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STUDIES ON H_2S INJURY TO RICE PLANTS

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Hydrogen sulphide injury is one of the most serious physiological diseases of rice. Baba and Harada (1954) observed that in the ill-drained boggy soils, root injury was caused by H_2S, $C0_2$ and toxic organic acids such as acetic and butyric acids. Baba (1958) noted root-rot due to H_2S injury in the sandy and boggy soils of Ceylon. Sulphide injury is wide spread in Andhra Pradesh (Powar *et al* 1960). Subramoney (1963) reported that the Kerala soils exhibited the capacity to produce H_2S.

A precise and diagnostic description of the symptoms of the disease to facilitate the easy detection of the injury under field conditions is not available and the present studies were undertaken with this end in view. Studies have also been made on the extent of damage caused to the growth and yield of the plants due to H_2S toxicity.

Material and Methods

The experiment was laid out in the paddy fields of the Agricultural College Farm, Vellayani, using a randomised block design. The treatments were as follows :-

- T_1 Control I (No treatment)
- T_2 Medium of sulphur reducing organisms containing ammonium sulphate at the rate of 50 Kg N/ha.
- T_3 Medium of sulphur reducing organisms containing ammonium chloride at the rate of 50 Kg N/ha.
- T_4 T_2 plus magnesium silicate at the rate of 600 Kg/ha.
- T_5 T_3 plus magnesium silicate at the rate of 600 Kg/ha.
- T_6 Control II (Nitrogen at the rate of 50 Kg N/ha in the form of urea).
- T_7 Nitrogen at the rate of 50 Kg N/ha in the form of ammonium sulphate plus H_2S dissolved in water.
- T_8 Nitrogen at the rate of 50 Kg N/ha in the form of ammonium chloride plus H_2S dissolved in water.
- T_9 T_7 plus magnesium silicate at the rate of 600 Kg/ha.
- T_{10} T_8 plus magnesium silicate at the rate cf 600 Kg/ha.

The medium of sulphur reducing organism contained besides the nitrogenous fertilizer, dipotassium phosphate, ferrous sulphate and sodium acetate at the rate of 25 Kg each per hectare. This was applied to the soil at the planting time. Magnesium silicate at the rate of 600 Kg per hectare was also applied at planting. P_2O_5 and K_2O

The roots gradually became brittle followed by decay and lateral roots increased in number. The tillers decayed with the subsequent production of a large number of non-productive tillers. This observation is in agreement with the observation made by Baba (1958).

Attack of *Helminthosporium* leaf-spot was observed on the H_2S affected plants. Mitsui (1958) and Baba *et al* (1957) had observed decreased resistance to the disease after H_2S treatment.

The affected roots showed a black colouration due to the deposition of ferrous sulphide which on smearing with dilute hydrochloric acid evolved H_2S gas.

Black spots were noted on the grains yielded by the affected plants. Locking up of earheads was another symptom noted in the injured plants.

Summary

Field experiments were carried out to investigate the nature of the symptoms of H_2S toxicity and its effects on the growth and yield of rice plants as well as incidence of pests and diseases. The yields of grain and straw of paddy and the production of bearing tillers were decreased due to H_2S injury. H_2S toxicity caused increase in the production of non-productive tillers. The grain-chaff ratio of affected plants was very narrow. The injured plants appeared to show increased susceptibility to *Helminthosporium* leaf-spot disease. Black ferrous sulphide deposits were seen on the roots and base of the stem of paddy which on smearing with dilute hydrochloric acid evolved H_2S gas. Locking up of earheads and development of black spots on the grains were also noted as a result of H_2S toxicity.

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Number of non-productive tillers: Analysis of the data reveals significant differences in the number of non-productive tillers due to treatment effects (Table 1). The plants injured at the early stages by H_2S produced by the sulphur reducing organisms put forth significantly higher number of non-productive tillers. Baba (1958) noted increase in non-fertile tillers due to H_2S toxicity. This is believed to be due to an attempt by the plant to produce more tillers at later stages of growth when tillers produced at earlier stages were destroyed by H_2S.

Yield of grain and straw: Table 2 shows that the differences in yield of grain and straw due to treatment effects were highly significant. Yield of plants affected by H_2S was considerably less than that of healthy plants. The injury which occurred at the later stages by H_2S dissolved in water reduced the yield of straw considerably.

Table 2

Effect of treatments inducing sulphide injury on yield of paddy

Treatments	Mean yield of grain per plant (g)	Mean yield of straw per plant (g)	Mean ratio of grain to chaff
T_1	28.66	28.07	3.78
T_2	25.00	43.92	2.54
T_3	30.29	48.82	1.82
T_4	34.99	47.05	2.28
T_5	49.78	59.37	1.96
T_6	74.89	92.37	5.94
T_7	37.54	40.67	2.74
T_8	31.06	44.32	2.12
T_9	30.64	37.90	2.62
T_{10}	37.28	39.40	2.60
C. D. at 5% level	3.59	11.15	1.02

Ratio of grain to chaff: The differences in this ratio were highly significant due to treatment effects (Table 2). The narrowest ratio was obtained in treatment which received medium of sulphur reducing organisms containing ammonium chloride (T_3) which was closely followed by treatment that received medium of sulphur reducing organisms containing ammonium chloride and magnesium silicate (T_5). The widest ratio was obtained in the plots receiving nitrogen only (T_6). In general, it may be seen that the plants injured by H_2S had always a narrow grain to chaff ratio.

Symptoms of H_2S injury: Although the medium to promote the growth and activity of the H_2S — producing organisms was applied to the soil at the time of transplantation of seedlings, the initial symptoms of H_2S toxicity appeared on the plants only about seventy five days after planting. The lower leaves first showed symptoms similar to those of potassium deficiency aod the entire leaves withered a week after the appearance of the initial symptoms. A decrease in water content was apparent from the loss of brightness of colour and the withering of leaves. Baba *et al* (1952) had shown that the. absorption of water was decreased by H_2S toxicity.

at the rate of 40 Kg/ha each were applied as basal dressing in the form of ultraphos and muriate of potash respectively in all the plots excepting those of control I. Nitrogen was applied to the respective plots at the rate of 40 Kg/ha at planting and 10 Kg/ha as top dressing one month after the first dose. Healthy seedlings of 35 days' growth of Ptb. 4 (145 days) were used for planting. The results were assessed in terms of the height of plants and the number of tillers observed at intervals of twenty-one days from the date of planting and in terms of the final yield of grain and straw. Observations were also made on the colour of leaves and stem at regular intervals as well as on the average number of chaff per ear.

Results and discussion

Height of plants : Table 1 shows that the difference in height due io treatment effect was highly significant. The highest mean height of 109.6cm was attained by plants in plots receiving only nitrogen (T_6) and the lowest of 93.7cm in the plots receiving nitrogen in the form of ammonium sulphate, H_2S dissolved in water and magnesium silicate (T_9).

Table 1

Effect of different treatments inducing sulphide injury on growth and tillering of paddy plants

Treatments	Mean height at flowering (cm)	Mean number of tillers at flowering	Mean number of non-productive tillers
T_1	97.60	10.40	2.75
T_2	101.20	13.20	8.75
T_3	94.40	16.40	11.50
T_4	102.40	14.50	6.25
T_5	105.50	17.70	7.00
T_6	109.60	23.40	5.75
T_7	95.50	12.90	3.75
T_8	100.50	13.10	5.00
T_9	93.70	13.10	5.25
T_{10}	97.00	13.40	2.75
C. D. at 5% level	4.51	1.66	3.96

It may also be seen that the height of plants injured by H_2S dissolved in water was significantly lower than that of plants injured by the H_2S produced by the sulphur reducing organisms.

Number of tillers : The highest mean number of tillers was produced by plants receiving nitrogen alone (T_6) which was followedby plants receiving the medium of sulphur reducing organisms with ammonium chloride plus magnesium silicate (T_5). The lowest mean was recorded by plants receiving no nutrients (T_1). In general it may be seen that treatments which enhanced the activity of sulphur reducing organisms as well as the plants injured by the H_2S solution showed a suppression of tillering (Table 1).