

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.

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 m² 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 (SO₄-S) content.

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 |

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.

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 SO₄-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 SO₄-S deposited by rainfall is used by the crop, which converts to 23.8 kg SO₄-S/ha/yr. In Guangxi, it was calculated that about 12.2 kg SO₄-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).

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**



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

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

| Crops | | S source | | | | |
|-------------------------|---------------|----------|--------|--------|---------|---------|
| | | 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 |

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