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THE EFFECT OF COATING THICKNESS ON THE RELEASE OF NITROGEN FROM SULPHUR-COATED UREA

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Ringkasan

Percubaan telah pun dijalankan untuk menyelidik kesan-kesan ketebalan lapisan sulful atas pengeluaran 'available' — Naitrojen dari "urea" yang berlapisan sulfur. Dari percubaan ini, telah pun didapati bahawa ketebalan lapisan adalah penting — lagi tebal lapisan sulfur ini, lagi kuranglah pengeluaran Naiterojennya.

Introduction

Losses of nitrogen applied to the soil in fertilizer are frequently large and occur in several ways. Plant-available forms, particularly, nitrates, are readily leached from the root zone. Volatilisation losses of ammonia and other forms of nitrogen losses such as the loss of N_2 and N_2O through denitrification from nitrate and nitrite are known to occur. For these reasons, there is much interest in controlling the release of applied N and thereby increasing the efficiency of its use. On soils subject to heavy leaching as in the sandy bris soils of the east coast of West Malaysia, slow-release N fertilizers may become essential (Joseph, 1972).

A number of advantages such as the reduction in frequency of fertilizer application, reduction of injury hazards from large applications and greater utilisation efficiency where leaching losses are normally high, have been enumerated which could accrue from fertilizer sources of controlled availability (Lawton, Kirk 1961; Lunt, *et al,* 1961; Oertli, *et al,* 1962a, Oertli, *et al,* 1962b; Oertli *et al,* 1961). Additional advantages could be minimisation of luxury consumption and ammonia fixation.

The interest in fertilizers with controlled availability is evident from several products that have appeared in recent years. Among them are frits to control the release of micronutrient (Rindt, *et al,* 1968) or potassium (Lunt, 1968) and organic compounds not readily mineralized by micro-organism and also sparingly soluble (Beaton *et al,* 1967, Musser *et al,* 1958). Recently, coatings such as poly-ethylene, resins, vinly acetate and sulphur have been developed to regulate the availability of inorganic fertilizers (Brown *et al,* 1966; Lawton, Kirk 1961, Lunt, *et al,* 1961; Oertli, *et al,* 1962a; Oertli, *et al,* 1961).

As a slow-release fertilizer, sulphur-coated urea (SCU) is a very promising one. It is inexpensive as compared to other N fertilizers such as urea-formaldehyde, C-D urea (2-Keto-4 Methyl-6 ureidohexahydro-pyrimidine), IBDU (1-1 diureidoisobutane), etc. (Brown *et al,* 1966, Lunt *et al,* 1968). Also SCU may have residual values on sulphur-deficient soils, although for in-year effectiveness, finely divided material generally is recommended (Rindt *et al,* 1968). This paper reports on an experiment which was planned to investigate the effect of coating thickness on the release of N from SCU.

Materials and Methods

A sandy silt loam soil (80% sand, 15% silt. 5% clay) with a pH of 5.5 was used in this experiment. This soil was mixed with quartz sand (—35 + 60 mesh) in the ratio of 1:3 parts by weight (Black, *et al*, 1965). One hundred and fifty grams of this soil-sand mixture were placed in 400 ml beakers. There were five treatments and the experiment was carried out in duplicate.

The treatments consist of 3 SCU sources (as listed in Table 1) and urea, each containing the same concentration of nutrient N of 100 millgrams and these were added and mixed with the 150 g soil-sand mixture in the respective beakers except the untreated soil which is the control. Then another 50 g of soil-sand mixture were added on top of the soil-sand fertilizer mixture.

Table 1 Materials used as sources of N

Materials	Grade (N-P-K-S)	Relative coating thickness
SCU*	34-0-0-21	thin
SCU	32-0-0-25	medium
SCU	30-0-0-30	thick

*SCU refers to Sulphur-coated Urea

Thirty ml of water were added to each beaker and the moisture was maintined at this level by regular checking throughout the experiment. The samples were then incubated at 25°C.

The samples were analysed for available N after the 1st, 4th, 8th and 12th week of incubation. In this paper, available N refers to (NH_4+NO_3)—N. Before sampling, the soil-sand-fertilizer mixture and soil-sand mixture were thoroughly mixed. 10 gm-wt of soil samples were shaken with 100 ml of 2N KCl for one hour and then filtered. 10 ml of the soil extracts were used for the analysis of available N using the Kjeldahl procedure (Black, *et al*, 1965).

Results and Discussion

The release of N from SCU is primarily a diffusion process (Lunt 1968). Water would diffuse through the coating into the granules and dissolve some of the salts, a concentration gradient would then be established between the internal and external solutions and more water would tend to enter the granules while salts tend to move outwards (Oertli, *et al*, 1962b). Oertli, *et al* (1962b), working with SCU containing 8%, 11% and 15% found that the effect of coating thickness in N release was large.

In this experiment, the differences in N release due to coating thickness are significant especially between uncoated urea and the various SCU's and between the 25% S and the 30% S (Table 2). Between the 25% S and the 30% S, as the coating thickness was increased, the amount of N-release was descreased. But in case of the 21% S and 25% S, there was no significant difference in N-release when the coating thickness was increased.

Table 2 New Duncan's Multiple Range Test

Treatments		Mean	5% Significance	1% Significance
T_1	46-0-0-0	420.1		
T_2	32-0-0-25	160.6		
T_3	34-0-0-21	114.9		
T_4	30-0-0-30	79.1		
T_5	Control	36.8		

Standard Error of Means	17.3
LSD @ 5%	53.2
LSD @ 1%	74.7

After 12 weeks of incubation, it was observed that there were significant differences in N-relcase due to the various treatments as indicated in Table 3. Among the 3 SCU's (T_2, T_3, T_4) themselves, there is also a significant difference in N-release (Table 3). This significant difference is attributed to the coating thickness of the SCU's

At the end of the first week of the experiment, 90% of N was released from urea; 38% N from the 25% S coating, 8% N from the 21% S coating and 8% N from the 30% S coating (Table 4). From Table 4 also, it can be observed that the different treatments responded differently with time. However there was no significant interaction between treatment and time (Table 3).

Table 3 Analysis of Variance

Component	Df	SS	MS	F
Total Main Plot	7	30,615.69	—	
Between Treatments	(4)	731,019.73	182,754.93	76.42**
T_2, T_3, T_4 Vs T_1, T_5	1	116,626.86	116,626.86	62.30**
Among T_2, T_3, T_4	2	26,717.31	13,358.65	5.42*
T_2 Vs T_5	1	587,675.56	587,675.56	212.70**
Treatments X Weeks	(12)	28,696.34	2,391.36	1.70 NS
(T_2, T_3, T_4 Vs T_1, T_5) X Wks	3	5,616.03	1,872.01	1.35 NS
(T_2, T_3, T_4) X Wks	6	14,791.47	2,465.24	1.75 NS
(T_1 Vs T_5) X Wks	3	8,288.84	2,762.94	1.96 NS
Error	16	22,455.22	1,403.45	
Total				

**Significant at 1% level

*Significant at 5% level

NS Non-significant

Table 4 Amount of N released from the various treatments

Treatment	N released (mean values) in ppm				%N released
	1st week	4th week	8th week	12th week	
T_1	450.2	414.2	351.5	464.5	90%
T_2	189.7	115.8	134.7	202.5	38%
T_3	58.5	132.6	110.9	157.7	12%
T_4	38.5	45.9	95.5	136.6	8%
T_5	26.6	29.4	42.8	48.3	—

Conclusion

Results from experiments indicate that SCU may be an effective material for controlling N-release. Rate of release of N was found to be influenced by its coating thickness. Increasing the coating thickness from 21% S to 30% S reduced the rate of release of N, while increasing the coating thickness from 21% S to 25% S was non-significant.

Hence, SCU could have some of the agronomic advantages of controlled N-release such as less loss of N by leaching and run-off, less volatilisation and denitrification loss of N, greater effectiveness of applied N and a possible reduction in nitrate pollution. However, more intensive studies on the various factors that may control N-release from SCU such as temperature, humidity, pH levels of soils have to be carried out.

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Summary

Experiments were conducted to investigate the effect of coating thickness on the release of available N from Sulphur-coated Urea. It was found that coating thickness had a marked effect — the thicker the coating, the lower was the amount of Nitrogen released.

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