

Rice Technology Bulletin

Department of Agriculture
Philippine Rice Research Institute (PhilRice)

ISSN 0117-9799

2001 No. 36

Management of Sulfur-Deficient Lowland Rice Soils



Rice Technology Bulletin Series

- No. 1 Released Rice Varieties (1968 - 1994)
 - No. 2 Pagpaparami at Pagpupuro ng Binhi sa Sariling Bukid
 - No. 3 Paggawa ng Maligaya Rice Hull Stove
 - No. 4 PhilRice Micromill
 - No. 5 PhilRice Flourmill
 - No. 6 PhilRice Drumseeder
 - No. 7 PhilRice Rototiller
 - No. 8 Rice Food Products
 - No. 9 PhilRice-UAF Batch Dryer
 - No. 10 Integrated Management of the Malayan Black Bug
 - No. 11 SG800 Rice Stripper-Harvestser
 - No. 12 Dry-Seeded Rice-Based Cropping Technologies
 - No. 13 Maligaya Rice Hull Stove
 - No. 14 10 Steps in Compost Production
 - No. 15 Rice Tungro Virus Disease
 - No. 16 The Philippine Rice Seed Industry and the National Rice Seed Production Network
 - No. 17 10 Hakbang sa Paggawa ng Kompost
 - No. 18 10 nga Addang ti Panagaramid iti Kompost
 - No. 19 Characteristics of Popular Philippine Rice Varieties
 - No. 20 Rice Stem Borers in the Philippines
 - No. 21 Rice Food Products (revised edition)
 - No. 22 Leaf Color Chart (English)
 - No. 23 Leaf Color Chart (Ilocano)
 - No. 24 Leaf Color Chart (Filipino)
 - No. 25 Equipment for Rice Production and Processing
 - No. 26 Use of 40kg Certified Seeds per Hectare
 - No. 27 Rice Wine
 - No. 28 Management of Field Rats
 - No. 29 Controlled Irrigation: A water-saving technique for transplanted rice
 - No. 30 Minus-one Element Technique: Nutrient deficiency test made easy
 - No. 31 Management of the Rice Black Bug
 - No. 32 Management of Zinc-Deficient Soils
 - No. 33 Management Options for the Golden Apple Snail
 - No. 34 Use of Evaporation Suppressant
 - No. 35 Pagpaparami ng Purong Binhi ng Palay
-

FOREWORD

With the increasing need to produce more rice, farmers resorted to using extensively high analysis (grade) fertilizers that do not contain sulfur. This could have aggravated sulfur deficiency, which is becoming widespread in lowland ricefields and could be contributing to the declining yields observed in some rice growing areas.

Other factors that contribute to the increasing occurrence of sulfur deficiency in lowland ricefields include increasing cropping intensity; use of high-yielding varieties that need higher rates of nitrogen, phosphorus, potassium, and sulfur; decreasing use of sulfur-containing pesticides; and better control of emission from industrial and domestic fuel burning.

To help farmers and technicians manage sulfur deficiency and increase rice productivity, our leading soil scientists and researchers produced this bulletin.

We hope that this publication will contribute in increasing rice productivity in sulfur-deficient areas.



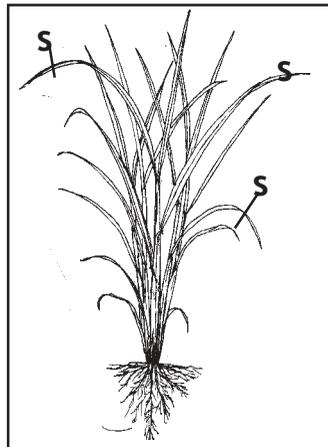
LEOCADIO S. SEBASTIAN

Executive Director

Importance of sulfur

Sulfur (S) is an essential nutrient that is needed by the rice plant to form chlorophyll, the green pigment. It is also needed to activate certain enzymes and synthesize vitamins such as biotin, thiamin, and vitamin B that are needed for plant growth.

In recent years, sulfur deficiency in lowland ricefields has become widespread and could be contributing to declining yields in some rice growing areas especially where heavy doses of nitrogen (N), phosphorus (P), and potassium (K) have been applied regularly.



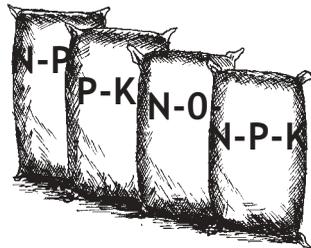
Sulfur-deficient areas



Descalsota et al. (1999) reported that sulfur deficiency is observed in some soils of Ilocos Norte, Cagayan, Isabela, La Union, Nueva Ecija, Nueva Vizcaya, Pangasinan, Tarlac, Pampanga, Zambales, Cavite, Batangas, Laguna, and Iloilo. They reported that the levels of available sulfur, *i.e.* sulfate sulfur, on the sites studied ranged from 0 to 9 parts per million (ppm). The critical level of sulfate sulfur in flooded rice soils is 9 ppm.

Causes of sulfur deficiency?

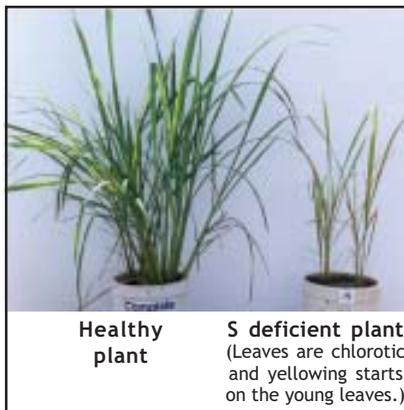
- Extensive use of fertilizers that do not contain sulfur, leaving the crop dependent on naturally available S from the soil, flood water, and atmosphere.
- Increasing cropping intensity.
- Use of high-yielding varieties that need higher rates of N, P, K, and S to attain their potential yield.



- Decreasing use of S-containing pesticides.
- Reduction in atmospheric pollution which minimizes sulfur enrichment through rain.
- Losses of S through soil erosion and leaching.
- Decreased use of organic fertilizers.

Symptoms of sulfur deficiency

- Stunted plants that are chlorotic. Plants resemble those which are deficient in nitrogen, except that yellowing starts on the young leaf. Chlorosis may involve the leaves of the whole plant or it may be severe only on the younger leaves.
- Pronounced elongation of roots followed by a general yellowing of upper leaves, spreading to the lower leaves, and finally the whole plant.
- Fewer and shorter panicles, and reduced number of spikelets at maturity (De Datta, 1981).
- Except in extreme deficiency, yellowing is not uniform throughout the field and is usually quite evident during the early stages of growth, between 2 weeks after planting and maximum tillering.



- Data from Brazil suggested that S deficiency reduces head rice yield and increases chalkiness in grain (Wang et al., 1976).
- Plants in high spots of the field are more normal looking than those in low spots, which are continuously submerged in water. Yellowing may disappear after maximum tillering but the tiller number and plant height do not change.

How to observe symptoms of sulfur deficiency

Sulfur deficiency symptoms are manifested at the early vegetative stage of the rice crop. Often, laboratory chemical analyses show adequate sulfate sulfur in the soil, and yet plants exhibit S deficiency. This indicates that soil chemical analysis is not always a reliable diagnostic tool for determining S deficiency in flooded soil.

Although S deficiency in lowland rice has been reported by Sen as early as 1938, it was only a decade or two ago that the deficiency has significantly been observed.

S-deficient plant	N-deficient plant
	
<p style="text-align: center;">S DEFICIENCY</p> <ul style="list-style-type: none"> • Deficiency symptoms do not move from the older to the younger leaves • Flowering is delayed and high percentage of unfilled grains are observed 	<p style="text-align: center;">N DEFICIENCY</p> <ul style="list-style-type: none"> • Deficiency symptoms start from the older leaves. • Flowering and maturity are hastened.

Amount of sulfur that can be removed from the rice plant

- A study showed that for a rice crop with a yield of 6.3 t/ha, sulfur removal was 11.4 kg/ha.
- In general, cereal crops such as rice have lower sulfur uptake than vegetables.

Amount of sulfur needed by the plant



20 kg/ha S is enough to correct S deficiency

From the field experiments conducted in the Philippines, sulfur rates beyond 20 kg per hectare did not produce further yield increase. This suggests that 20 kg of sulfur per hectare is sufficient to correct sulfur deficiency considering that a rice crop removes 1.7-2.8 kg S per ton of rice produced (Yoshida, 1981).

Best time to apply sulfur

- For early maturing cultivars, basal application, especially with elemental S is more appropriate than topdressing at a later stage of plant growth. Thus, S should be applied not later than 15 days after transplanting (DAT).
- With medium to late maturing cultivars, sulfur application can still be done as late as 30 DAT.



For early maturing varieties, apply S not later than 15 DAT.

For medium and late maturing varieties, apply S not later than 30 DAT.

Common fertilizer sources of sulfur*

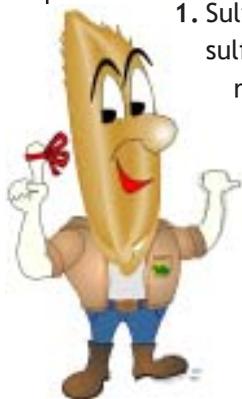
Common Fertilizer Sources of S	Sulfur Content (%)	Total Plant Food Content (%)*
Ammonium sulfate	24.2	45
Ammonium nitrate-sulfate	5.0	35
Ammonium phosphate-sulfate	15.4	51
Ammonium sulfate-nitrate	15.1	38
Elemental sulfur	97.0	
Gypsum	15-18	
Urea sulfur	20.0	
Single superphosphate	12-14	30-34
Triple superphosphate	1.5	47.5
Potassium-magnesium sulfate		
Potassium sulfate	16-18	69
Sulfate bentonite	90.0	
Zinc sulfate	17.8	0 (36.4 Zn)
Guano, chicken manure	variable	variable

*Mamaril 1982, De Datta 1981

Studies conducted in the Philippines using Tropic Vertic Fluvaquent soil showed average yield increase of 92 and 100% attributed to four sources of S at 20 and 40 kg per hectare, respectively. The S sources were ammonium sulfate (AS), elemental S (ES), gypsum (CS), and urea sulfur (US). Yield increase using sulfur bentonite (SB) was only 26% over NPK treatment (Mamaril, et al. 1991).

Mamaril and Gonzales (1987) observed the same results from wetland rice soil samples taken from 11 locations in the Philippines. US produced the highest yield followed by ES, AS, and CS. SB even produced lower yield than NPK treatment in some soils.

To sum up



1. Sulfate and elemental S containing fertilizers such as ammonium sulfate or gypsum and urea sulfur could be good sources of S for rice plants.
2. Generally, 20 kg S per hectare is adequate although in more extreme S deficiency, 40 kg per hectare may be applied.
3. Residual effect could be observed in the subsequent rice crop even at 20 kg S per hectare. At 40 kg S per hectare, the residual effect may still be observed on the second subsequent crop.
4. Sulfur should be applied at transplanting together with basal N application. For early maturing varieties, S should be applied not later than 15 DAT. For medium to late maturing rice varieties (125 days or longer), S may be applied even as late as 30 DAT.

Literature Cited

- De Datta, S.K. 1981. Principles and practices of rice production. John Wiley & Sons, New York, U.S.A. 618pp.
- Descalsota, J.P., C.P. Mamaril, and G.O San Valentin. 1999. Evaluation of the soil fertility status of some rice soils in the Philippines. Paper presented during the 2nd Annual Meeting and Symposium of the Philippine Society of Soil Science and Technology, Inc. Benguet State University, La Trinidad, Benguet. May 20-21.
- Mamaril, C.P. 1982. Sulfur and crop growth. INSSFER Training Program. April 7. 29 pp.
- Mamaril, C.P. and P.B. Gonzales. 1987. Sulfur status and requirements of the Philippines. In Proceedings of the Symposium on Fertilizer Sulfur Requirements and Sources in Developing Countries of Asia and Pacific, jointly sponsored by FADINAP, FAO, TSI, and ACIAR. Bangkok, Thailand. 26-30 January 1988. 67-75p.

-
- Mamaril, C.P., P.B. Gonzales, and V.N. Cacnio. 1991. Sulfur management in lowland rice. Paper presented at the International Symposium on the "Role of Sulphur, Magnesium, and Micronutrients in Balanced Plant Nutrition." Chengdu, Sichuan, Peoples Republic of China. April 3-10. 15pp.
- Sen, A.T. 1938. Further experiments on the occurrence of depressed yellow patch of paddy in Mandalay Farm. Burma Dept. Agric. Rep. 1937-1938.
- Wang, C.H., T.H. Liem, and D.S. Mikkelsen. 1976. Sulfur deficiency - a limiting factor in rice production in the lower Amazon Basin. Development of sulfur deficiency as a limiting factor for rice production. IRI Res. Inst. Inc. Bull. 47. 46pp.
- Yoshida, S. 1981. Fundamental of Rice Crop Science. International Rice Research Institute, Los Baños, Laguna, Philippines. 269 pp.

Subject Matter Specialists

Cezar P. Mamaril, PhD
Genaro O. San Valentin, PhD
Josue P. Descalsota
Josephine DG. Mina

Managing Editor/Desktop Artist

Olive Rose M. Asis

Layout

Carlo G. Dacumos (*carlo77@mozcom.com*)

Illustrator

Carlito N. Bibal

Editorial Advisers

Leocadio S. Sebastian, PhD
Teresa P. De Leon

For further information, contact:

Agronomy, Soils, and Plant Physiology Division
Philippine Rice Research Institute
Maligaya, Science City of Muñoz, 3119 Nueva Ecija
Tel. No. (044) 456-0285; -0113 local 259, 212

Published 2001 by the Philippine Rice Research Institute. Readers are encouraged to reproduce the contents of this bulletin with acknowledgment.

DA-PhilRice

The Philippine Rice Research Institute (PhilRice) is a government corporation attached to the Department of Agriculture (DA). Executive Order 1061 approved on November 5, 1985 and amended by EO 60 dated Nov. 7, 1986, created PhilRice to help develop high-yielding technologies so that farmers can produce enough rice for all Filipinos. PhilRice accomplishes this mission through research, technology promotion, and policy advocacy, which are implemented through a network that includes 57 agencies and 115 seed centers strategically located nationwide.

Its interdisciplinary programs include the following: (1) direct-seeded and (2) transplanted irrigated lowland rice; (3) hybrid rice; (4) rice for adverse environments; (5) rice-based farming systems; (6) policy research and advocacy; and (7) technology promotion. With these programs, PhilRice aims to develop and promote technologies that are ecosystem-based, location- and problem-specific, and profitable to the Filipino farmers.

*for more information,
write, visit or call:*

DA-PhilRice Maligaya

Science City of Muñoz, 3119 Nueva Ecija
Tel: 63 (044) 456-0113, -0258, -0277
Tel/Fax: 63 (044) 456-0112; -0651 local 511;
-0652 local 515;

e-mail: philrice@mozcom.com
Website: <http://www.philrice.net>

DA-PhilRice Los Baños

UPLB Campus, College, 4031 Laguna
Tel: 63 (049) 536-3631 to 33, -3635
Tel/Fax: 63 (049) 536-3515
e-mail: philrice@laguna.net

DA-PhilRice San Mateo

Malasin, San Mateo, 3318 Isabela
Tel: 63 (078) 664-2280, -2954
Tel/Fax: 63 (078) 664-2953
e-mail: philrice_isabela@digitelone.com

DA-PhilRice Batac

17 Tabug, Batac, 2906 Ilocos Norte
Tel: 63 (077) 792-4714
Tel/Fax: 63 (077) 792-4702
e-mail: philrice@iln.csi.com.ph

DA-PhilRice Midsayap

Bual Norte, Midsayap, 9410 North Cotabato
Tel: 63 (06422) 97242
Tel/Fax: 63 (06422) 98178
e-mail: philrice@microweb.com.ph

DA-PhilRice Agusan

Basilisa, RTRomualdez, 8611 Agusan del Norte
Tel: 63 (085) 818-2277, -3377; (918) 406-1145
Tel/Fax: 63 (085) 818-4477
e-mail: cvces001@cdo.philcom.com.ph



DA-PhilRice

Department of Agriculture
Philippine Rice Research Institute

