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Integrated effect of sulphur and farm yard manure on yield, quality of crops and nutrient status under rice-mustard cropping system in north eastern coastal plain zone of Odisha

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ABSTRACT

Field experiments were conducted during 2012-13 and 2013-14 on sandy loam soil of irrigated medium land with paddy (var. Ranidhan) at Regional Research & Transfer Technology Station, Ranital Farm, located at Bhadrak, Odisha followed by mustard (var. M 27) grown during rabi season as residual crop in same experimental plot without application of sulphur and farmyard manure. Integrated use of 30 kg S along with FYM either @1.5 or 3.0 t ha^{-1} is beneficial in terms of crop productivity. Paddy and mustard crops registered additional grain yields of 57.8% and 58.5% with combined application of 30 kg S ha^{-1} and 3 t ha^{-1} FYM over control, respectively. Residual effect was more prominent under application of 30 kg S along with FYM either @ 1.5 or 3.0 t ha^{-1}. Seed yield of mustard increased by 15.5 and 16.3%, respectively with combined use of S and FYM over single application of 30 kg S ha^{-1}. Quality characteristics of rice and mustard were also influenced significantly and favorably by integrated sulphur management. Integration of S and FYM resulted in an increase of 6.8 to 12.8% in oil content of mustard over control. Combined application of 45 or 60 kg S with 1.5 or 3.0 t FYM ha^{-1} recorded higher content of available N and S in soil over lower levels of S resulted in buildup of 13 to 16 kg of available N and 16.6 to 19.9 kg of available S over initial level.

Key words: *productivity, residual effect, crop quality, oil content and available nutrient status*

Rice-mustard is an efficient, potential and sustainable cropping system in north eastern coastal plain zone of Odisha. Mustard is the edible oil seed crop for people of Odisha. The average productivity is, however, very low and not sufficient to meet the need of local consumption. Among the several constraints, improper nutritional management is a major impediment for increasing the crop productivity. After NPK, S is the fourth plant nutrient deficiency of which is widespread in India and considered as the quality and quantity limiting factor particularly for oil seed and paddy (Sakal *et al*. 2001). Sulphur plays an important role in growth and development of crops as it is a constituent of amino acids like methionine, cysteine and cystine; needed for the synthesis of other metabolites like co-enzymes A, thiamin and glutathione and is also required for synthesis of chlorophyll and improvement of oil production in oil seed crops. Organically bound sulphur is the potential source of plant available sulphur in many soils; therefore, use of organic manures improves the availability of sulphur in soils and leaves a residual effect for longer time. Farm yard manure is a complete food for crops including S with wide ranging benefits. Thus, the integrated use of sulphur and farmyard manure improves the availability of sulphur in soils and plays a significant role in improving quality and seed development (Ghosh *et al.* 2002; Singh and Sinsinwar 2006). Keeping these facts in view, present study was undertaken to evaluate the integrated effect of sulphur and farmyard manure on yield, quality of crops and available nutrient status of soil under rice-mustard cropping system in north eastern coastal plain zone of Odisha.

MATERIALS AND METHODS

The field experiments were conducted during wet season of 2012-13 and 2013-14 on sandy loam soil of irrigated medium land with paddy (var. Ranidhan) at Regional Research & Transfer Technology Station, Ranital Farm, located at Bhadrak, Odisha. The soil had initial properties of pH 6.1, OC 4.1 g kg^{-1}, available N 245 kg ha^{-1}, available P_2O_5 22.8 kg ha^{-1}, available K_2O 184.5 kg ha^{-1}and available S 26.1 kg ha^{-1}. The experiment was laid out in a split plot design with four replications. The main plot treatments included three levels of farm yard manure (FYM) viz., no FYM(M_0), FYM@ 1.5 ($M_{1.5}$) and 3.0 ($M_{3.0}$) t ha^{-1}. The sub-plot treatments included different levels of sulphur viz., control, sulphur @ 15, 30, 45 and 60 kg ha^{-1}. The N, P, K and S content of FYM were 0.5, 0.26, 0.6, and 0.22%, respectively. The FYM was incorporated into soil 15 days prior to transplanting of kharif paddy. A basal dose of 25% N (20 kg N), 40 kg P_2O_5 and 40 kg K_2 O per hectare were applied at the time of transplanting of paddy through urea, diammonium phosphate and muriate of potash, respectively. Fifty percent N (40 kg N) was top dressed at 21 days after planting (DAP) and rest 25 % N (20 kg N) was applied at panicle initiation (PI) stage. Sulphur was applied at the time of final land preparation through gypsum. After harvest of paddy, mustard (var. M 27) was grown during rabi season as residual crop in same experimental plots without application of sulphur and farmyard manure. However, a fertilizer dose of 20-40-40 kg N P_2O_5 K_2O ha^{-1} was applied to the second crop. The seeds were collected at the time of harvest and determined for protein content of paddy grain and oil content of mustard seed as per the standard procedure (Sadasivam and Manickam 1996). Soil samples were collected after two years of experiments and analyzed for available N, P, K and S as per the procedure described by Jackson (1973).

RESULTS AND DISCUSSION

A perusal of data (Table 1) revealed that application of graded doses of S to paddy significantly enhanced the grain and straw yield over control. Highest grain yield (4035 kg ha^{-1}) and straw yield (7973 kg ha^{-1}) was recorded with the application of 30 kg S ha^{-1} over rest of the treatments but was at par with the application of 45 kg S ha^{-1}. Application of 30 kg S ha^{-1} increased the grain and straw yield of paddy to the tune of 35.7 and 40.5%, respectively over control. However, better improvement in yields was exhibited when S and FYM were integrated together. Among the different integrated practices, significantly the higher grain and straw yields were obtained when 30 kg S ha-1 was integrated along with FYM either @ 1.5 or 3.0 t ha^{-1} and resulted in an additional grain yield of 57.8 and 58.5% over control, respectively. This increase might be due to steady decomposition of FYM and release of nutrients throughout the crop growth period coupled with better assimilation of nutrients (Kumar *et al*. 2008). These findings indicate that the combined application of S and FYM is superior to sole application of either S or FYM. Such beneficial effects of integrated use of FYM with chemical fertilizers corroborated the earlier findings of Singh and Sinsinwar (2006).

In mustard, marked positive residual effect of addition of S and FYM to preceding paddy was noticed in terms of seed and stover yield (Table 2). Residual

Table 1. Integrated effect of sulphur and farmyard manure the yield of paddy (pooled mean of two years)

S levels(kg ha^{-1})	Grain yield (kg ha^{-1})				Straw yield (kg ha^{-1})			
	M_o	$M_{1.5}$	$M_{3.0}$	Mean	M_o	$M_{1.5}$	$M_{3.0}$	Mean
S_0	2740	3050	3129	2973	5030	5970	6020	5673
S_{15}	3319	4163	4275	3919	6470	8050	8340	7620
S_{30}	3438	4325	4342	4035	6780	8530	8610	7973
S_{45}	3568	4278	4243	4030	7040	8390	8420	7950
S_{60}	3525	4225	4178	3976	6890	8270	8360	7870
Mean	3318	4008	4033	-	6442	7842	7950	-
CD(P<0.05)								
S		48				26		
M		44				21		
SxM		80				42		

Table 2 Integrated effect of sulphur and farmyard manure the yield of mustard (pooled mean of two years)

S levels(kg ha^{-1})	Seed yield (kg ha^{-1})				Stover yield (kg ha^{-1})			
	M_o	$M_{1.5}$	$M_{3.0}$	Mean	M_o	$M_{1.5}$	$M_{3.0}$	Mean
S_0	650	696	684	677	1653	1844	1813	1770
S_{15}	755	791	780	775	2355	2412	2385	2384
S_{30}	821	948	955	908	2346	2563	2550	2486
S_{45}	853	924	918	898	2308	2510	2488	2435
S_{60}	830	888	893	870	2295	2459	2419	2391
Mean	782	929	846	-	2191	2358	2331	-
CD(P<0.05)								
S		10				28		
M		9				34		
SxM		16				52		

effect was more prominent under application of 30 kg S along with FYM either @ 1.5 or 3.0 t ha^{-1} and the seed yield increment was to the extent of 15.5 and 16.3%, respectively over single application of 30 kg S ha^{-1}. In general, the marked improvement in productivity of mustard with residual S and FYM could be ascribed to the enhancement of available sulphur content of soil. Similar findings were reported by Jena *et al*. (2006) and Barik *et al.* (2006).

The levels of protein content in rice were significantly influenced by application of S (Table 3). The maximum protein content was recorded with 30 kg S ha^{-1} which was 20.8% higher than control. Among the integrated treatments, the highest value of protein content (8.9%) was recorded in the treatment having integration of 30 kg S with 3.0 t FYM ha-^{1}, resulting in an increase of 23.6% over control.

Oil content in mustard seeds significantly increased from 37.5 to 41.1% with increase in S levels from 0 to 60 kg ha^{-1} (Table 3). The highest oil content (41.3%) was obtained due to integration of 60 kg S with 3.0 t FYM ha^{-1} which resulted in a 12.8% increase in oil content over control. This increase might be due to residual supply of S along with other available nutrients by FYM as well as gypsum which ultimately resulted in more synthesis of oil (triacylglycerol) as biosynthesis of oil involves S-containing compounds such as acetyl CoA and this might have produced higher amount of oil in mustard. Similar results were also reported for mustard by Basumatary *et al*. (2006).

Integrated use of S and FYM had a significant influence on the available nutrient status of soil (Table 4). Combined application of 45 or 60 kg S either along with 1.5 or 3.0 t FYM ha^{-1} recorded the highest

Table 3. Integrated effect of sulphur and farmyard manure on quality characteristics of rice and mustard (pooled mean of two years)

S levels(kg ha^{-1})	Protein content in rice (%)				Oil content of mustard (%)			
	M_o	$M_{1.5}$	$M_{3.0}$	Mean	M_o	$M_{1.5}$	$M_{3.0}$	Mean
S_0	7.2	8.0	7.9	7.7	36.6	37.9	38.0	37.5
S_{15}	8.2	8.6	8.7	8.5	37.9	39.1	39.4	38.8
S_{30}	8.4	8.8	8.9	8.7	38.9	40.1	40.3	39.8
S_{45}	8.5	8.7	8.7	8.6	39.7	40.7	41.0	40.5
S_{60}	8.4	8.7	8.7	8.6	40.8	41.2	41.3	41.1
Mean	8.1	8.6	8.6	-	38.8	39.8	40.0	-
CD(P<0.05)								
S		0.06				0.09		
M		0.05				0.11		
SxM		0.13				0.15		

Table4. Integrated effect of sulphur and farmyard manure on available nutrient content of soil kg ha^{-1})

S levels(kg ha^{-1})	Nitrogen				Phosphorus				Potassium				Sulphur			
	M_o	$M_{1.5}$	$M_{3.0}$	Mean	M_o	$M_{1.5}$	$M_{3.0}$	Mean	M_o	$M_{1.5}$	$M_{3.0}$	Mean	M_o	$M_{1.5}$	$M_{3.0}$	Mean
S_0	240	246	247	244	18.0	19.5	21.0	19.5	173	180	180	178	22.3	25.9	26.1	24.8
S_{15}	248	252	257	252	20.0	22.0	22.2	21.4	175	184	184	181	29.2	37.1	39.3	35.2
S_{30}	250	254	259	254	21.8	23.7	23.8	23.1	179	185	186	183	32.6	39.9	41.5	38.0
S_{45}	253	258	260	257	20.5	22.5	22.5	21.8	176	188	189	184	35.4	42.7	44.5	40.8
S_{60}	254	260	261	258	19.0	20.0	21.8	20.2	174	183	183	180	36.0	44.9	46.0	42.3
Mean	249	254	257	-	19.8	21.5	22.2	-	175	184	184	-	31.1	38.1	39.5	-
CD(P<0.05)																
S		2				0.5				1				2.1		
M		3				0.7				1				1.6		
SxM		4				0.9				2				3.2		

content of available N and S in soil and resulted in an improvement of 13 to 16 kg of available N and 16.6 to 19.9 kg of available S over initial level. This improvement might be due to the direct addition of N through FYM and chemical fertilizers (Singh *et al*. 2006). Availability of P is increased up to 30 kg S ha^{-1} beyond which there was a deleterious effect on availability of P. The lower P availability with higher levels of S might be ascribed to the negative interaction between the elements. Similar observations were also made by Patgiri and Barua (1993). In respect of available K, a declining trend from its initial level (184 kg ha^{-1}) was observed with application of S alone. However, an improvement of 4 and 5 kg ha^{-1}over initial value was recorded with application of 45 kg S along with FYM either @ 1.5 or 3.0 t ha^{-1}. Similarly, a slight improvement of 1 and 2 kg ha^{-1} was also recorded with combined application of 30 kg S along with FYM either @ 1.5 or 3.0 t ha^{-1}. This improvement might be due to the beneficial effect of application of FYM along with inorganic fertilizers. The application of FYM might have caused the reduction of K fixation and consequently increased release of K due to the interaction of organic matter with clay besides the direct addition to the available K pools of the soil (Tondon 1987). Similar findings have been reported by Thakur *et al*. (2001) attributing similar reasons.

From the study, it could be inferred that integrated use of 30 kg S along with FYM either @1.5 or 3.0 t ha^{-1} is beneficial in terms of obtaining high crop productivity and soil available nutrient status under rice-mustard sequence. Quality characteristics of rice and mustard were also influenced significantly and favourably by integrated sulphur management. Integration of S and FYM resulted in an increase of 6.8 to 12.8% in oil content over control.

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