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Sulphur Application in Rice Blackgram Cropping System – Changes in Yield, Economics and Post Harvest Quality

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Abstract

Field experiment was conducted during *kharif* 2006 and *rabi* 2006-07 in Sulphur (S) deficient clay soil of the Research Farm of Directorate of Rice Research, Rajendranagar, Hyderabad with the objective of applied, residual and cumulative effect of Sulphur on rice-blackgram cropping system. The experiment was conducted in split plot design with three replications. The main plot treatments included 2 fertilizer schedules and subplot treatments were 4 S schedules. The results revealed that in rice, recommended fertilizer dose (RFD) has given significantly higher grain yield of (5.20 t/ ha) over half the RFD (4.70 t/ha). Among the sulphur schedules, Sulphur application in *kharif* has given maximum grain yield (5.56 t/ha) followed by Sulphur application in both *kharif* and *rabi* seasons (5.23 t/ha). Straw yield showed similar trend as that of grain yield at fertilizer levels and S schedules. Blackgram has given maximum seed yield (1.8 t/ha) with RFD applied in *kharif*. Among the S schedules, application in *kharif* or *rabi* or both *kharif* and *rabi* resulted in significantly higher seed yield. Stalk yield was significantly high with S application in both *kharif* and *rabi* at both fertilizer levels. Rice equivalent yield was maximum with RFD (10.14 t/ha). S application in *kharif* (10.31 t/ha) followed by S application in both *kharif* and *rabi* (10.14 t/ha) recorded higher yields. Economics have shown that, gross returns obtained were high with RFD+S application in both *kharif* and *rabi*. Net returns were high with RFD + S application during *kharif* season. In S deficient clay soil, S application significantly increased the productivity of rice-blackgram cropping system.

Key words: Sulphur, cropping system, rice, blackgram, rice equivalent yield, economic return

Introduction

Sulphur is considered as the fourth major nutrient for crops (Platou and Jones, 1982). It is a critical nutrient for crop growth, and it's deficiency is accentuated in soils of the tropics by intensive agricultural practices, less use of organic manures, removal of crop residues and leaching of Sulphur by heavy rains (Yadvinder Singh *et al*., 2005). Deficiency is also caused by absence of Sulphate containing fertilizers, low Sulphur content in irrigation water, rain water and soil condition. As a result of leaching and lack of replenishment of the nutrients lost, soils of the tropical region are either inherently deficient in Sulphur or are likely to become more deficient due to continuous cropping. Sulphur deficiency in soil adversely affects not only the crop yields but also the nutritional quality of the crop. Sulphur deficiency is common in crop rotations including pulses and oil seeds.Sulphur contributes to an increase in crop yields in three different ways as it provides a direct nutritive value; it provides indirect nutritive value as soil amendment; it improves use efficiency of other essential plant nutrients, particularly nitrogen and phosphorus. To augment the production of legume crops, S may be identified as a key element and fertilizer S must form part of the integrated management program. Hence present study was conducted with the objective of applied, residual and cumulative effect of Sulphur on rice-blackgram cropping system.

Materials and Methods

Field experiment on rice pulse system was conducted during *kharif* and *rabi* seasons of 2008-09 in the research farm of Directorate of Rice Research. The soil is clayey in texture with a pH of 8.28 and EC of 0.665 dsm-1. The organic carbon content was 0.56 %.The available N, P_20_5 and K_2O status of the soil were 314, 109 kg/ ha respectively. The soil was deficient in available Sulphur (8.32 ppm). The main plot treatments included 2 fertilizer schedules (F1-RFD (Recommended Fertilizer Schedule-100:50:50 NPK); F2 -Half the RFD); 4 S Schedules as subplot treatments (S1 No sulphur; S2 Sulphur during *kharif* ; S3 Sulphur during *rabi*; S4 Sulphur during *kharif* and *rabi*). The experiment was laid out in split plot design with three replications. The fertilizer levels of N, P_2O_5 and K_2O were as per the general recommendation (120:60:40). Sulphur was applied as per the treatments @ 30 kg/ha as Ammonium Sulphate. Half the dose of Nitrogen as Ammonium Sulphate and full

dose of P_2O_5 and K_2O as diammonium phosphate, and K_2O as muriate of Potash, was applied basically. The balance N was applied in two equal splits at maximum tillering and panicle initiation stage in the form of urea. During *rabi* season blackgram was sown by using residual moisture and nutrients except S treatments. All the other cultural operations were followed as per the package of practices to rice and blackgram crops then and there.

The available Sulphur was estimated colorimetrically using soil extraction with 0.15% $CaCl_2$ solution (Williams and Steinbergs, 1959). The grain yields were recorded and analysed statistically. Economics including cost and returns were calculated.

Results and Discussion

Yield

Recommended Fertilizer Schedule of 120:60:40 has given significantly higher grain yield of (5.20 t/ha) over half the recommended dose (4.70 t/ha) Table 1. Among the sulphur schedules, Sulphur application in *kharif* has given maximum grain yield (5.56 t/ha) followed by Sulphur application in both *kharif* and *rabi* seasons (5.23 t/ha). The interaction of fertilizer levels and sulphur treatments were significant. Straw yield showed similar trend as that of grain yield at fertilizer levels and S schedules except that interactions were not significant. Though the visual deficiency symptoms were not appeared due to hidden hunger, there is apparent increase in growth and yield. The influence of Sulphur application on the rice yield was well explained by (Clarson and Ramaswami, 1992). Nambiar and Ghosh (1984) reported similar results in S deficient soils of Barrackpore where S application increased paddy yield by (1.2 t/ha).

Blackgram has given maximum seed yield of (1.8 t/ha) with RFD applied in *kharif*. Among the S schedules, application in *kharif* or *rabi* or both *kharif* and *rabi* resulted in significantly higher seed yield than no Sulphur plot. Interactions were found to be significant. Stalk yield was significantly high with S application in both *kharif* and *rabi* at both fertilizer levels and interactions were not significant. Table 1. Aulakh and Pasricha (1986) also demonstrated that application of Sulphur containing phosphrous fertilizer gave an extra yield over S free nitrogen and phosphorus fertilized plots.

Rice equivalent yield was maximum with RFD (10.14 t/ha). S application in *kharif* (10.31 t/ha) followed by S application in both *kharif* and *rabi* (10.14 t/ha) recorded higher yields. Interactions were significant (Table 1).

Economics

The cost of cultivation was high (Rs. 28,612/-) in the treatment with RFD + S application in both *kharif* and *rabi* seasons and low in treatment with half the recommended dose +No S application (Rs. 176,00/-). Gross returns obtained were high with RFD + S application in both *kharif* and *rabi*. Net returns were high with RFD+ S application during *kharif* season (Table 1). Tandon (1986) reported that such high levels of profitability have been obtained on fields which were deficient in S and in the absence of optimum levels of other nutrients.

Post harvest quality of Paddy

Head rice recovery (%) and polished rice (%) were significantly influenced by S schedules. Maximum % were observed in treatments with S application during *kharif* season, S application during both seasons. The hulling % was not influenced by S application. Whereas milling % was significantly influenced by S application during *kharif* and during both seasons. Interaction of fertilizer levels and S schedules also showed the similar trend. The brokens % was more in S control treatments than S applied during paddy season and applied during both seasons (Table 2).

Nutrient composition

In paddy seed the nitrogen content was influenced by fertilizer levels and S schedules. S schedules except control have influenced similarly. The N content ranged from 0.86 to 0.93% and Protein content 5.14 to 5.52%. Phosphorus content was influenced by S application during *rabi*. Sulphur schedules altered K content significantly with highest being observed in *rabi* season plot. S schedules have significant influence on S content of grain. Except control, S applied in any season or both seasons increased S content considerably (0.44 to 0.46%). Zinc content of paddy grain was not altered by any of the treatments (Table-3).

In black-gram seed, N content was significantly influenced by fertilizer levels, S schedules. Recommended dose has resulted in maximum N content of 3.57%. Among S schedules, S application in both seasons resulted in significantly high N content. Protein content followed similar trend as that N content with highest of 22.82% with recommended dose+S application during both seasons. Phosphorus content was also significantly high with S application during both seasons & during *rabi* season. Potassium content of seed was not influenced significantly by any of the treatments. Sulphur content was altered significantly by S schedules. Application of S during both seasons and during current *rabi* season only. Were on par (0.31 and 0.30%). Fertilizer levels or interactions were not significant enough to alter S content. Zinc content was influenced significantly by S schedules and S application in both the seasons and during *rabi* season recorded significantly high content of 77.67 – 76.67 ppm (Table 3).

Conclusion

In S deficient clay soil, S application during *kharif* season significantly increased the productivity of rice-blackgram cropping system.

Table 1: Yield and economics of Rice-Blackgram System as influenced by Sulphur nutrition

Rice (t/ha) Grain	Sub-plot treatments (S1,S2,S3,S4)		Blackgram			Rice equivalent yield	Cost of cultivation	Gross returns	Net returns	C : B Ratio
			Straw	Seed	Stalk	(t/ha)	(Rs./ha)	(Rs./ha)	(Rs./ha)	
Half RFD	Control	3.71	5.01	0.87	2.50	6.07	17600	39152	21552	2.22
	S in *kharif*	5.47	5.66	1.59	3.80	9.76	22406	62952	40546	2.81
	S in *rabi*	4.38	5.45	1.70	3.40	8.97	22406	57857	35451	2.58
	S in *kharif* and *rabi*	5.21	5.91	1.73	4.57	9.87	27212	63662	36450	2.34
RFD	Control	4.88	3.49	1.46	3.20	8.81	19000	56825	37825	2.99
	S in *kharif*	5.64	4.80	1.94	3.97	10.86	23806	70047	46241	2.94
	S in *rabi*	5.04	4.50	1.98	3.53	10.38	23806	66951	43145	2.81
	S in *kharif* and *rabi*	5.24	4.71	1.92	5.63	10.41	28612	67145	38533	2.35
C.D.(0.05)	M x S	0.24	NS	0.12	NS					
	S x M	0.25	NS	0.13	NS					
Main										
	Half RFD	4.70	4.34	1.47	3.57	8.67	22406	55941	33535	2.50
	RFD	5.20	5.51	1.82	4.08	10.11	23806	65235	41429	2.74
C.D.(0.05)		0.26	0.23	0.15	NS					
C.V. (%)		2.97	2.59	5.30						
Sub										
	Control	4.30	4.25	1.16	2.85	7.44	18300	47982	29682	2.62
	S in *kharif*	5.56	5.23	1.76	3.88	10.31	23106	66512	43406	2.88
	S in *rabi*	4.71	5.00	1.84	3.47	9.68	23106	62404	39298	2.70
	S in *kharif* and *rabi*	5.23	5.31	1.82	5.10	10.14	27912	65429	37517	2.34
C.D.(0.05)		0.17	0.36	0.08	0.59					
C.V. (%)		2.77	5.80	3.99	12.35					
Exp. Mean		4.95		1.65	3.83					

Table 2: Post Harvest quality of paddy

Treatments		Hulling %	Milling %	Polished Rice %	HRR%	Brokens %
Main	**F1**	81.1	74.8	81.3	68.3	37.6
	F2	75.0	75.5	89.4	72.1	41.6
CD(0.05)		NS	NS	NS	NS	NS
Sub	**S1**	76.5	58.2	72.2	67.0	41.5
	S2	70.5	84.8	82.4	71.5	37.9
	S3	86.4	70.0	81.7	69.9	40.3
	S4	78.8	83.7	85.1	78.4	38.7
CD (0.05)		NS	10.7	6.3	5.1	NS
F at same S		NS	15.2	8.9	7.3	22.9
S at same F			21.2	14.6	9.1	23.6

Table 3: Nutrient composition of paddy and Black-gram seed in rice-Blackgram system

Treat-ment	Sulphur content %		N content %		Protein content %		P content %		K content %		Zn content ppm	
	Paddy	Black gram	Paddy	Black gram	Paddy	Black gram	Paddy	Black gram	Paddy	Black gram	Paddy	Black gram
120-60-40 NPK	0.43	0.28	0.83	3.48	4.91	20.95	0.31	0.65	0.16	1.03	10.83	72.50
60-30-20 NPK	0.44	0.30	0.89	3.57	5.30	21.84	0.37	0.71	0.17	1.02	14.58	73.50
CD(0.05)	*NS*	NS	*0.06*	0.03	*0.38*	0.63	*NS*	NS	*NS*	NS	*NS*	NS
Control	0.39	0.27	0.75	3.36	4.44	20.61	0.35	0.60	0.16	1.03	10.50	66.67
S-*kharif*	0.44	0.29	0.86	3.54	5.14	20.99	0.30	0.65	0.15	1.06	13.50	71.00
S-*rabi*	0.46	0.30	0.89	3.54	5.32	21.69	0.41	0.71	0.21	0.95	12.50	76.67
S-*kharif &rabi*	0.45	0.31	0.93	3.67	5.52	22.29	0.29	0.75	0.13	1.05	14.33	77.67
CD (0.05)	0.02	0.03	0.07	0.09	0.41	0.14	0.07	0.07	0.03	NS	NS	5.06
NPK at same S	0.05	NS	NS	0.12	NS	0.20	NS	0.10	0.05	NS	NS	7.16
S at same NPK	0.04	NS		0.11		0.36		0.11	0.04	NS		6.60

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