EFFECT OF DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS UPON THE UPTAKE OF ZINC AND MANGANESE WITH SPECIAL REFERENCE TO RICE CROP.

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In a pot study on rice, urea and superphosphate were each applied at the rate of 60, 120 and 180 lbs. of N or P_2O_5/acre in all possible combinrtions. Chemical analysis of grain and straw revealed that the up-take of Zn by rice plants increased as the rate of N applied was increased. However, phosphate fertilizer exerted a depressive influence on Zn uptake. Mn uptake was increased by both nitrogen and phosphorus fertilizers. The increase in Mn caused by nitrogen fertilizer was greater than that by P fertilizer.

INTRODUCTION

Untill recently traditional low-yielding varieties of rice were grown in West Pakistan, micronutrient element disorders or deficiencies were very rare, possibly because the requirement of these crops were low and the amounts in soil were sufficient to meet their requirement. But with the introduction of high yielding varieties judicious and liberal fertilization has become necessary. Deficiencies of micronutrients are sometimes observable on high yielding varieties need higher amounts of micronutients which the soils may not be able to supply. An interection between the macro- and micro-nutrients may as be one of the cause of low availability of micronutrients. This study was undertaken to assess the effect of N and P on uptake of Zn and Mn in rice. Steckel *et al.* (1948) observed a beneficial effect of superphosphate on the uptake of applied manganese when both fertilizers were mixed together. He attributed this beneficial effect to precipitation of manganese as manganous phosphate which could retard the oxidation of manganese and would provide a constant though small supply of divalent manganese. Woltz *et al.* (1953) reported an increase in yield and zinc uptake by clover when nitrogen was applied as urea and ammonium nitrate. The increase in Zn uptake was attributed to the lowering of soil pH. Boawn *et al.* (1954) reported that phosphate has no adverse effect on Zn absorption or utilization. Regardless of the mechanism of phosphate induced zinc deficiency the bean plant, though extremly sensitive, did not appear to be influenced by a high concentration of phosphate either in soil or in plant tissue. More than doubling the concentration of phosphate in plant tissue failed to produce zinc deficiency symptoms or reduce the yield of drymatter of bean grown in green house. Clark *et al.* (1957) observed that fertilization of rice with urea nitrogen at the rate of 400 lbs/acre resulted in an increase in the uptake of manganese by plants. This was due to change in soil pH brought about by the fertilizer. Langin *et al.* (1962) reported that fertilizer nitrogen enhanced zinc uptake by corn plants because nitrogen usually reduced plant P content. Vlamis and Williams (1962) reported that phosphate resulted in higher Mn in tissues. The tendency of

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P to increase Mn uptake suggested the possibility of tying up of Fe either on roots or with-in plant and indirectly, thus effecting absorption of manganese. Burleson *et al.* (1961) concluded that P fertilization may induce Zn deficiency in some crops under certain soil and climatic conditions enhanced by cold wet soils during early part of the growing season by restricting root development near to the zone of fertilizer placement. He suggested P-Zn antagonism within the roots. Stukenholtz *et al.* (1966) reported that nitrogen placement with phosphorus promoted zinc uptake because it benefits phosphorus promoted zinc uptake because it benefits phosphorus utilization. He further reported that P application decreased zinc uptake in corn. Depressive action of P on Zn was attributed to the inhibited translocation from roots to tops.

MATERIALS AND METHODS

The experiment was conducted in glazed pots using a normal (non-saline, non-alkali) sandy clay loam soil. Nitrogen as urea and phosphorus as triple superphosphate were applied each at three levels in all possible combinations. The levels of nitrogen and phosphorus were 60, 120 and 180 lbs of N and P_2O_5/ acre. The treatments were completely randomized and there were in all four repeats. Treatments were thoroughly mixed in requisite quantities with soil prior to filling in the pots. Seedlings were transplanted at the rate of 3 plants/ pot. Water was applied at appropriate intervals to maintain required level of water for rice growth. Crop was harvested at maturity and grain and straw yields were recorded and representative samples were obtained for N, P, K, Ca+Mg, Zn and Mn determinations. Samples were washed thoroughly with distilled water to remove the dust particles and were air dried. Straw samples were chopped with stainless steel sharp edged knife. Samples were then kept in a well cleaned oven at 70°C temperature for more than 36 hours for complete dryness. The grain samples were then husked with a clean wooden mortar and pestle. Both grain and straw samples were then ground in a laboratory grinding mill with stainless steel blades, and stored in clean plastic jars.

Zinc was determined by Dithiazone method as proposed by Prince, (1954); using Bausch and Lomb "spectronic 20", Manganese was estimated by potassium periodate oxidation method using Bausch and Lomb "spectronic 20" as also described by, Prince.

RESULTS AND DISCUSSION

Rice was grown in glazed pots. Urea and superphosphate were added separately and in combination to supply zero, 60, 120 and 180 lbs/acre of

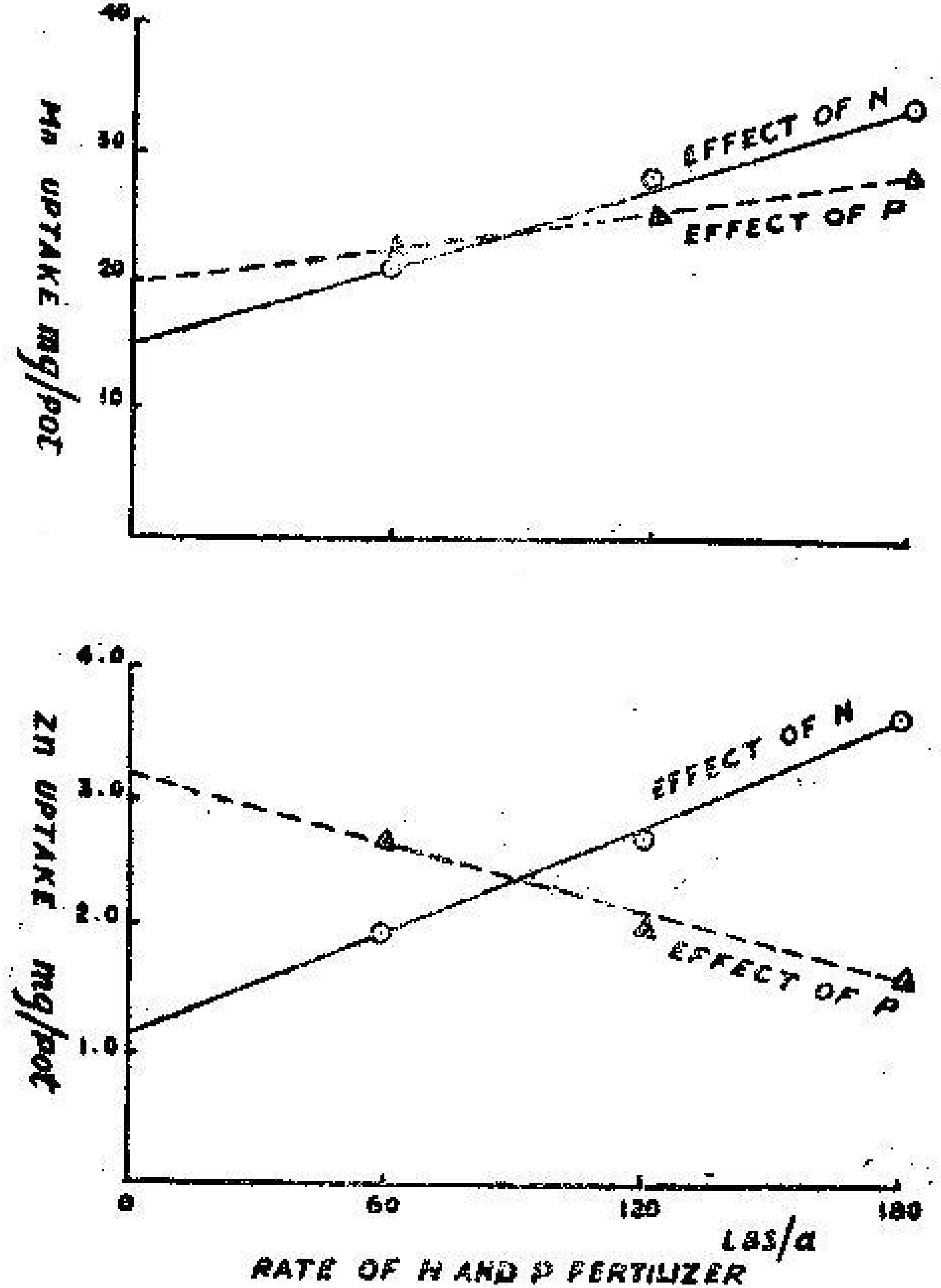

FIG. 1 EFFECT OF N AND P FERTILIZERS ON Zn OR Mn UPTAKE BY RICE PLANTS

the nutrient element or elements. The purpose was to see the effects, if any, of these nutrients on the uptake of Zn and Mn by rice plants. The data obtained are given in Tables 1 and 2 and illustrated in Fig. 1.

Effect on Zn uptake

The data given in Table 1 and illustrated in Fig. 1 (bottom) revealed that uptake of Zn by rice plants increased as the rate of N applied was increased.

The Zn uptake was found to be 1.97 mg per pot when 60 lbs. of N were applied. The uptake increased to 2.72 and 3.57 mg with 120 and 180 lbs. N, respectively. Enhanced uptake of Zn due to N fertilizers may be due to its favourable influence on root growth resulting in absorption of higher amounts of Zn.

Woltz et al. (1953) observed similar increase in the Zn uptake by clover when N was applied as urea and ammonium nitrate. They attributed this effect to the lowering of soil pH. The nitrification of ammonium-N causes the production of acidity which neutralises the alkalinity resulting in the lowering of soil pH. *Langin et al.* (1962) reported that fertilizer N enhanced Zn uptake by corn plants because N usually reduced plant P content.

Phosphate fertilizer has exerted a depressive influence on the Zn uptake by rice plants.

The Zn uptake was found to be 3.22 mg/pot when no P fertilizer was applied. The uptake decreased to 2.66 mg with the application of 60 lbs P. The uptake was further reduced to 2.0 and 1.61 mg/pot, respectively by the use of 120 and 180 lbs. P. The reduction in the Zn uptake may be attributed to the Zn-P interaction resulting in the formation of isoluble compound and thus reducing the available Zn. Burleson *et al.* (1961) and Stukenholtz *et al.* (1966) concluded that the reduced uptake of Zn as a result of P fertilization was mainly due to the inhibitive effects of P on Zn translocation from roots to the tops.

From the observations made in this investigation and those of Burleson and Stukenholtz it may be concluded that P exerts insolubilizing effect both in soil and in the roots.

TABLE 1. *Concentration and uptake of zinc in rice grain and straw as affected by different levels of nitrogen and phosphorus.*

(Average of four repeats)

N & P Treatments	Grain		Straw		Total
	conc.	uptake	conc.	uptake	uptake
	ppm	mg/pot	ppm	mg/pot	mg/pot
60-0-0	35.8	1.011	32.7	1.460	2.472 fg
120-0-0	43.3	1.441	39.3	2.214	3.655 c
180-0-0	47.1	1.748	41.2	2.988	4.737 a
0-60-0	28.2	0.647	22.4	0.714	1.362 j
60-60-0	30.2	0.916	24.9	1.209	2.126 h
120-60-0	39.0	1.029	32.3	1.876	3.156 d
180-60-0	42.4	1.529	35.6	2.464	3.993 b
0-120-0	18.3	0.478	13.3	0.495	0.974 k
60-120-0	25.9	0.828	18.7	0.968	1.796 i
120-120-0	27.1	0.956	22.7	1.420	2.299 gh
180-120-0	32.2	1.192	26.5	1.794	2.986 e
0-180-0	6.6	0.200	10.0	0.410	0.610 l
60-180-0	20.0	0.637	14.3	0.786	1.473 j
120-180-0	22.1	0.819	16.4	0.966	1.785 i
180-180-0	26.9	1.077	21.5	1.487	2.564 f

Averages followed by the same letters did not differ statistically among themselves at P.05 probabily level.

Effect on Mn Uptake

The data are given in Table 2 and illustrated in Fig 1 (top). It is evident from the data that Mn uptake was increased by both nitrogen and phosphorus fertilizers. The increase in Mn caused by nitrogen fertilizer was much more in magnitude than that obtained by P fertilizer. The Mn uptake increased from 15 to 33 mg/pot when nitrogen application was increased from zero to 180 lbs./a. Thus N application brought about more than 100% increase in the Mn uptake. The application of P-fertilizer increased the uptake from 20 to 28 mg/pot indicating an increase of about 40%. It was further evidenced that P application was effective only when phosphorus to nitrogen ratio was one or greater. At lower rates, P affected only very minor changes. When N application was 60 lbs, all rates of P produced good effects but when N was increased to 120 lbs., P application of 60 lbs. had no effect. When level of N was raised to 180 lbs, P levels at 180 lbs were effective and the lower rates i.e. 60 and 120 had very little effect.

The increase in Mn uptake due to N and P fertilizers have also been observed by Steckel *et al.* (1948), Clark, *et al.* (1957) and Vlamis and Williams (1962).

TABLE 2. *Concentration and uptake of manganese in rice grain and straw as affected by different levels of nitrogen and phosphorus.*

(Average of four repeats)

N & P Treatments	Grain		Straw		Total
	conc.	uptake	conc.	uptake	uptake
	ppm	mg/pot	ppm	mg/pot	mg/pot
60-0-0	24.5	0.688	369.2	16.40	17.092 fg
120-0-0	29.0	0.962	410.0	24.30	25.520 d
180-0-0	28.5	1.066	425.0	30.77	31.826 bc
0-60-0	23.0	0.527	355.0	11.33	11.858 h
60-60-0	26.0	0.786	376.2	18.20	18.999 f
120-60-0	26.0	0.852	427.5	24.76	25.617 d
180-60-0	36.1	1.256	450.0	30.98	32.236 b
0-120-0	25.0	0.649	383.7	14.23	14.877 g
60-120-0	33.0	1.050	407.5	21.11	22.163 e
120-120-0	37.0	1.304	440.0	28.12	29.424 c
180-120-0	39.0	1.439	455.0	31.00	32.569 b
0-180-0	34.5	1.044	470.0	17.22	18.269 f
60-180-0	37.0	1.274	440.0	24.23	25.484 d
120-180-0	39.0	1.446	483.0	28.45	29.896 bc
180-180-0	43.2	1.725	498.7	34.39	36.120 a

Averages followed by the same letters did not differ satistically among themselves at P. 05.

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