Effect of Sulphate Fertilizer Applications on Leaf Sulphur Status of Oil Palm

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RINGKASAN

Satu kajian dijalankan bagi membuat perbandingan kecekapan baja urea dan ammonium sulfat bagi kelapa sawit. Rawatan sulfat dibuat untuk mengetahui tahap sulfur dalam kelapa sawit. Data yang diperolehi dari rawatan selama 7 tahun diringkaskan dalam makalah ini.

Hasil menunjukkan bahawa semua plot yang menerima rawatan sulfur dan tanpa sulfur dapat mengekalkan tahap kepekatan sulfur dalam daun yang tinggi di antara 0.16%-0.30% dan kebanyakan plot mempunyai kepekatan sulfur dalam daun dari 0.18%-0.25%. Imbangan sulfur bagi keperluan kelapa sawit dapat dikekalkan melalui penambahan baja yang mengandungi sulfur, kitaran semula sulfur, jumlah kandungan sulfur dalam tanah dan input sulfur dari hujan.

INTRODUCTION

Sulphur(s) as a macronutrient is considered essential for plant growth. In most plants S is required in similar amounts as phosphorus and plays an important role in protein formation, enzyme synthesis, and other important functions. The oil content of various crops has been shown to be influenced by sulphur nutrition. Studies have shown that by increasing the supply of sulphur fertilizer to rapeseed, mustard, and onion plants increases their oil content. It was noted that the oil content of mustard continued to increase with higher rates of sulphur, beyond the point of maximum plant yield. In India, sulphur fertilization increased the oil content of six oilseed crops up to 8.5 per cent (Tandon, 1984).

Strong sulphur responses were obtained in pot experiments on marine sands ('Bris') of the East Coast with *Stylosanthes guianensis* (Tham and Kerridge 1979) but not on several Ultisol and Oxisol soils derived from shale and granite where lack of response was consistent with high SO_4-S status of the soils (Tham and Kerridge 1982). It has been observed that the degree of sulphate adsorption in such Ultisols and Oxisols was related to the proportion of amorphous Al and Fe oxides (Zaharah and Samsiah 1980). Besides soil reserves, accretion of S in rainfall may also lessen the requirement for S. Zahari *et al.* (1983) reported depositions of S in rainfall, ranging from 9-21 kg S/ha/yr, were obtained at areas in close proximity to major industries and at coastal areas.

Although S deficiencies in many tropical regions are due to a low inherent sulphur status in the soil, higher crop yield are also removing greater quantities of sulphur from the soil. One of the most important causes is the current trend toward increased consumption of sulphur free, high analysis fertilizers. Perhaps more important has been the switch in the types of nitrogen fertilizers used; where the application of nitrogen source primarily in the form of urea has increased

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compared with ammonium sulphate (24 per cent sulphur). Even though this practice has reduced the cost of production to the grower, it has consequently resulted in the unintentional neglect of S in the plant nutrient. In addition, with increasing usage of locally produced dolomite as a magnesium source, it is possible that S deficiency may become a limiting factor in the future.

Considerable research has been carried out on the mineral nutrition of the oil palm, involving both macronutrients and micronutrients. However, the importance of sulphur in oil palm appears to have been overlooked. A trial was conducted to compare the effectiveness of urea and traditional ammonium sulphate fertilizer for oil palm. In this trial a sulphate treatment was included to determine the effect and status of S in oil palm. Data obtained over a 7-year period are summarized in this paper.

FIELD TRIAL METHODOLOGY

Location and soil type

A trial was conducted under mature oil palms (1975 planting) on the East Coast of Peninsular Malaysia to evaluate the performance of urea and ammonium sulphate. This trial was located at FELDA Kerteh, Terengganu on a Lancang series soil a Typic Paleudult which was developed from granodiorite.

Experimental Design and Treatments

The trial tested two replicates of an 3Mx2Rx3T factorial in which M is the method of fertilizer application, R is the rate of application and T is the type of nitrogen (N) fertilizer used. A total of 42 plots with 6 controls were used in this experiment. Each plot consisted of 24 palms and 8 core palms were recorded and sampled for nutrient analysis.

In this trial a sulphate treatment was included.

The trial tested three types of N fertilizer:

T_1: Ammonium Sulphate
T_2: Standard Urea (2.9 mm granular size)
T_3: Standard Urea plus K applied as Potassium Sulphate (4.8 kg/palm/year).

The standard rates tested in the factorial treatments in the trial were 0.4 and 0.8 kg N per palm per year, whilst zero N fertilizer was tested in the additional control plots. High rates of P, K and Mg fertilizers were supplied to all plots to ensure no deficiency of any of these nutrients even at the highest N rate. The potash fertilizers were applied in 2 doses per year (4 kg/palm/year), broadcasted overall, whilst the rock phosphate (2 kg/palm/year) and ground magnesium limestone (1 kg/palm/year) were broadcasted overall once a year as blanket. The treatments and quantity of fertilizers applied for each plot is shown in *Table 1*.

The methods of fertilizer application:

M_1: Broadcast on weeded circle, 2 applications per year.
M_2: Broadcast on weeded circle, 4 applications per year.
M_3: Overall broadcast, 2 applications per year.

All the treatments were applied in October 1983. However leaf analysis data for sulphur presented in this paper were taken in April 1991 (7 years after treatments commenced).

Leaf Analysis

Leaf samples of frond 17 were taken from 8 recorded palms in each plot, to make a composite sample for each plot for analysis.

TABLE 1. THE TREATMENT AND QUANTITY OF FERTILIZERS APPLIED FOR EACH PLOT (kg/palm yr)

Treatments MRT	Plot No.	Ammonium Sulphate	Urea	Muriate of Potash	Sulphate of Potash	Plot No.	Ammonium Sulphate	Urea	Muriate of Potash	Sulphate of Potash
111	1	1.91	–	4	–	22	1.91	–	4	–
112	2	–	0.89	4	–	23	–	0.89	4	–
113	3	–	0.89	–	4.8	24	–	0.89	–	4.8
121	4	3.82	–	4	–	25	3.82	–	4	–
122	5	–	1.78	4	–	26	–	1.78	4	–
123	6	–	1.78	–	4.8	27	–	1.78	4	4.8
211	7	1.91	–	4	–	28	1.91	–	4	–
212	8	–	0.89	4	–	29	–	0.89	4	–
213	9	–	0.89	–	4.8	30	–	0.89	–	4.8
221	10	3.82	–	4	–	31	3.82	–	4	–
222	11	–	1.78	4	–	32	–	1.78	4	–
223	12	–	1.78	–	4.8	33	–	1.78	–	4.8
311	13	1.91	–	4	–	34	1.91	–	4	–
312	14	–	0.89	4	–	35	–	0.89	4	–
313	15	–	0.89	–	4.8	36	–	0.89	–	4.8
321	16	3.82	–	4	–	37	3.82	–	4	–
322	17	–	1.78	4	–	38	–	1.78	4	–
323	18	–	1.78	–	4.8	39	–	1.78	–	4.8
000	19	–	–	4	–	40	–	–	4	–
000	20	–	–	4	–	41	–	–	4	–
000	21	–	–	4	–	42	–	–	4	–

R0 - No N fertilizer application
R1 - 0.4 kg/palm N per year
R2 - 0.8 kg/palm N year

M1 - Broadcasted on weeded circle, 2 applications per year
M2 - Broadcasted on weeded circle, 4 applications per year
M3 - Overall broadcasted, 2 applications per year

Blanket fertilizers

4 kg/palm muriate of potash per year except in T3 plots
2 kg/palm CIRP per year
1 kg/palm GML per year

T1 - Sulphate of Ammonia
T2 - Standard granular area
T3 - Standard granular urea plus K applied as sulphate of potash 94.8 kg/palm/year)

TABLE 2. RATES OF SULPHUR ADDED AS SULPHATE FERTILIZERS AND CONCENTRATIONS OF S FROND 17 IN EACH PLOT (DATE OF SAMPLING: 13 APRIL 1991)

Plot No.	Ammonium Sulphate (kg/palm/yr)	Potassium Sulphate (kg/palm/yr)	% S Frond 17	Plot No.	Ammonium Sulphate (kg/palm/yr)	Potassium Sulphate (kg/palm/yr)	5S Frond 1
1	0.458	–	0.203	22	0.485	–	0.189
2	–	–	0.219	23	–	–	0.186
3	–	0.864	0.194	24	–	0.864	0.193
4	0.916	–	0.159	25	0.916	–	0.187
5	–	–	0.163	26	–	–	0.270
6	–	0.864	0.183	27	–	0.864	0.301
7	0.458	–	0.205	28	0.458	–	0.261
8	–	–	0.174	29	–	–	0.213
9	–	0.864	0.183	30	–	0.864	0.252
10	0.916	–	0.189	31	0.916	–	0.267
11	–	–	0.191	32	–	–	0.251
12	–	0.864	0.195	33	–	0.864	0.208
13	0.458	–	0.179	34	0.458	–	0.216
14	–	–	0.187	35	–	–	0.223
15	–	0.864	0.196	36	–	0.864	0.210
16	0.916	– 0.216	37	0.9	16	–	0.232
17	–	–	0.193	38	–	–	0.224
18	–	0.864	0.195	39	–	0.864	0.234
19	–	–	0.220	40	–	–	0.189
20	–	–	0.172	41	–	–	0.215
21	–	–	0.207	42	–	–	0.203

Note: Sulphur applied in the form of Ammonium Sulphate (24%S) and Potassium Sulphate (18%S)

TABLE 3. DISTRIBUTION OF S CONCENTRATION BY PLOT

% S (Frond 17)	No. of Plot	% of total plot
0.16–0.18%	5	12%
0.18–0.25%	31	74%
0.25–0.30%	6	14%

TABLE 4. QUANTITY OF SULPHUR ADDED AND MEAN VALUES OF S CONCENTRATION B PLOT

S (kg/palm/yr)	No. of plot	Mean values of % S (Frond 17)
0	18	0.209
0.458*	6	0.208
0.864+	12	0.212
0.916*	6	0.206

*S applied in the form of Ammonium Sulphate
+S apllied in the form of Potassium Sulphate

Total S was determined by the method of Wisconsin Soil Testing and Plant Analysis Procedures (1976) using nitric-per-chloric acid digestion and by the barium sulphate turbidity method. Plant sample weighed at 0.5 g and 5 ml of mixed, concentrated nitric-perchloric acid were used.

RESULTS AND DISCUSSION

The leaf S concentration sampled from frond 17 taken seven years after sulphate fertilizer treatments for each plot is shown in *Table 2.*

The concentration of sulphur varied and ranged from the lowest reading of 0.16% to the highest reading of 0.30%. As shown in *Table 3*, about 12% of the total plots were found within the range of 0.16%–0.18%, whereas about 14% of the total plots were in the range of 0.25% – 0.30% S concentration. Overall, nearly 74% of the total plots fall within the range of 0.18% – 0.25% S concentration.

However, when data were compared acccording to the mean values of S concentration to the quantity of S added, there was no significant difference between the level of added S and S concentration, as shown in *Table 3*. The average values of S concentration for all fertilizer treatments are close to 0.21% S.

From the results obtained, it is clear that the soil has a high sulphur supplying capacity where the zero sulphur treatment showed high leaf S concentration after seven years of treatment which is comparable to those treatment where sulphur was added. As mentioned earlier, sulphur status on several Ultisol and Oxisol soils have high SO_4-S capacity thus, in these soils, sulphur is unlikely to be a limitation. In addition, the site is situated close to the palm oil mill and coastal area where the deposition or return of atmospheric sulphur in rainfall was expected.

Ng *et al.* (1968) found that the average sulphur content of oil palm (10 years old) was in the range of 0.156% – 0.192%. However, Ollagnier and Ochs, (1972) proposed from their finding a critical range of 0.20 – 0.23 per cent of dry matter in leaf 17.

Based on Ng *et al.* (1968) oil palm has the highest S requirement which was 65-85 kg S/ha compared with other major crops such as coconut, rice, cocoa and rubber. The fertilizer S needed for oil palm was about 90-120 kg S/ha for Ultisol and Oxisol soils and applied as ammonium sulphate and kieserite. Ultisol and Oxisol soils have approximately 652-1000 kg Soil S/ha at 1 meter depth and source of sulphur from precipitation amounts to approximately 4-21 kg S/ha.

The results obtained from this experiment supported the above finding because the majority of the plots have sulphur concentrations in the range of 0.18% – 0.25%. No deficiency symptoms were observed for all the plots including those that did not receive added sulphur. As stated earlier, contribution of atmospheric S in rainfall amounted to approximately 15% from total fertilizer S needed for oil palm. In addition, organic matter decomposition from pruned fronds and aborted flowers and bunches is able to increase the reserve sulphate to the soil where recycling of organic waste material could significantly supply 18-25 kg S/ha (Ng *et al.*, 1968).

CONCLUSION

From the above results and discussion it can be assumed that the soil has a high sulphur supplying capacity where no deficiency symptom were observed after seven years of treatment with zero sulphur level. S balance sheet for oil palm is maintained through added sulphur fertilizers, recycled sulphur, total sulphur reserves in the soil and source of sulphur from precipitation.

Commonly used fertilizers such as ammonium sulphate and kieserite contain considerable amounts of S to provide the requirements of the oil palm crop, thus, masking the contribution of this essential nutrient in crop production. However, with the continuous use of sulphur-free fertilizers such as urea the status of S needs to be monitored in the long term.

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