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# EFFECT OF DIFFERENT LEVELS OF IRON MANGANESE AND PHOSPHORUS ON THE YIELD AND NUTRIENT CONTENT OF RICE

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The effects of Fe, Mn and P on the growth of plant parameters and their contents were studied using rice in a calcareous soil. It was observed that the applications of Fe, Mn and P either alone or in combination has no beneficial effects except in isolated cases on the yields, plant height and growth of tillers. Accordingly any of them when applied together or in combination to the growth medium, tended to reduce the uptake of each other by rice, straw and grain. Further research on this line using foliar application of these nutrients may give some conclusive results.

## INTRODUCTION

The increasing importance of iron, manganese and phosphorus fertilizers for different crops have resulted in more attention being given to their uptake from the soil and their accumulation and distribution in plants. In the arid and semi-arid regions, P is the principle nutrient applied to leguminous and other field crops. When large quantities of P are used, iron chlorosis and stress conditions often result [1].

Iron and manganese are essential for chlorophyll synthesis and for the activities of numerous enzymes in plant system [2]. Some investigators [3] have reported that the combined roles of iron and manganese are much more important than their individual roles. Shive [4] presented data for a number of crops suggesting that an Fe/Mn ratio of 1.5 – 2.5 is required for normal growth of plants.

Calcareous soils are of wide occurrence in most arid and semiarid regions of the world. Excessive amounts of $CaCO_3$ and other soluble salts decrease the availability of iron and manganese to plants and it is often necessary to supply additional iron and manganese to the soil [5]. The present work was conducted in pot houses to determine the effects of iron, manganese and phosphorus on growth and mineral composition of rice grain and straw.

## MATERIALS AND METHODS

Soil samples of plough depth were collected, air-dried, powdered and then thoroughly mixed. They were fertilized with 80 ppm of N as ammonium sulphate. Soil portions of 4.5 kg (pH 7.8, $CaCO_3$ 8.6 %) were filled in ploythene-lined plastic pots of 20 cm surface diameter and 22 cm depth. Four series of experiments were set up. In each series P in the form of $KH_2PO_4$ was added to soil at different rates; Fe as $FeSO_4$ and Mn as $MnSO_4$ were also added at variable levels to the same pots. The different levels of Fe, Mn and P used in this investigation are shown in Table 1.

Four weeks old rice seedlings (cv. IR – 8) were transplanted at the rate of four seedlings per pot. The pots were kept flooded to 5 cm depth with water throughout plant growth. There were four replicates of each treatment.

Rice plants were harvested by cutting the plants above ground level at maturity period. The samples were dried at 70°, cooled in a dessicator and finally weighed for their dry weights. Rice grains were collected from each

Table 1. Levels of elements applied to soil.

| Levels of Fe and Mn each added (ppm) | Levels of P (ppm) |
|---|---|
| 0,0 | 0,20,40,60 |
| 10,10 | 0,20,40,60 |
| 20,20 | 0,20,40,60 |
| 40,40 | 0,20,40,60 |

treatment, dried and weighed out. Samples of straw and grain were digested in a mixture of nitric, perchloric and sulphuric acids (5:2:1). The digest was analyzed for P by vanadomolybdo phosphoric yellow method, while iron and manganese were determined by O-phenonthroline and periodate methods respectively [6].

## RESULTS AND DISCUSSION

The application of Fe and Mn alongwith different levels of P has variable effects on the yield, plant height and number of tillers. Addition of P in the absence of Fe and Mn increased plant height, number of tillers, straw and grain yield in majority of cases. But the treatment effects were not significant. Similarly increased levels of iron and manganese without P slightly increased the plant height but had no effects on other plant parameters (Table 2). It is therefore concluded that the application of Fe, Mn and P alone and in combination in this soil has no beneficial effects on the growth of rice plants.

The iron content of rice straw and grain was reduced by P levels with out Fe and Mn, but only at 40 ppm P level an increase in Fe concentration was recorded (Table 3). Iron and Manganese applications without P have no clear effects on the uptake of Fe by grain and straw. Combined effects of P, Fe and Mn has inconsistent effects on the uptake of Fe by rice grain and straw with the exception of 20 ppm P alongwith 20 ppm Fe and Mn, where Fe uptake increased in grain. The reason for increased Fe in rice grain at this level is not clear and is being investigated. High levels of P have been found to reduce Fe absorption by plants, especially under neutral or alkaline conditions [1], due to conversion of $Fe^{++}$ to insoluble ferric forms in these soils [7]. However, it was also observed that rice straw contained more Fe than grain at all levels of these elements.

The manganese content of straw and grain was increased by increased P levels with zero Fe and Mn, but a slight reduction at 60 ppm P was recorded. With the increased application of Fe and Mn from 0 to 40 ppm manganese concentration decreased in straw and grain without P additions. But only at 10 ppm Fe and Mn and increase uptake of Mn was recorded in grain. The reduction of Mn in straw and grain with the additions of Fe and Mn might perhaps be due to the antagonistic, effects of these elements. This confirms the results reported by other workers for different crops [8, 9]. As with Fe, the combined effects of Fe, Mn and P has no appreciable effects on the uptake of Mn by yield components. It was observed from Table 5 that application of P, Fe and Mn alone and in combination has no significant effects on the uptake of P by rice grain and straw. Literature has revealed that P is an important constituent of grain of may cereals and is necessary for seed developments.

It was therefore concluded from the above study that the applications of P, Fe and Mn either alone or in combination has no beneficial effects on the yields, plant height and growth of tillers. On the other hand when

Table 2. Effects of Fe, Mn and P on plant height, number of tillers, straw and grain wts. of rice plants.

| | Levels of Fe and Mn each applied in ppm. | | | |
|---|---|---|---|---|
| P levels (ppm) | 0 | 10 | 20 | 40 |
| **Plant height (cm)** | | | | |
| 0 | 65.5 | 67.5 | 69.0 | 72.0 |
| 20 | 67.0 | 67.8 | 68.3 | 73.3 |
| 40 | 71.3 | 69.0 | 72.5 | 73.0 |
| 60 | 70.8 | 70.0 | 72.0 | 67.5 |

Continued

| | | | | |
|---|---|---|---|---|
| SE | 2.43 | 2.33 | 2.42 | 2.16 |
| LSD at 5% | NS | NS | NS | NS |
| Number of tillers/pot | | | | |
| 0 | 11.0 | 11.3 | 13.3 | 11.3 |
| 20 | 12.8 | 15.0 | 13.3 | 13.8 |
| 40 | 12.8 | 15.0 | 13.3 | 13.8 |
| 60 | 12.8 | 13.0 | 12.5 | 13.3 |
| SE | 1.12 | 1.32 | 1.32 | 1.02 |
| LSD at 5% | NS | NS | NS | NS |
| Straw wt. g/pot. | | | | |
| 0 | 12.1 | 13.7 | 18.2 | 13.5 |
| 20 | 12.2 | 14.6 | 15.5 | 13.8 |
| 40 | 16.6 | 18.4 | 17.4 | 14.7 |
| 60 | 15.3 | 15.9 | 15.9 | 14.3 |
| SE | 1.51 | 1.78 | 1.43 | 1.01 |
| LSD at 5% | NS | NS | NS | NS |
| Grain wt. g/pot. | | | | |
| 0 | 12.0 | 13.7 | 15.6 | 15.5 |
| 20 | 13.0 | 15.5 | 16.2 | 13.1 |
| 40 | 16.3 | 13.7 | 16.2 | 15.3 |
| 60 | 14.2 | 16.1 | 15.7 | 13.3 |
| SE | 1.15 | 1.09 | 1.33 | 0.91 |
| LSD at 5% | NS | NS | NS | NS |

Table 3. Effects of P, Fe and Mn, on the content of Fe in straw and grain of rice.

| | Levels of Fe and Mn each applied in ppm | | | |
|---|---|---|---|---|
| P levels (ppm) | 0 | 10 | 20 | 40 |
| Fe concentration in straw(ppm) | | | | |
| 0 | 640 | 512 | 601 | 607 |
| 20 | 504 | 523 | 579 | 456 |
| 40 | 681 | 661 | 573 | 509 |
| 60 | 603 | 573 | 558 | 509 |
| S.E. | 74 | 52 | 26 | 44 |
| LSD at 5 % NS | NS | NS | NS | NS |
| Fe concentration in grain (ppm) | | | | |
| 0 | 101 | 81 | 76 | 87 |
| 20 | 78 | 89 | 138 | 80 |
| 40 | 104 | 91 | 90 | 68 |
| 60 | 83 | 92 | 73 | 84 |
| S.E. | 3.7 | 4.8 | 7.8 | 4.7 |
| LSD at 5% | 11.5 | NS | 24.1 | NS |

Table 4. Effects of P,Fe and Mn on the content of Mn in straw and grain of rice.

| | Levels of Fe and Mn each applied in ppm. | | | |
|---|---|---|---|---|
| P levels (ppm) | 0 | 10 | 20 | 40 |
| Mn concentration straw (ppm). | | | | |
| 0 | 256 | 249 | 245 | 225 |
| 20 | 268 | 260 | 253 | 261 |
| 40 | 290 | 290 | 262 | 370 |

Continued

| | | | | |
|---|---|---|---|---|
| 60 | 274 | 240 | 270 | 295 |
| S.E | 17 | 16 | 18 | 37 |
| LSD at 5% | NS | NS | NS | NS |
| Mn concentration in grain (ppm) | | | | |
| 0 | 34 | 38 | 29 | 29 |
| 20 | 37 | 40 | 28 | 38 |
| 40 | 42 | 37 | 31 | 33 |
| 60 | 37 | 40 | 33 | 34 |
| S.E. | 2.8 | 3.4 | 2.9 | 2.4 |
| LSD at 5% | NS | NS | NS | NS |

Table 5. Effects of Fe and Mn on the content of P in straw and grain of rice.

| | Levels of Fe and Mn each applied in ppm. | | | |
|---|---|---|---|---|
| P levels (ppm) | 0 | 10 | 20 | 40 |
| P % in rice straw. | | | | |
| 0 | 0.13 | 0.13 | 0.07 | 0.06 |
| 20 | 0.13 | 0.13 | 0.07 | 0.09 |
| 40 | 0.13 | 0.10 | 0.09 | 0.09 |
| 60 | 0.15 | 0.09 | 0.09 | 0.09 |
| SE | 0.006 | 0.009 | 0.007 | 0.008 |
| LSD at 5% | NS | 0.027 | 0.020 | 0.023 |
| P % in grain. | | | | |
| 0 | 0.28 | 0.22 | 0.26 | 0.24 |
| 20 | 0.29 | 0.25 | 0.28 | 0.28 |
| 40 | 0.30 | 0.26 | 0.28 | 0.26 |
| 60 | 0.31 | 0.28 | 0.29 | 0.28 |
| SE | 0.006 | 0.008 | 0.006 | 0.009 |
| LSD at 5 % | NS | 0.023 | 0.018 | 0.030 |

any of them applied together to the growth medium, tended to reduce the uptake of each other by rice straw and grain in majority of cases.

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