

## *A Physiological Disease of Paddy due to Iron Toxicity*

Sulphur oxidation and production of acidity were considered to be the major toxic factors in Kuttanad soils for a long time. But later, an unknown disease termed "Makarakkal" or Kuttupachel" was reported. The symptoms of the disease were mistaken for Stem-borer or blast. Hence an investigation was carried out to know the exact reason for toxicity prevalent in the soils which ultimately led to the failure of the crop,

For a study, soil samples and ground water samples were collected from five representative areas where the disease was wide spread.

### *Chemical determinations.*

pH, loss on ignition, lime content, total

ferric and aluminium oxides, ferrous iron, sulphates and chlorides were determined in the usual way. The ground water from affected localities were analysed for pH, lime, chlorine, ferrous iron, and sulphate and chlorides in ignited residue. Chemical and microscopic examinations of the red scum were carried out. Pot culture experiments were conducted to find out the role of ground water and ferrous iron in the disease.

### *Experimental results and discussion.*

The results of chemical analysis of soil samples and ground waters from affected localities are presented in Tables 1 and 2 respectively.

TABLE 1

Particulars soil sample	pH	Loss on ignition %	Total $Fe_2O_3 + Al_2O_3$	Ferrous iron	lime CaO	$SO_4$ %	Chloride %
1. Mundar estate (Kari land)	2.3	33.2	13.1	220	nil	2.30	1.90
2. Puthom (Lake region)	2.5	28.4	12.2	200	0.006	0.34	0.21
3. Neelamperoor (Kuttanad)	3.6	24.7	11.7	195	Trace	0.31	0.19
4. Thottapally Kari land)	4.3	30.1	10.9	200	nil	0.54	0.21
5. Venattukad (Kuttanad)	4.5	25.3	11.8	210	0.003	0.34	0.21



Field showing wilting of paddy seedlings in patches.

TABLE II

Analytical results of ground waters from the affected localities.

Particulars of samples	pH.	lime %	Al %	Ferrous iron %	Sulphate in the ignited residue %	Chloride in ignited residue %
1. Ambalapuzha (Kuttanad)	2.9	0.004	1.9	3.4	12	10.4
2. Mandar estate (Kari land)	2.2	Nil	1.1	3.9	14	7.1
3. Neelamperoor (Kuttanad)	3.4	Trace	0.87	3.1	1.1	6.1
4. Thottapally (Kariland)	2.1	Nil	2.1	4.9	14	12.2

Table I reveals that the soil samples are highly acid, the pH ranging from 2.3 to 4.5. The loss on ignition which varies from 24.7 to 33.2 shows the high organic matter status of the soils. The total iron and aluminium in the soils are more or less the same ranging from 10.9 to 13.1% and the maximum Ferrous iron concentration calculated in ppm. is as high as 210 ppm. The lime content (as CaO) is very low. The values for sulphates and chlorides are also appreciable.

The ferrous iron present in ground waters ranges from 3.1% to 4.9%. The chloride values in the ignited residues are also appreciably high showing the extreme saline nature of the soils. Two soil samples from Neelam-

peroor and another from Thottapally were kept in distilled water and the amount of ferrous iron that came to solution was determined every day for 15 days. First ferrous iron was determined in the solution and then the solution treated with concentrated  $\text{HNO}_3$ , and the total iron found out. The difference accounted for ferric iron. A standard solution of ferric salt was prepared (50 ppm. ferric iron) and 1 ml. of Ammonium Thiocyanate (1%) was added. The same volume of soil solution was treated with 1 ml. of 1% ammonium Thiocyanate and the colour compared with the colour of the standard solution using Klett's colorimeter. The results are presented below in table III.

TABLE III.

Days	<i>Neelamperoor soils</i>		Days	<i>Thottapally soil</i>	
	Ferrous iron ppm.			Ferrous iron ppm.	
0	20		0	30	
	20		1	45	
2	30		2	65	
3	59		3	90	

<i>Neelamperoor soils</i>		<i>Thottappally soil</i>	
Days	Ferrous iron ppm.	Days	Ferrous iron ppm.
4	75	4	115
5	105	5	150
6	135	6	190
7	165	7	200
8	195	8	180
9	180	9	145
10	125	10	115
11	125	11	80
12	50	12	50
13	40	13	40
14	30	14	30
15	29	15	30

The concentration of iron increased first to a maximum in seven days and then recorded a fall to minimum in seven days. A brown colour was observed in the solution, simultaneous with the fall in concentration of ferrous iron in them. The intensity of the colour increased and finally a red scum

appeared on the surface. The soils from areas where wilting was reported invariably showed the appearance of red scum. The microscopic examination of the red scum revealed the scum in the field was identical with that formed during the experiment. The analysis of the red scum gave the following results.

TABLE IV.

Locality	Percentage loss on ignition	Percentage of total iron as ( $\text{Fe}_2\text{O}_3$ )
1. Thottappally (Kari land)	4.6	54.3
2. Neelamperoor (Kuttanad)	3.2	49.5
3. Venattukad (Kuttanad)	4.1	56.2

The results show that the red scum is composed of ferric oxide.

Pot culture studies were carried out to find out the role of ground water and ferrous iron in the toxicity disease. In one set of pots paddy plants were watered with the ground water from the affected field. In another set the paddy plants were

given ferrous sulphate (70 ppm). The same type of soil (sandy loam) was used in the pot culture studied. In order to have close relation with the soils in affected areas no lime was applied in the pot experiments. The symptom of the disorder which appeared in the field developed in both experiments. The main symptoms of the disease are yellowing

of older leaves followed by brown spots, and the slow dying out the seedlings. Hence it is assumed that the disease developed is a *physiological disease due to iron toxicity*.

#### SUMMARY AND CONCLUSION

The evidence and results gathered from the present investigation strongly support the assumption that as far as soil conditions in Kuttanad are concerned, "*iron produces a physiological disease*". The appearance of red scum which is a common occurrence has been traced to the formation of an iron compound. The symptoms of the disease noted are yellowing of the older leaves followed by the formation of reddish brown spots, darkening of root system and gradual dying off of the paddy plants. The main conclusion are as follows :—

1. The soils in the disease affected areas

contained iron in solution and are very poor in lime status.

2. The ground water from the fields where wilting was very common contained large amount of iron.
3. The red scum formation is a common phenomenon observed in the soils of the affected areas.
4. The examination of the diseased plants under microscope revealed accumulation of ferric iron in the Paranchyma and Vascular bundle region.
5. The iron solubilisation and the red scum formation in these soils could be fairly suppressed in two ways. viz. (1) by sterilisation and the other by treatment with lime,  $\text{Cu SO}_4$ , superphosphate etc.

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