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Effect of levels and sources of sulphur on growth, yield, economics and quality of rice (*Oryza sativa* L.) under partially reclaimed Sodic soil

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Abstract
The experiment was conducted at the Instructional Farm of N. D. University of Agriculture & Technology, Kumarganj, Faizabad (U.P.) during *Kharif* season of 2015-2016. The experiment comprises ten treatments *viz*. 100% NPK (150:60: 40: kg ha^{-1}), 100% NPK+ 75% S through SSP, 100% NPK+ 100% S through SSP, 100% NPK + 125% S through SSP,100% NPK + 75% S through Phospho Gypsum, 100% NPK + 100% S through Phospho Gypsum, 100% NPK + 125% S through Phospho Gypsum, 100% NPK + 75% S through Sulphur Bentonite, 100% NPK + 100% S through Sulphur Bentonite and 100% NPK + 125% S through Sulphur Bentonite replicated thrice in Randomized Block Design. Rice variety Sarjoo-52 was taken for experimentation. The data revealed that growth parameters *viz*. plant height, no. of tillers per running meter and leaf area index were found significantly superior over other treatments with the application of 100% NPK + 125% S through SSP. The maximum benefit: cost ratio was obtained in plot treated with 100% NPK + 100% S through SSP followed by 100% NPK + 125% S through SSP, respectively.

Keywords: Bentonite, phosphogypsum, rice, sulphur

1. Introduction
Rice (*Oryza sativa* L.), belonging to the family Poaceae (Gramineae) is the most staple food crop of the world. It is the rich source of energy that contains reasonable amount of protein (6-10%), carbohydrate (70-80%), mineral (1.2-2.0%) and vitamins. More than 90 per cent of the world's rice is grown and consumed in Asia (rice bowl of the world), where 16 per cent of the earth's people and two third of world's poor. According to (FAO 2014) global statistically data, the worldwide production of rice 719.74 million tonnes with acreage of 160.6 mha of production of 475.5 mt. In India it is cultivated over an area of about 43.9 mha with an annual production 106.10 mt (Anonymous 2015) [2]. Uttar Pradesh is the largest rice growing state after west Bengal where it is grown over an area of 5.964 mha and production of 12.91 mt with 1862 kg ha^{-1} average productivity.

The present situations indicate that our population would be 1.5 billion (of the world population of 11 billion) by 2050. Rising population and per capita increase are pushing up the demand, which needs to be met through enhanced productivity per unit area, input and time. The annual increase in demand in India is estimated to be 2.6 millions tones in rice. The 10th plan has targeted growth rate of 4% plus in agriculture. This demands a concerted material effort considering that the food grain growth rate was only 1.95 per cent during the 10th plan. Sulphur has vital metabolic function in plants; it is required for synthesis in the form of sulphur containing amino acids (cystine, Cystein and methionine) *i.e*. essential components of proteins. Sulphur is absorbed by plants in the form of sulphate (SO_4^{2-}) ion. Sulphur is an fourth essential plant nutrient after N, P and K and the third most widely deficient nutrient (Tondon, 2011) [12]. It plays pivotal role in oil and protein synthesis. Besides its contribution in greater proportion in synthesis of sulphur containing amino acid *i.e.* (methionine, cysteine and cystine), vitamins like thiamine and biotin, iron-sulphur protein compex-ferrodoxin, sulphur glycosides and co-enzyme-A. About 2 per cent of the organic sulphur in the plant is present in the water soluble thiol (-SH) fraction, and under normal conditions tripeptide glutathione accounts nearly for more than 90% of this fraction. Sulphur requirement for optimal growth varies between 0.1 and 0.5% on dry weight basis of plants and its relative requirement increases in the order of graminae <leguminoceae <cruciferae.

Materials and Methods

The present experiment was conducted at Student Instructional Farm Department of Soil Science and Agril. Chemistry, N.D. University of Agriculture and Technology Kumarganj, Faizabad U.P. (India).It is located at 24.4^0 to 26.5^0 N latitude, 82.12^0 to 83.98^0C E longitude and at an altitude 113 m above the mean sea level in the Indo-Gangetic plains of central Uttar Pradesh. The experiment was carried out under Randomized Complete Block Design comprising of 7 treatments with 3 replications *i.e.*,100% NPK (150:60: 40: kg ha^{-1}), 100% NPK+ 75% S through SSP, 100% NPK+ 100% S through SSP, 100% NPK + 125% S through SSP,100% NPK + 75% S through Phospho Gypsum, 100% NPK + 100% S through Phospho Gypsum, 100% NPK + 125% S through Phospho Gypsum, 100% NPK + 75% S through Sulphur Bentonite, 100% NPK + 100% S through Sulphur Bentonite and 100% NPK + 125% S through Sulphur Bentonite during the year 2015-16. The soils of experimental field was silty loam in texture, alkaline in reaction (pH 8.43), deficient in organic carbon (0.30%), low in available nitrogen (170 kg/ha) and the available sulphur (8.90 ppm) medium in available phosphorus (14.20kg/ha) and available potash (228.10kg/ha). Rice variety Sarjoo-52 was sowing for the nursery on June 22, 2015 and harvested November 14, 2015.

Observations to be recorded

Plant height (cm)

The Plant height at 30, 60, 90 DAT and at harvest was recorded on five hills located at different places in the plot. The height of individual hill was recorded with the help of meter scale from base of the plant to the tip of the tallest plant part and averaged.

Number of tillers hill^{-1}

The number of tillers hill^{-1} were counted randomaly at 30, 60, 90 DAT and at harvest from the selected five places and averaged in per running meter.

Leaf area index (%)

The total numbers of leaves of two hills were divided into three groups and measured the length and broadest width of each group. The leaf area was calculated by multiplying this area to number of leaves in each group with the factor. This factor is determined on the basis of actual area measured by leaf area meter and recorded by above method. After calculating total leaf area, it was divided by ground area in order to get leaf area index. The LAI was recorded two times during the course of investigation of crop at 60 & 90 DAT. This was calculated according to the following formula as mentioned

$$\text{LAI} = \frac{\text{Leaf area (cm}^2\text{)}}{\text{Ground area (cm}^2\text{)}}$$

Number of panicles hill^{-1}

Number of panicles hill^{-1} was counted at 90 days after transplanting.

Length of panicles (cm)

Five panicles were randomly selected from each plot. The length of panicle was measured in cm with the help of meter scale and averaged.

Test weight (g)

The sample comprising of 1000 grains were counted irrespective of shape and size from each plot and weight of 1000 grains were recorded (g) and expressed as the test weight at 14% moisture.

Grain yield (q ha^{-1})

After taking the bundles weight of the harvested produce of each net plot, their grains were separated manually. The grains of each plot thus obtained were air-dried, weighed and recorded in kg per plot. Finally it was converted into q ha^{-1} at 14% moisture by multiplying with conversion factor.

Straw yield (q ha^{-1})

Straw yield was recorded from each plot by subtraction the grain yield from the biological yield and expressed in q ha^{-1}.

Harvest index (%)

Harvest index of each experimental plot was calculated with the help of following formula:

$$H.I\ (\%) = \frac{\text{Grain Yield (q/ha)}}{\text{Total Biological Yield (q/ha)}} \times 100$$

Result and Discussion

Growth characters

All the crop growth characters were significantly influenced by application of sulphur (Table 1.0). Rice plant height is one of the important growth and development indicators. The growth character like plant height at 30, 60, 90 DAT and at harvest stage of crop growth was significantly affected due to sulphur application.

Table 1: Effect of levels and sources of sulphur on growth characters of rice

Treatments	Plant height (cm)				Number of tillers per running meter				LAI (%)	
	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	60 DAT	90 DAT
(T_1):100% NPK (150: 60: 40kg ha^{-1})	37.34	56.68	71.21	72.99	44.85	75.97	76.24	75.20	3.57	5.42
(T_2):100% NPK + 75% S through SSP	40.32	68.22	78.67	80.05	50.48	85.43	87.68	87.60	3.65	5.67
(T_3):100% NPK + 100% S through SSP	43.10	76.48	85.10	86.88	54.64	96.63	96.60	95.60	3.87	5.92
(T_4):100% NPK + 125% S through SSP	43.45	77.17	85.80	86.88	56.54	98.23	98.89	97.56	3.90	5.95
(T_5):100% NPK + 75% S through Phospho Gypsum	41.18	65.75	74.98	76.76	48.96	79.39	82.34	82.04	3.61	5.57
(T_6):100% NPK + 100% S through Phospho Gypsum	42.88	74.79	82.05	83.53	53.50	91.05	93.16	91.88	3.78	5.87
(T_7):100% NPK + 125% S through Phospho Gypsum	43.32	75.39	82.64	85.42	54.39	92.64	93.88	93.10	3.80	5.89
(T_8):100% NPK + 75% S through Sulphur Bentonite	39.12	64.40	73.54	75.32	46.31	76.50	77.60	76.92	3.42	5.48
(T_9):100% NPK + 100% S through Sulphur Bentonite	42.11	72.43	79.27	80.75	50.37	87.35	89.12	89.00	3.63	5.62
(T_{10}):100% NPK + 125% S through Sulphur Bentonite	42.47	72.78	79.98	81.86	51.88	88.36	89.45	87.75	3.65	5.64
SEm±	0.79	1.35	2.11	2.13	1.46	3.61	3.80	3.56	0.07	0.11
C.D. (P=0.05)	2.34	4.00	6.50	6.58	4.35	10.74	10.72	10.34	0.21	0.32

Apparently, the tallest plant was observed in, T_4 which was significantly superior to T_1, T_2, T_5, T_8 and at par with all other treatments. The number of tiller per running meter was appreciably increased due to addition of sulphur particularly when used at the recommended rate. The maximum numbers of tillers per running meter (56.54, 89.33 and 98.23) were found in 100% NPK + 125% S through SSP (T_4), which was at par with T_3, T_6, T_7 and significantly superior over all other treatments at 30, 60 and 90 DAT crop growth. At harvest stage the highest number of tillers per running meter (100.71) was recorded due to T_4 which was significantly superior over T_1, T_2, T_5, T_8, T_9 and at par with all other treatments. Application of sulphur influences leaf area index (LAI) significantly. LAI was improved with advancement of growth stage at 60 and 90 DAT. The maximum leaf area index (3.90 and 5.95%) were noticed with T_4, which was at par with T_3, T_6, T_7 and significantly superior than rest of the treatments at 60 and 90 DAT of crop growth. The increase in growth characters like, plant height, number of tillers per running meter and leaf area index under sulphur treatments may be due to its effected in the metabolism of growing plants which may effectively explain the observed response of sulphur application. It enters in the biosynthesis of protein, chlorophyll, enzyme, co-enzymes and certain alkaloids either as constituent or as an activator or co-factor including positive shift in the metabolism of plant. Similar findings were also reported by Sriramchandra sekharan *et al*. (2014).

Growth and yield attributes

Amongst the yield and yield components resulted from vegetative growth and development, the question as to whether an increment of a plant nutrient with results in a yield increase or not depend on the original nutrient level to which this increment is added. Yield attributes in this study comprised of the number of panicle per hill, length of panicle, test weight of grain, grain yield, straw yield and harvest index (Table- 4.4 and 4.5). Yield and yield attributing characters were significantly enhanced by sulphur application except test weight of grain and harvest index of rice crop.

The number of panicle per hill, which contributes to the economic yield, significantly influenced with sulphur application. The number of panicle per hill of rice crop was significantly increased at T_4, which was at par T_3, T_6, T_7, T_9, T_{10}. Panicle length responded significantly to sulphur application. The maximum length of panicle (24.68cm) was noted due to T_4, which was at par with T_3 and significantly superior over all other treatments. Sulphur application did not show definite trend on test weight of grain and harvest index. However, maximum test weight of grain and harvest index was noted with 100% NPK + 125% S through SSP (T_4) and minimum in untreated plot (T_1).

The grain and straw yield was significantly affected due to application of sulphur. The highest grain and straw yield (48.87 and 72.28 q ha^{-1}) were obtained in T_4, which was at par with T_3, T_7 and significantly higher over all other treatment. The increase in yield was mainly due to enhanced rate of photosynthesis and carbohydrate metabolism as influenced by sulphur application. It might be due to the application of sulphur which provides better condition for the development of crop due to improved physico-chemical properties of soil, better nutrients uptake and growth by crops. These results were enclose conformity with the finding of Liu *et al.* (1992) [6], Malarvizhi *et al.* (1993) [7], Biswas *et al.* (2004) [3], Varghese *et al.* (2006) [14], Manivannan *et al.* (2007) [8], Tang *et al.* (2009) [13], Shamim *et al.* (2010) [10], Kumar *et al.* (2014) [5] and Dubey *et al.* (2016) [4]

Table 2: Effect of levels and sources of sulphur on yield contributing parameter of rice

Treatments	No. of panicle per hill	Length of panicle (cm)	Test weight (gm)	Seed yield (q ha^{-1})	Straw yield (qha^{-1})	Harvest Index (%)
(T_1):100% NPK (150: 60:40kg ha^{-1})	7.60	20.18	20.05	39.83	61.73	39.22
(T_2):100% NPK + 75% S through SSP	8.54	22.39	20.78	43.12	65.13	39.83
(T_3):100% NPK + 100% S through SSP	9.66	24.68	21.02	46.95	69.48	40.32
(T_4):100% NPK + 125% S through SSP	9.82	25.07	21.12	48.87	72.28	40.34
(T_5):100% NPK + 75% S through Phospho Gypsum	7.94	20.38	20.42	42.01	63.85	39.68
(T_6):100% NPK + 100% S through Phospho Gypsum	9.11	21.28	20.45	44.07	66.98	39.68
(T_7):100% NPK + 125% S through Phospho Gypsum	9.26	23.67	20.98	47.89	71.83	40.00
(T_8):100% NPK + 75% S through Sulphur Bentonite	7.65	19.65	20.22	41.80	63.95	39.53
(T_9):100% NPK + 100% S through Sulphur Bentonite	8.74	22.45	20.42	43.55	66.19	39.68
(T_{10}):100% NPK + 125% S through Sulphur Bentonite	8.84	22.70	20.30	45.09	68.53	39.68
SEm±	0.37	0.43	088	1.18	0.98	2.09
C.D. (P=0.05)	1.09	1.27	NS	3.47	2.91	NS

Quality Parameter

The protein contents of rice grain were significantly increased due to the application of different levels and sources of sulphur (Table-3.0). The highest protein content (8.0%) in grain was obtained in treatment T_4, which was significantly higher than T_1, T_2, T_5, T_8 & T_9 and statistically at par with T_6, T_7 and T_{10} respectively. The role of sulphur is well known in improving the quality and quantity of protein by increasing sulphur bearing amino acids like cysteine, cystine and methionine, which are essential for synthesis of protein. These results are in agreement with the findings of Malarvizhi *et al.* (1993) [7], Tang *et al.* (2009) [13] and Kumar *et al*. (2014) [5].

Economics of various treatments

The highest total cost of cultivation were recorded due to T_4 (100% NPK + 125% S through SSP), followed by T_3 (100% NPK + 100% S through SSP) but lower in untreated plots (T_3).Amongst the different levels and sources of sulphur, gross return and net return were maximum at T_4 followed by T_7 were as minimum with absolute control (T_1).

Table 3: Effect of levels and sources of sulphur on economics of various treatments.

Treatments	Cost of cultivation Rs./ha	Gross income Rs./ha	Net income Rs./ha	Benefit Cost Ratio
(T_1):100% NPK (150: 60: 40kg ha^{-1})	34304	61186	26882	0.78
(T_2):100% NPK + 75% S through SSP	35352	66757	31405	0.89
(T_3):100% NPK + 100% S through SSP	35705	72594	36889	1.03
(T_4):100% NPK + 125% S through SSP	36050	75560	39510	1.10
(T_5):100% NPK + 75% S through Phospho Gypsum	34823	65065	30242	0.87
(T_6):100% NPK + 100% S through Phospho Gypsum	34998	68256	33258	0.95
(T_7):100% NPK + 125% S through Phospho Gypsum	35164	74110	38946	1.11
(T_8):100% NPK + 75% S through Sulphur Bentonite	34397	64767	30370	0.88
(T_9):100% NPK + 100% S through Sulphur Bentonite	34428	67450	33022	0.96
(T_{10}):100% NPK + 125% S through Sulphur Bentonite	34460	69835	35375	1.03
(T_1):100% NPK (150: 60: 40kg ha^{-1})	34304	61186	26882	0.78

However, benefit: cost ratio were highest with T_7 followed by T_4 and lowest in treatment T_1 (100% NPK). This might be due to difference in cost of cultivation and gross return. The results proved by the similar finding of Rahman *et al.* (2007) [9].

Conclusion

The application of 100% NPK + 125% S through SSP gave significantly higher response on growth, yield and quality of rice crop. The maximum cost of cultivation, gross return, net return and benefit: cost ratio was observed due to 100% NPK along with 125% S through SSP.

Based on experimentation the application of 100% NPK along with 125% S through SSP has been recommended to the farmers of Eastern Uttar- Pradesh for profitable cultivation of rice crop especially in partially reclaimed Sodic soil during *Kharif* season.

Reference

1. AOAC. Association on official Agril. chem. official method of analysis, P B 540, Benjmin franklin station, Washington-4 D.C, 1970.
2. Anonymous. Press Information Bureau Government of India Ministry of Agriculture & Farmers Welfare, 2015.
3. Biswas BC, Sarkar MC, Tanwar SPS, Das S, Kalwe SP. Sulphur deficiency in soils and crop response to fertilizer sulphur in India. Fertilize News. 2004; 49(10):13-18, 21-28:31-33.8.
4. Dubey SD, Tiwari DD, Pandey SB, Singh UN, Katiyar NK. Effect of nitrogen, sulphur and zinc application on yield, nutrient uptake and quality of rice. Indian Society of Soil Science. 2016; 13(4):0972-3226.
5. Kumar Rakesh, Lal JK, Kumar, Arvind, Agrawal BK, Karmakar S. Effect of different source and level of sulphur on yield, S uptake and protein content in rice and pea growth in sequence on analfisol. Journal of the Indian society of soil science. 2014; 62:140-143.
6. Liu CQ, Wu XJ, Cao SQ. Sulphur status and crop response in paddy soils of China. International symposium paddy soils, Nanjing, China. 1992; 9:214-221
7. Malarvizhi P, Subramanian S, Gopalswamy A. Effect of sulphur sludge on nutrient availability, yield and quality of rice in red soil of Periyar-Vaigai command area. Red and Lateric Soils of India - resource Appraisal and management. 1993; 11:299-303
8. Manivannan R, Sriramachandrasekharan MV, Ravichandran M. Genotype differences of rice for yield and nutrient uptake due to sulfur fertilization. Advances in Plant Science. 2007; 20(2):585-587.5
9. Rahman MN, Islam MB, Sayem SM, Rahman MA, Masud MM. Effect of different rates of sulphur on the yield and yield attributes of rice in old Brahmaputra floodplain soil. Journal of Soil and Nature. 2007; 1(1):22-26.9.
10. Shamim AHM, Khan MHR, Akae T. The effectiveness of sulfidic materials as a source of sulfur fertilizer for the production of rice in two sulfurdeficitsoils. Songklanakarin Journal of Science and Technology. 2010; 32(6):643-652, 32.
11. Sriramachandrasekharan MV, Bhuvaneswari R, Ravichandran M. Integrated use of organics and sulphur on the rice yield and sustainable soil health in sulphur deficientsoil. Plant Archives. 2004; 4(2):281-286.10
12. Tondon HLS. Sulphur in soils, crops and fertilizers-from research to practical application. (Development and Consultation organization, New Delhi, India), 2011.
13. Tang Hai Tao, Ma Guo Hui, Liao Yu Lin, Tang Hai Ming, Tang Rui. Effects of soil nutrient elements on rice qualities (Chinese). Research of Agricultural Modernization. 2009; 30(6):735-738.12.
14. Varghese M, Varghese Kins, Singh SS. Effect of differentlevels and sources of sulphur on growth yield and grain quality of basmati rice cv. Pusa basmati-2. Agril. Science digest. 2006; 26(1):45-49.
15. Walkley A, Black JA. An examination of Degtzariff method for determination of soil organic matter and proposed modification of chromic acid titration method. Soil Sci. 1934; 37:29-38.