ASPECTS OF THE FE- AND MN NUTRITION OF RICE PLANTS

I. IRON- AND MANGANESE UPTAKE BY RICE PLANTS, GROWN UNDER AEROBIC AND ANAEROBIC CONDITIONS

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KEY WORDS

Active iron Active manganese C-A values Iron contents Lowland rice Manganese contents NPK-nutrition Oryza sativa Root precipitates Soil pH Upland rice

SUMMARY

The combination of low Mn levels and high Fe levels in tissues of lowland rice varieties, as often encountered when rice is grown on acid soils, is not likely to result from an antagonistic effect of Fe on the uptake of Mn.

Experiments with rice plants growing on sand, supplied with Fe and Mn, and subjected to various pH levels and moisture regimes, made it clear that under acid anaerobic conditions the absorption of Mn by rice plants is little affected by the presence of large quantities of Fe, and that under acid aerobic conditions the absorption of Fe by rice plants is little affected by the presence of large quantities of Mn.

INTRODUCTION

In water cultures, it is often observed that rice plants show chlorotic symptoms, resembling those caused by iron deficiency. Chemical analysis of the plant material usually fails to confirm the hypothesis that lack of iron is the cause, because the iron contents of the plants are often normal, but not seldom excessively high Mn contents are found, thus giving rise to the assumption, that the symptoms may be a reflection of Mn excess rather than of Fe shortage.

Weeraratna\textsuperscript{15}, working with field-grown plants, reported wide variations in Mn contents of rice leaves of plants of different age. The highest contents in lowland rice were found in 4-week old plants, at a growth stage coinciding with that, at which Senewiratne and Mikkelsen\textsuperscript{12} had observed a slight chlorosis of the leaves.

Vlamis and Williams\textsuperscript{14} found, that the Fe- and Mn contents of younger rice
leaves were lower than those of older leaves. The usual observation is, that Fe-and Mn deficiencies manifest themselves in discoloration of young leaves, whereas toxic levels at these metals result in discoloration of older leaves.

In the authors' laboratory, it was furthermore observed, that the chlorotic symptoms in young rice leaves tend to be more severe, when greenhouse temperatures are low. This observation appears to be in line with the findings reported by Löhnis, and also by Heenan and Carter, that at high temperatures certain plants are more resistant to high levels of soil manganese than at lower temperatures.

The symptoms of chlorosis in rice leaves on water culture are most pronounced when rice is grown on solutions containing nitrate, and having pH values higher than 6. Similar findings are obtained with other cereals, whereas dicotyledonous plants, when grown on identical solutions, do not show such symptoms.

The question then presents itself, whether the high Mn-uptake rate of rice plants grown on water cultures is an artefact, associated with some unnatural conditions prevailing in nutrient cultures, such as an absence of reductive conditions, and the presence of nitrate nitrogen, the latter leading to pH rises, which cannot be counteracted, due to the absence of a pH buffering mechanism. An answer to this question may be given with the aid of results obtained in experiments, in which some of the conditions characteristic of water cultures were also present in the solid media used for the growth of rice.

LITERATURE REVIEW

The Annual Reports of the International Rice Research Institute in the Philippines for the period 1964–1973 contain information on Fe- and Mn contents of leaves of rice grown on soils varying in a number of characteristics, among others pH values. Rice was grown on these soils under both aerobic (upland) and anaerobic (lowland) conditions. The results on Fe- and Mn contents of mature leaves are summarized in Fig. 1. It can be seen that high levels of either one of the two elements in rice leaves are always accompanied by relatively low levels of the other element, which phenomenon could be considered as indicative of a mutual antagonism between the two metals, either during uptake by the roots, or during translocation from the roots to the leaves.

When the pH levels of the soils represented by the various points in Fig. 1 are taken into consideration, three zones, as shown in Fig. 1, can be delineated. It appears that in soils producing rice leaves with Fe levels higher than 500 ppm, the pH levels are usually lower than 5.0. When the Mn content of rice leaves is higher