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EFFECTS OF COPPER AND PHOSPHORUS ON GROWTH AND NUTRIENT CONTENT OF RICE

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The effects of Cu and P on the dry matter yield and nutrient content of P and Cu were studied under pot house condition on rice plant on an alkaline soil. The application of Cu alone upto 4 ppm increased the straw and grain yield of rice, whereas yield decreased with further increase in Cu levels. Similarly addition of P alone upto 40 ppm increased yield but decrease was observed beyond that level. The application of Cu upto 4 ppm in the presence of P however, increased yields at all P levels. The maximum straw and grain yields were recorded when 4 ppm Cu was supplied with 40 ppm P.

Phosphorus concentration in straw and grain increased with increase in P levels but without Cu. P concentration also increased with Cu addition upto 4 ppm. With further addition of Cu, P content decreased in both parts of the plant. The increased application of Cu increased the Cu content of straw and grain at all P levels. The application of 40 ppm P generally increased Cu concentration in both plant parts. But decrease was observed with further increase in P levels. The low levels of Cu and P were essential for better plant growth and efficient utilization of these nutrients. Antagonistic effect was observed only when one of the nutrients was applied in larger quantities in the growth medium.

INTRODUCTION

Among various factors contributing to plant growth, nutrients availability plays a vital role, however, these may interact synergistrically or antagonistically either in soil, in plant or at absorption sites. Copper and phosphorus both of which are essential nutrients for plants and animals, find an important place in the use of macro and micronutrients for increasing crop production. A number of investigations have reported that excessive or prolonged use of phosphatic fertilizers may alter the availability of other essential elements, especially micronutrients such as Zn, Mn and Cu [1, 2, 3]. In agronomic crop production, Zn-induced P deficiencies are generally the primary concern with excessive P applications [4, 5]. However, several authors have reported on the relationship between P and Cu and their effects on plant growth and yield. The occurrence of P, induced Cu deficiencies in citrus have been well documented [6, 7, 8]. There are also evidences of antagonistic P and Cu relationships in some cereal crops [9, 10]. Brown [9] reported that Cu deficiencies in wheat resulted in less Cu translocation to the upper leaves and the P applications accentuated Cu deficiency.

Very little information concerning the effects of Cu and P on yield and nutrient content of rice plant is, however available. The experiments reported herein were designed to study this aspect of the problem.

MATERIALS AND METHODS

The effect of Cu and P on the yields and the nutrient content of P and Cu were studied in a pot experiment involving a possible combination of five rates of Cu (0,2, 4, 6 and 24 ppm), and five rates of P (0, 20, 40, 80 and 100 ppm) applied in triplicate to rice seedlings growing in alkaline soil. The phosphorus and copper were mixed in the soil and kept on plastic sheet for three days prior to transplanting the rice seedlings to allow time for any reaction to take place between P, Cu and other soil constituents. The alkaline soil used contained N 0.059 %, P 0.03 %, K .55 %, available P 2.0 ppm, and K 3.2 ppm and pH 7.9. Standard methods of soil analysis were followed for determination of the above soil properties.

Phosphorus was applied as potassium dihydrogen phosphate and Cu was applied as finely ground copper sulphate. Both compounds were mixed with the soil in a mixer along with the basic fertilizers containing 40 and 30 ppm N and K respectively. The prepared soil in individual 18 cm surface diameter tin pots (3 kg), was kept moist by adding distilled water. Three plants/pot of rice variety N-sial were grown upto maturity.

At harvest the yield of grain and straw recorded separately. The samples were ground in a stainless steel Wiley Mill. For P and Cu determination 0.5 g of straw and grain samples were prepared for analysis by wt-digestion procedures, using nitric, perchloric and sulphuric acids. Cu was determined by a carbamate colorimeter method utilizing carbon tetrachloride [12] and P in the plant digest was estimated by vanadomolybdophosphoric yellow method.

RESULTS AND DISCUSSION

The straw and grain yield, and nutrient content were effected by Cu and P applications (Tables 1-4). The application of Cu alone upto 4 ppm increased the straw and grain yield of rice (Tables 1 & 2), whereas, yield decreased with further increase in Cu levels. The yield with 24 ppm Cu was even less than the yield recorded in the control pots (no Cu and no P). It was also observed that yield increased with P alone upto 40 ppm and decreased considerably at the highest P level (100 ppm P). The application of Cu upto 4 ppm in the presence of P, increased yield at all levels of P. The maximum straw and grain yields were recorded when 4 ppm Cu was supplied with 40 ppm P. Decrease followed afterwards with further increase in Cu and P levels. The results thus revealed that yield of rice was maximum when both Cu and P applied at a low level in the soil. The decrease in yield at higher Cu and P levels seems to be due to chemical reactions between Cu and P in the soil with a high pH. It was also observed that these nutrients responded well when applied separately at low levels in the growth medium.

Phosphorus concentration in straw and grain of rice increased considerably with increasing P levels in the absence of Cu application (Table 3). Phosphorus concentration also increased with Cu application upto 4 ppm. With further increase in Cu level, the P concentration decreased in straw and grain. Several authors [6, 11] have reported that Cu at low level stimulated P absorption and translocation by plant roots. It was also observed that P concentration in rice grain was much higher than that of straw. Literature reveals that P is an important constitution of grain of many cereals and is necessary for seed formation.

It was observed from Table 4 that Cu concentration in rice grain and straw increased with increasing levels of Cu at all the P levels. The application of 40 ppm P generally

Table 1. Effect of different levels of P and Cu on straw yield of rice (g/pot).

Cu levels (ppm)	P levels (ppm)					Mean
	0	20	40	80	100	
0	23.97	32.87	34.03	34.00	30.23	31.02c
2	28.50	35.57	37.03	34.1	30.30	33.10b
4	29.67	36.60	37.51	34.1	31.23	33.85a
12	29.00	34.50	36.07	35.70	30.60	33.35b
24	24.17	27.73	28.97	29.00	28.33	27.77d
Mean	27.06d	33.45b	34.91a	33.39b	30.14c	

LSD (0.05), Cu & P 0.45, Cu x P 1.01.

Table 2. Effect of different levels of P and Cu on grain yield of rice (g/pot).

Cu levels (ppm)	P. levels (ppm)					Mean
	0	20	40	80	100	
0	8.20	10.17	11.87	10.87	10.87	10.23c
2	9.07	11.30	12.80	10.97	10.50	10.93b
4	10.30	12.93	13.60	11.93	11.77	11.98a
12	9.43	10.80	12.30	11.70	11.40	11.13b
24	6.37	8.00	9.93	10.90	10.03	9.05d
Mean	8.67c	10.40d	12.07a	11.20b	10.77c	

LSD (0.05), Cu & P 0.28, Cu x P 0.63.

Table 3. Effect of different levels of P and Cu on P concentration in straw and grain.

Cu levels (ppm)	P levels (ppm) 0	20	40	80	100	Mean
	P concentration in straw (ppm)					
0	780	1465	1709	2192	2549	1739d
2	833	1834	1950	2385	2512	1903a
4	980	1888	2020	2355	2508	1829c
12	940	1837	1952	2132	2465	1865b
24	872	1600	1932	2021	2355	1765d
Mean	881e	1725d	1912c	2217b	2478a	

LSD (0.05), Cu & P 26.41, Cu x P 59.05.

Cu levels (ppm)	P levels (ppm) 0	20	40	80	100	Mean
	P concentration in grain (ppm)					
0	1314	1917	2600	2921	3640	2478c
2	1504	2424	2916	3234	3920	2799b
4	1590	2540	3148	3323	3926	2905a
12	1588	2528	3057	3240	3982	2879a
24	1020	2062	2628	2628	3832	2436d
Mean	1403e	2294d	2872c	3069b	3860a	

LSD (0.05), Cu & P 55.37, Cu x P 123.82.

Table 4. Effect of different levels of P and Cu on Cu concentration in straw and grain.

Cu levels (ppm)	P levels (ppm) 0	20	40	80	100	Mean
	Cu concentration in straw (ppm)					
0	3.43	3.73	4.27	4.03	3.63	3.82e
2	4.37	5.17	5.57	4.67	3.87	4.73d
4	4.30	5.73	5.57	5.57	4.80	5.19c
12	7.27	6.20	4.80	5.03	4.90	5.64b
24	11.27	11.20	9.27	9.03	7.07	9.57a
Mean	6.13b	6.40a	5.89c	5.67d	4.85e	

LSD (0.05), Cu & P 0.19, Cu x P 0.43.

Cu levels (ppm)	P levels (ppm) 0	20	40	80	100	Mean
	Cu concentration in grain (ppm)					
0	4.63	4.90	6.10	4.90	3.80	4.87e

(Continued - - - - -)

(Table 4, continued.)

2	6.23	7.80	7.60	6.13	4.40	6.57d
4	8.83	9.03	8.60	8.00	5.47	7.99c
12	12.07	1.90	11.63	10.17	6.90	10.53b
24	17.33	18.50	17.63	14.0	12.53	16.00a
Mean	9.82c	10.43a	10.31b	8.64d	6.75e	

LSD (0.05), Cu & P 0.41, Cu x P 0.91.

increased Cu concentration in both plant parts. P application beyond 40 ppm substantially decreased Cu concentration in grain and straw. This showed that in the presence of high P, absorption and utilization of Cu from soil is reduced. The findings of several workers have revealed that high levels of P decreased the absorption and translocation of Cu by plant roots [6, 7, 8]. It was concluded from the above experiment that the low levels of Cu and P were essential for better plant growth and efficient utilization of these nutrients, and antagonistic effect was observed only when one of the nutrients was applied in large quantities in the growth medium.

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