and 3 levels of sulphur (0.00, 20.00 and 40.00 kg ha<sup>-1</sup> as S<sub>0</sub>, S<sub>1</sub> and S<sub>2</sub>, respectively).

These treatments were replicated three times. Recommended dose of nitrogen, phosphorus and potassium (N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O @ 120:60:60 kg ha<sup>-1</sup> in the form of urea (46 % N), di-ammonium phosphate (46% P<sub>2</sub>O<sub>5</sub> and 18% N) and muriate of potash (60% K<sub>2</sub>O), 60 kg ha<sup>-1</sup> nitrogen and full dose of P (as per treatments) and K were applied as basal application and rest 60 kg ha<sup>-1</sup> nitrogen was applied at 30 days after sowing. Sulphur in form of Cosavet (90% S) was applied as per treatments. The protein and nitrogen content in seeds was worked out by using the following analysis method.

## Protein content (%)

Protein content in grain was determined by multiplying nitrogen content in grain (%) by a factor 6.25 (Gassi *et al.*, 1973)<sup>3</sup>.

Protein content (%) = N content in grain (%) × 6.25

## Nitrogen content in grain

Estimation of nitrogen content in grain was carried out by micro Kjeldahl's method as described by A. O. A. C. (Anon., 1965)<sup>4</sup>. The uptake of nitrogen by grain was calculated with formula as given below:

$$\text{Nitrogen uptake by grain (kg ha}^{-1}\text{)} = \frac{\text{Nitrogen content in grain (\%)} \times \text{Grain yield (kg ha}^{-1}\text{)}}{100}$$

## Results and Discussion

### Effect of phosphorus

The results furnished that different treatment of phosphorus significant influenced on yield and quality of wheat (Table 1). Application of 90 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> (P<sub>3</sub>) recorded significantly maximum number of tillers (89.9), number of grains spike<sup>-1</sup> (44.8), test weight of (46.18 g), grain yield of (4451 kg ha<sup>-1</sup>), straw yield (6886 kg ha<sup>-1</sup>) and protein content of (12.69 %) which was remained at par with P<sub>2</sub> (i.e. 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>).

Yield attributes and yield *viz.*, increased number of tillers by 10.67 % and 8.21 % number of grains spike<sup>-1</sup> by 12.89 % and 8.12 %, test weight by 9.59 % and 5.21 %, grain yield by 26.41 % and 13.44 %, straw yield by 14.47 % and 8.86 % and protein content 18.83 % and 12.66 % respectively by 90 kg P<sub>2</sub>O<sub>5</sub>

ha<sup>-1</sup> (P<sub>3</sub>) and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> (P<sub>2</sub>) under the control (P<sub>0</sub>). Increase in yield attributes and yield with increase in the level of phosphorus is due to one of the important function of phosphorus is to increase the number of tillers in cereals. Phosphorus plays an important role in enzymatic reaction and metabolism which ultimately increase the total and effective tillers. Phosphorus is the important constituent and co-enzymes which are important for photosynthesis and protein synthesis. 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 results confirm the earlier finding of Khan *et al.*, (2007)<sup>5</sup>, Gaur and Singh (2010)<sup>6</sup>, Hussain *et al.*, (2011)<sup>7</sup> and Arshad *et al.*, (2016)<sup>8</sup>.

**Table.1** Effect of phosphorus and sulphur on yield and quality of wheat

Treatment	Number of tillers (Meter row length)	Number of grains spike <sup>-1</sup>	Test weight (g)	Grain yield (kg ha <sup>-1</sup> )	Straw yield (kg ha <sup>-1</sup> )	Protein content (%)
<b>Phosphorus (P<sub>2</sub>O<sub>5</sub> kg ha<sup>-1</sup>)</b>						
P <sub>0</sub> - 0	81.2	39.7	42.14	3521	6016	10.62
P <sub>1</sub> - 30	83.0	40.8	43.44	3623	6242	11.12
P <sub>2</sub> - 60	87.9	42.9	44.33	3994	6549	11.97
P <sub>3</sub> - 90	89.9	44.8	46.18	4451	6886	12.69
S.Em.±	2.32	1.13	0.76	163	216	0.30
C.D. at 5 %	6.82	3.33	2.23	478	635	0.88
<b>Sulphur (S kg ha<sup>-1</sup>)</b>						
S <sub>0</sub> - 0	81.1	39.9	42.44	3398	6127	11.03
S <sub>1</sub> - 20	86.8	43.0	43.85	3940	6334	11.64
S <sub>2</sub> - 40	88.6	43.1	45.78	4354	6809	12.08
S.Em.±	2.01	0.98	0.66	141	187	0.26
C.D. at 5 %	5.91	2.88	1.93	414	550	0.77
<b>Interaction (P×S)</b>						
S.Em.±	4.03	1.96	1.32	282	375	0.52
C.D. at 5 %	NS	5.76	3.86	828	NS	NS
C.V. %	8.16	8.09	5.18	12.55	10.11	7.80

**Table.2** Interaction effect of phosphorus and sulphur on number of grains spike<sup>-1</sup>

Levels of phosphorus	Levels of sulphur		
	S <sub>0</sub> - 0	S <sub>1</sub> - 20	S <sub>2</sub> -40
P <sub>0</sub> - 0	39.33	41.33	38.33
P <sub>1</sub> - 30	42.67	39.33	40.33
P <sub>2</sub> - 60	37.33	44.67	46.67
P <sub>3</sub> - 90	40.00	47.00	47.33
S.Em.±		1.96	
C.D. at 5 %		5.76	

**Table.3** Interaction effect of phosphorus and sulphur on test weight

Levels of phosphorus	Levels of sulphur		
	S <sub>0</sub> - 0	S <sub>1</sub> - 20	S <sub>2</sub> -40
P <sub>0</sub> - 0	38.08	42.47	45.87
P <sub>1</sub> - 30	40.40	43.62	46.30
P <sub>2</sub> - 60	45.60	43.20	44.20
P <sub>3</sub> - 90	45.67	46.10	46.77
S.Em.±		1.32	
C.D. at 5 %		3.86	

**Table.4** Interaction effect of phosphorus and sulphur on grain yield

Levels of phosphorus	Levels of sulphur		
	S <sub>0</sub> - 0	S <sub>1</sub> - 20	S <sub>2</sub> -40
P <sub>0</sub> - 0	2711	3574	4276
P <sub>1</sub> - 30	3287	3160	4422
P <sub>2</sub> - 60	3881	4321	3779
P <sub>3</sub> - 90	3711	4703	4937
S.Em.±		282	
C.D. at 5 %		828	

### Effect of sulphur

The results showed that different levels of sulphur manifested their significant influence on yield and quality of wheat (Table 1). Significantly maximum number of tillers (88.6), number of grains spike<sup>-1</sup> (43.1) test weight of (45.78 g), grain yield of (4354 kg ha<sup>-1</sup>), straw yield (6809 kg ha<sup>-1</sup>) and protein content of (12.08 %) were registered with application of 40 kg S ha<sup>-1</sup> (S<sub>2</sub>) and it was found at par 20 kg S ha<sup>-1</sup> (S<sub>1</sub>). Significantly

increased number of tillers by 9.14 % and 6.88 %, number of grains spike<sup>-1</sup> by 8.37 % and 8.16 %, test weight by 7.89 % and 3.32 %, grain yield by 28.14 % and 15.96 %, straw yield by 11.12 % and 3.38 % and protein content by 9.44 % and 5.51 % respectively by 40 kg S ha<sup>-1</sup> (S<sub>2</sub>) and 20 kg S ha<sup>-1</sup> (S<sub>1</sub>) under the control (P<sub>0</sub>). It might be due to the fact that sulphur is a part of essential amino acids 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. Sulphur supply affects the utilization of the available nitrogen by crop. Since, nitrogen and sulphur are required for the synthesis of proteins; the ratio of total N to total S in plant tissue has a direct bearing on protein synthesis. These result are in close conformity with those reported by Orman and Ok (2012), Singh and Bhadoria (2013), Khan *et al.*, (2015), Kharub and Dhillon (2007), Palsaniva and Ahlawat (2007), Manchanda *et al.*, (2011), Singh and Singh (2016) and Podlesna and Pietrzak (2008) in wheat crop.

### **Interaction Effect of Phosphorus and Sulphur**

The perusal of data presented in (Table 2, 3 and 4) clearly indicate that Interaction effect of between phosphorus and sulphur were found significant with respect to number of grain spike<sup>-1</sup>, test weight and grain yield. Combined Application of 90 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> + 40 kg S ha<sup>-1</sup> (P<sub>3</sub>S<sub>2</sub>) recorded maximum number of grain spike<sup>-1</sup> (47.33) and remained at par with P<sub>3</sub>S<sub>1</sub>, P<sub>2</sub>S<sub>2</sub>, P<sub>2</sub>S<sub>1</sub> and P<sub>1</sub>S<sub>0</sub>. Significantly the minimum number of grains spike<sup>-1</sup> (38.33) was recorded under treatment combination P<sub>0</sub>S<sub>2</sub>. Wheat crop was fertilized with 90 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> + 40 kg S ha<sup>-1</sup> (P<sub>3</sub>S<sub>2</sub>) produced bold size grain which recorded maximum test weight of 46.77 g and it was remained statistically on same bar with treatment combinations of P<sub>3</sub>S<sub>1</sub>, P<sub>3</sub>S<sub>0</sub>, P<sub>2</sub>S<sub>2</sub>, P<sub>2</sub>S<sub>1</sub>, P<sub>2</sub>S<sub>0</sub>, P<sub>1</sub>S<sub>2</sub>, P<sub>1</sub>S<sub>1</sub> and P<sub>0</sub>S<sub>2</sub>. Significantly minimum test weight of (38.08g) was noted under treatment combination of P<sub>0</sub>S<sub>0</sub>. Significantly the maximum grain yield (4937 kg ha<sup>-1</sup>) was produced when wheat crop was fertilized with 90 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> + 40 kg S ha<sup>-1</sup> (P<sub>3</sub>S<sub>2</sub>) which was remained statistically at par with treatment combinations of P<sub>3</sub>S<sub>1</sub>, P<sub>2</sub>S<sub>1</sub>, P<sub>1</sub>S<sub>2</sub>, and P<sub>0</sub>S<sub>2</sub>. Significantly the lower grain yield of (2711 kg ha<sup>-1</sup>) was recorded under

control treatment (P<sub>0</sub>S<sub>0</sub>). It might be because phosphorus and sulphur are being absorbed as anions and have a synergistic effect on each other. The results collaborate with the findings of Marok and Dev (1980), Randhawa and Arora (2000), Islam *et al.*, (2006) and Abdallah *et al.*, (2013) in wheat crop.

In conclusion based on the results of one year field investigation, it seem quite logical is conclude that application of phosphorus @ 90 kg ha<sup>-1</sup> and application of sulphur @ 40 kg ha<sup>-1</sup> recorded the highest No. of tillers, No. of grain spike<sup>-1</sup>, test weight, grain yield, straw yield and protein content in grain which were significantly superior over their respective lower levels.

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