Statement XII :

Mortality Studies 1955–'56.

Treated on 29–12–1956. Mortality after one week of treatment i. e., on 5–1–1956.

	Treatment	No. of dead mealy bugs.	Number alive	Total	Percentage of mortality
1.	Folidol 0·05%	104	41	145	71·7
2.	Folidol 0·025%	76	49	125	60·8
3.	Systox 0·15%	109	28	137	79·6
4.	Endrin 0·04%	55	135	190	29·0
5.	Control	6	162	168	3·6

Mortality was highest under Systox 0·15% (1 oz. in 4 galls) and Folidol 0·05% (1 oz. in 6¼ galls).

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Note on the Liberation of Hydrogen Sulphide in Submerged Paddy Soils

by

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Introduction: Hydrogen sulphide is toxic to plants even in small puantities. It causes injury to the root cells and inhibits respiration. The toxicity is a function of the concentration and time of contact of H_2S with the plant. The injury increases with time of exposure of the plant to the gas even in minute quantities (1. 2). The uptake of nutrients is vitally affected and Baba *et al*, (3) from their studies on the nutrition of rice showed that the absorption of some nutrients particularly potassium and silica and of water was decreased by the addition of H_2S. As a result of similar studies, Mitsui *et al*, (4, 5) showed that passing H_2S through the culture solution at the rate of two bubbles a second for 30 minutes caused a market reduction in ion accumulation, water absorption and protein synthesis during the subsequent 23 hours. Ion uptake was reduced in the following order:— $P_2O_5 > K_2O > Sio_2 > NH_4 > MnO > H_2O >$ $Mgo > CaO$. They concluded that the severe Helminthsporium root rot noticed in certain soils was a result of H_2S injury. The toxicity due to H_2S is believed to be the cause of the disease known locally in Japan as 'AKIOCHI' or autumn disease which is prevalent in old sandy degraded soils (6). The subject has rightly received more than passing interest in Japan and detailed studies have been made there with reference to the conditions favouring H_2S toxicity and ameliorative mehods to be adopted to prevent the disease.

The sulphides are the reduction products of sulphates brought about by a small group of anaerobic bacteria at high pH (7). The fertilizers ammonium sulphate, super and potassium sulphate are the chief sources of sulphate. Besides, the animo acids, cystine and methionine also yield on anaerobic decomposition H_2S and mercaptans. The conditions obtaining in a submerged paddy soil with considerable amounts of easily decomposable organic matter are ideal for anaerobic decomposition and the reduction products like Fe^{++}, Mn^{++}, NH_3, CH_4 and H_2S are present in varying amounts depending on factors such as period of submergence, drainage, amount of organic matter, fertilizers added and nature of soil. This paper gives an account of the preliminary studies conducted with particular reference to the liberation of H_2S in paddy soils receiving different manurial and cultural treatments.

Materials and Methods: The formation of H_2S is one of the aspects under study in the experiment that is being conducted in the Paddy Breeding Station, Coimbatore, to assess the benefits of intercultivation under the Japanese and Madras methods of Paddy cultivation. Based on these two manurial treatments, 5 different methods of interculture were under study, thus making a total of 10 treatments. Samples of the swampy soils were drawn at intervals of every fortnight, both before and after intercultivation, and tested for H_2S and and soil reaction (pH).

Hydrogen sulphide was estimated by removing the gas from the pasty roil by suction after mixing with sufficient water to allow a current of H_2S free air to pass through it and absorbing the gas in a 5% solution of potassium antimony tartrate. The soil suspension was also boiled for 10 minutes to remove all the H_2S dissolved in the soil-water. The formation of a yellow colour indicated the presence of H_2S and by comparing the intensity of the colour with those of known standards the quantity of H_2S present in the swampy soil was estimated. Measurement of the pH of the samples was also carried out.

Results: It may be seen from the table that under 'Japanese manuring' (Treatments 1 to 5) no H_2S was detected in the soil in the first two rounds but traces in the third round. Later on H_2S was completely absent.

In the 'Local manuring' (Treatments 6 to 10) H_2S in traces was noted earlier but as the crop growth advanced it was completely absent.

The pH of the soils is on the alkline side which is as expected under anaerobic decomposition of organic matter in paddy soils.

Discussion: The necessity for moderate drainage in paddy soils needs no emphasis, for, the excess of reduction products formed must be removed from the root zone be it either Fe^{++}, Mn^{++} or H_2S (8). Under conditions obtaining in normal paddy soils the concentration of H_2S is not generally alowed to reach toxic level, for, any H_2S formed is almost completely removed from solution as the sparingly soluble ferrous sulphide. As long as the soil is saturated with calcium or iron the toxicity is not serious. Only when iron is deficient, H_2S or methyl sulphide will appear (9). This defensive mechanism is absent in the case of old sandy paddy soils in Japan – called degraded soils – for they are highly leached soils and the soil constituents Si, Mn, Fe, Mg, Ca and K have disappeared from the top soil (10, 11). It is in these soils that AKIOCHI or autumn disease is prevalent and one of the remedial measures adopted to prevent the disease is to apply red upland soil, containing iron. The deficiency of iron in the 'degraded soils' mainly causes H_2S to accumulate to toxic limits (12).

There is a unique mechanism in paddy which keep reduced substances at safe distance from causing injury to the plant. The roots of paddy plants are believed to diffuse oxygen, younger roots diffusing more oxygen than older roots, and keep an oxidising environment in the immediate vicinity of the roots, which acts as a defensive wall against possible incursion of excessive and harmful reduced products (13).

All sulphates increase the risk of harmful H_2S accumulation due to reduction and it is for this reason ammonium chloride and potassium chloride are found more suitable for paddy growing in degraded soils, low in manganese and iron, in Japan (11, 14).

The liberation of H_2S under the soil and climatic conditions and manuring in Madras State is not likely to depress the yield of paddy. The soils in Madras State including the highly leached laterite soils, contain adequate reserves of iron which has a protective action in removing H_2S from solution. The provision of moderate drainage ensures the quick removal of the reduced products.

Summary and Conclusion: The formation of hydrogen sulphide in paddy soils and the conditions leading to its toxicity on crop growth have been discussed. It has been shown that only in soils highly deficient in iron as in the case of certain soils of Japan that the harmful effects of this product will be felt. Results of some preliminary studies on the formation of this toxic gas in the paddy soils at Coimbatore have been furnished. It can safely be concluded that the liberation of Hydrogen sulphide, under the soil conditions cultural and manurial practices obtaining in Madras State is not likely to present a serious problem.

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Results of estimation of Hydrogen Sulphide (H_2S) and pH in the Paddy Soils under Intercultivation Experiments in the Paddy Breeding Station, Coimbatore.

Particulars	1st round				2nd round				3rd round				4th round				5th round			
	Preinter-cultiva tion		Post in-terculti vation																	
	A		B		A		B		A		B		A		B		A		B	
	30—11—55		2—12—55		13—12—55		17—12—55		31—12—55		3—1—56		17—1—56		20—1—56		31—1—56		2—2—56	
	H_2S	pH	H_2S	pH	H_2S	pH	H_2S	pH	H_2S	pH	H_2S	pH	H_2S	pH	H_2S	pH	H_2S	pH	H_2S	pH
Japanese Manuring+Interculti-vation by Japanese Rotary intercultivator once in 15, 30 & 45 days after planting.	Nil	7·90	nil	7·80	nil	7·35	nil	7·4	Trace	7·20	Trace	7·06	nil	7·10	nil	7·40	nil	7·40	nil	7·38
Jap. manuring+working hand rake once in 15, 30, 45 days.	,,	7 60	,,	7·70	,,	7·20	,,	7·40	,,	7·14	,,	7·08	,,	7·00	,,	7·02	Trace	7·42	Trace	7·50
Jap. manuring+weeding twice and working Jap. rotary inter-cultivator, 15, 30 days after each weeding.	,,	7·60	,,	7·60	,,	7·20	,,	7·60	,,	7·42	,,	7 06	,,	7 00	,,	7·00	nil	7·40	nil	7·40
Jap. manuring and weeding twice.	,,	7·60	,,	7·40	,,	7·20	,,	7·52	,,	7·20	,,	7·12	,,	7·20	,,	7·1	Trace	7·50	,,	7·40
— do — + No weeding and no trampling.	,,	7·45	,,	7·30	,,	7·35	,,	7·46	,,	7·22	,,	7·10	,,	7·24	,,	7·1	nil	7·40	,,	7·58
Local manuring + as in 1	,,	7·60	,,	7·35	Trace	7·10	Trace	7·58	,,	6·96	,,	7·14	,,	7·06	,,	7·06	Trace	7·44	Trace	7·42
— do — + as in 2	,,	7·60	,,	7·30	,,	7·20	,,	7·58	,,	6·92	,,	7·10	,,	7·16	,,	6·9	,,	7·62	nil	7·50
— do — + as in 3	,,	7·60	,,	7·35	,,	7·45	,,	7·60	,,	7·00	,,	7·26	,,	7·06	,,	6·9	,,	7·36	Trace	7·30
— do — + as in 4	,,	7·70	,,	7·30	,,	7·40	,,	7·50	,,	7·00	,,	7·15	,,	7·00	,,	7·2	,,	7·46	,,	7·38
Local Manuring + as in 5	,,	7·70	Sample not received		,,	7·40	,,	7·46	,,	6·94	Sample not received		,,	7·08	,,	7·14	,,	7·40	nil	7·40