Effect of Various Sulfur Sources on Yield and Soil Sulfur Balance in a Rice-Rice Cropping Pattern in Guangxi Province

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Guangxi is a major agricultural province in China, located in the southern sub-tropical region. Years of high temperature, heavy rainfall, and cultivation have resulted in soils with low cation exchange capacity (CEC), low organic matter, and low levels of plant available phosphorus (P), potassium (K) and sulfur (S). Recent cultural practices with a rice-rice cropping pattern have increased nutrient demand in this area and brought attention to proper S balances in these soils.

Guangxi's major lowland cropping system is early rice followed by late rice. In the past, Guangxi had low rice yields. Soil S supply was not considered important because past practices of recycling organic matter and extensive use of single superphosphate (SSP) had provided most S needs. That situation changed as farmers began striving for higher rice yields to satisfy the needs of a growing population.

Success was achieved with more nitrogen (N), P and K fertilizer and higher plant populations. However, an increasing amount of organic matter began to be diverted to commercial uses such as fodder or fuel. Also, farmers reduced S inputs by becoming more reliant on calcium magnesium phosphate (CaMgP) as the source for supplying P. It is apparent that any increase in yield also increased S uptake by rice (**Table 1**). Thus, Guangxi's prevailing conditions of climate, soil, fertilizer use, and cropping intensity combined to create a serious S imbalance.

Table 1. Total rice production and S uptake, Guangxi, 1978-1995, 1,000 tonnes.

Year	Crop	Total yield	S uptake
1978	Rice	9,110	11.0
1980	Rice	10,070	12.2
1985	Rice	9,860	11.9
1990	Rice	12,390	15.0
1995	Rice	13,080	15.8

The two locations chosen for this study were Qaogong in Laibin county and Loshi in Wuming county. Sulfur sources tested in the field were ammonium sulfate (AS), SSP, elemental S (ES) and gypsum (GYP). Sulfur was applied at 30 kg S/ha in early rice. The following late rice crop did not receive additional S. Treatment plot size was 33 m^2 with each treatment replicated three times. Plant population was 375,000 plants/ha. Rain and irrigation water samples were collected and analyzed for sulfate-S (SO_4-S) content.

Reported results are averages of these two locations.

Results indicate that all S sources had a positive effect on early rice yield (**Table 2**). Yield increases ranged from 9 to 10 percent higher than plots receiving no S. The residual effect of S increased late rice yield from 7 to 8 percent. The effect of S on total yield of the rice-rice cropping pattern was significant and ranged from 8.3 to 9.2 percent. There were no significant differences in yield responses among the four S sources.

Application of various S sources to an early rice-late rice cropping system increased yield of both crops significantly in Guangxi province.

The S rice needs for normal growth can originate from inorganic or organic forms in soil, atmospheric deposition, or fertilizer. Sulfur deficiency will occur if these inputs are not in balance with crop uptake. Analysis of water from rain combined with rainfall data indicates 47.6 kg SO_4-S/ha are deposited annually. Due to soil absorption and losses associated with water flow, it is estimated that only about 50 percent of the SO_4-S deposited by rainfall is used by the crop, which converts to 23.8 kg SO_4-S/ha/yr. In Guangxi, it was calculated that about 12.2 kg SO_4-S/ha was added to the rice crops per year through irrigation water. This estimate of S received from water supplies by the two rice crops, compared against plant uptake data when 30 kg S/ha is added as fertilizer, suggests positive S balances (**Table 3**).

Table 2. Effect of various S sources on rice yield (kg/ha), Guangxi.

		S source				
Crops		**CK**	**AS**	**SSP**	**ES**	**GYP**
Early rice yield, kg/ha	Average	6,103	6,661	6,675	6,735	6,726
	> CK	–	558*	572**	632**	623**
	Rel. yield, %	100	109	109	110	110
Late rice yield, kg/ha	Average	5,337	5,747	5,721	5,760	5,715
	> CK	–	410**	384**	423**	378**
	Rel yield, %	100	108	107	108	107
Total yield, kg/ha	Average	11,441	12,408	12,397	12,495	12,442
	> CK	_	967**	956**	1,054**	1,001**
	Rel. yield, %	100	108	108	109	109

*,**Significantly different from CK (zero S) at 0.2 and 0.05 levels, respectively.

Table 3. Sulfur balance (kg/ha) in an early rice-late rice cropping pattern, Guangxi.

Item treatment	**CK**	**AS**	**SSP**	**ES**	**GYP**
Sulfur from rain, irrigation, and fertilizer	36.0	66.0	66.0	66.0	66.0
Rice sulfur uptake	38.6	44.4	43.1	45.8	44.2
Sulfur balance	-2.6	21.6	22.9	20.2	21.8

Application of various S sources to an early rice-late rice cropping pattern increased yield of both crops significantly. There was no real difference among the S sources as far as their effect on yield. When 30 kg S/ha was applied to this lowland cropping pattern in Guangxi, a positive S balance remained in the soil. Without added S there was a negative S balance, depletion of soil reserves, and lower yields. Use of S-containing fertilizers would seem a good strategy for high yield rice production in these areas of Guangxi province. **BCI**

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