EFFECT OF APPLIED ZINC AND MANGANESE ON THE GROWTH OF RICE II. AT DIFFERENT STAGES OF GROWTH

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ABSTRACT

Rice (*Oryza sativa* L., variety JAYA) plants were raised up to maturity. Dry weight of roots and shoots and micronutrient contents were determined at 30 and 60 days after transplanting and at maturity. Dry weight of roots increased with plant growth up to 60 days, but dry weight of shoots continued to increase up to maturity. Response of rice to zinc application was more during early stages whereas response to manganese application was more during subsequent stages of growth. Micronutrient content of shoots was at its peak during early growth, but decreased with time up to maturity. Content of zinc, manganese and iron in roots increased throughout the growth period. Content of copper in roots and shoots decreased after 30 days of growth.

INTRODUCTION

Rice plant's growth pattern and process of nutrient uptake differ greatly from those of other plants (ISHIZUKA, 1965). In determining the rational fertilization of micronutrients, it is not only necessary to take into account nutrient uptake at maturity but also at different stages of growth. It is also desirable to estimate the contribution of nutrients absorbed at different stages of growth towards grain yield. The information on this aspect is lacking. Accordingly, the present study has been designed to study the growth pattern and nutrient uptake by rice at different stages of growth.

MATERIAL AND METHODS

Laungowal loam, a (Paraquic) Natric Camborthid from village Duggan in District Sangrur (Punjab, India), was the test soil. Physico-chemical characteristics and different treatments are described in a previous paper (BRAR AND SEKHON, 1976). Rice (*Oryza sativa* L., variety Jaya) seedlings were raised for 15 days before transplanting in treated pots. There were three replications and plants were kept under submerged conditions throughout the growth. Plants were harvested after 30 and 60 days of transplanting and at maturity. Preparation of samples and analysis for micronutrients is given earlier (BRAR AND SEKHON, 1976).

RESULTS AND DISCUSSION

The data in Table 1 show that dry weight of roots and shoots increased with growth upto 60 days. However, dry weight of shoots alone continued to increase upto maturity. It is largely due to ear initiation and development. Thus ratio of dry weight of roots to dry weight of shoots decreased from 0.55 to 0.18 with increase in growth from 30 days to maturity, indicating that root development occurs mainly during early stages of growth.

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Table 1—Effect of zinc and manganese application on dry weight of plant at different stages of growth

Rate of application (ppm) Mn		Zn	Dry weight of roots (g/pot) 30 Days	60 Days	Maturity	Dry weight of shoots (g/pot) 30 Days	60 Days	Maturity Straw	Paddy
0	..	0	0.7	4.4	4.2	3.2	16.6	19.1	11.6
		5	4.7	8.2	7.6	9.1	26.1	28.9	16.9
		10	4.8	8.3	7.5	8.3	27.4	31.3	16.4
10	..	0	0.9	7.5	7.3	3.1	28.8	27.2	16.7
		5	4.7	8.9	10.3	7.4	28.6	31.4	19.0
		10	4.1	8.9	9.8	6.7	28.7	24.7	19.2
20	..	0	1.0	7.6	7.4	3.2	26.8	26.6	16.7
		5	4.9	11.0	10.6	7.4	30.8	29.3	19.1
		10	4.4	7.8	8.9	7.4	25.0	23.2	18.9
Mean	..	..	3.4	8.1	8.2	6.2	26.5	26.9	17.2
C. D. at 5%									
	Zn	..	1.44	1.35	1.48	1.44	3.39	3.35	2.14
	Mn	..	NS	1.35	1.48	NS	3.39	NS	2.14
	Zn × Mn	..	NS	NS	NS	NS	5.85	5.79	NS

It is also evident from the data that increase in weight of the plant with advancement of growth depended upon the availability of zinc to the plants. Although the weight of plants, at all stages of growth, was higher in zinc treated pots, but the ratio of increase in weight between 30 days of growth and maturity was more in no-zinc pots. This difference might be due to poor growth of untreated plants at early stage of growth which was overcome with advancement in growth. Rate of increase in dry weight of roots during this period was about 7-fold in no-zinc and 2.5-fold in 5 ppm zinc treated pots. Increase in weight of shoot was about 12-fold in no-zinc and 6-fold in 5 ppm zinc treated pots. Data pertaining to zinc content in shoots also showed that it was maximum at 30 days of growth and it continued to decrease upto maturity in zinc treated pots. However, under conditions of zinc deficiency, when zinc was not applied to the soil, the plant continued to absorb and translocate zinc throughout the period of growth. It resulted in increase in the weight of shoots with time. This may explain why zinc deficiency symptoms observed during early stages of crop growth often disappear during later stages of growth.

Dry weight of plants increased with an application of 5 ppm zinc and 10 ppm manganese respectively at all stages of growth except during the initial stage when response to manganese was insignificant. Response of rice to zinc application was more during early stages. Increase in root weight was more than 500 per cent with application of 5 ppm zinc to the soil at 30 days of growth, whereas it decreased to less than 200 per cent during subsequent stages of growth. Similar trend in shoot growth was observed. Response of rice to manganese application was more during later stages of growth.

Rice yield depends upon the magnitude of photosynthesis during the ripening period (MATSUSHIMA, 1972 and STANSEL, BOLLICH, THYSELL AND HALL, 1965 as cited by YOSHIDA, 1972). Higher response of plants to the application of manganese at later stages of growth is expected, since manganese increases the photosynthesis of plants through its involvement in electron transport (CHENIAE & MARTIN, 1970). Contribution of ear photo synthesis to the dry weight of grain has also been estimated to an extent of 23 per cent (ENYI, 1962).

Micronutrient content in rice plant as depicted in Fig. 1 shows that micronutrient content of shoots was at its peak at 30 days of growth, and then decreased with advancement in growth upto maturity. The pattern of nutrient concentration observed in this study could be explained in terms of the factors which according to TANAKA, NAVASERO, PARAO, PARIO AND RAMERVEZ (1964) are nutrient availability in the soil, nutrient absorbing and translocating power of roots at various growth stages and rate of increase in dry weight. Decrease in content of these nutrients within 30 to 60 days of transplanting paddy was due to dilution effect caused by tremendous increase in growth of shoots during this period. Further decrease in nutrient content with time upto maturity may be due to translocation of these nutrients from shoots to grains.

The trend was different in roots where content of zinc, iron and manganese increased throughout the growth period. Evidently, roots continue to absorb micronutrients throughout the growth period. TANAKA, NAVASERO, PARAO; PARIO AND RAMERVEZ (1964) also observed that nutrient absorbing power of roots remains constant throughout the growing season. However, these micronutrients accumulate in roots do not get transported to shoots. Content of copper in roots and shoots decreased after 30 days of growth. Apparently, absorption of copper by roots decreased after 30 days of growth which is different from the absorption pattern of zinc, iron and manganese.

Effect of application of zinc and manganese on the content of zinc, manganese, iron and copper was similar as found earlier by the authors (BRAR & SEKHON, 1976). Application of zinc and manganese decreased the content of iron and copper in the plants.

The coefficients of correlation between grain yield and uptake of zinc and manganese both by root and shoot, at different stages of growth (Table 2), indicate that the nutrient uptake by shoot is a better indicator of the ultimate grain yield only during early stages of growth while at maturity the uptake by roots may give better predictability. This may be due to the translocation of nutrients from the shoot portion to the grains at later stages of growth, while the roots continue to absorb and accumulate these nutrients upto maturity.

Table 2—Coefficients of correlation between uptake of zinc and manganese at different stages of growth and grain yield of paddy

Plant part	Zinc			Manganese		
	30 days	60 days	Maturity	30 days	60 days	Maturity
Root	0.725*	0.758*	0.881**	0.776*	0.883**	0.885**
Shoot	0.784**	0.738*	0.571	0.925**	0.781**	0·684*

*Significant at 5% level
**Significant at 1% level

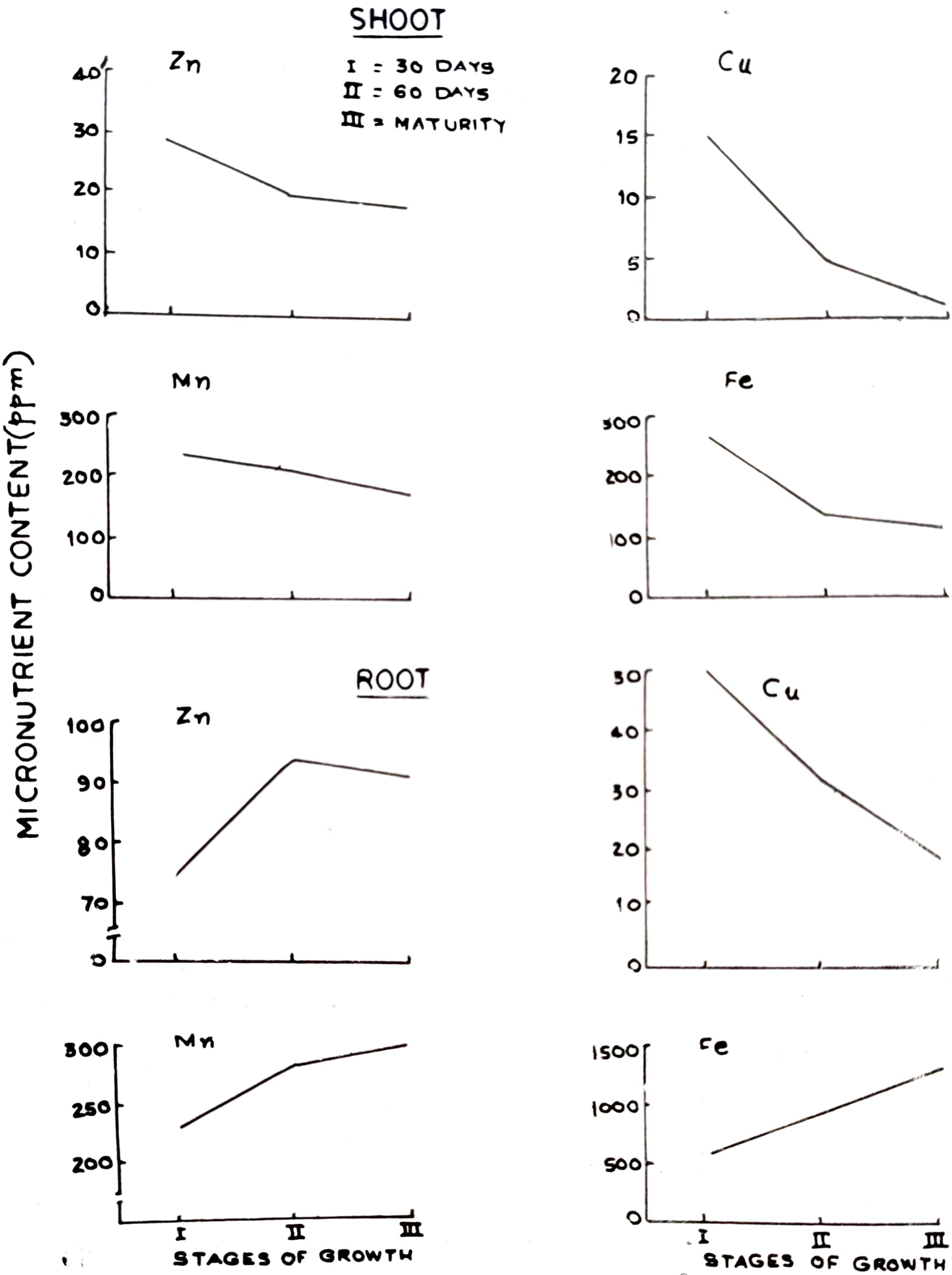

FIG.1. MICRONUTRIENT CONTENT AT DIFFERENT STAGES OF GROWTH OF RICE

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REFERENCES

BRAR, M. S. & SEKHON, G. S. (1976). Effect of applied zinc and manganese on the growth of rice. I. Under flooded and non flooded conditions. *Geophytolotogy*. **6**: 272-276.

CHENIAE, G. M. & MARTIN, L. F. (1970). Site of function of manganese-within photosystem II. Role in O_2 evolution and system II. *Biochem. biophys. Acta*. **197**: 219-39.

ENYI, B. A. C. (1962). The contribution of different organs to grain weight in upland and swamp rice. *Ann. Bot.* **26**: 529-531.

ISHIZUKA, I. (1965). Nutrient uptake at different stages of growth, pp. 199-217. In *The mineral nutrition of rice plant*. The Johns Hopkins Press, Baltimore, Maryland, U.S.A.

TANAKA, A., NAVASERO, S. A., PARAO, C. V., PARIO, F. T. & RAMERVEZ, E. (1964). Growth habit of the rice plant in the tropics and its effect on nitrogen response. *Tech. Bull. Int. Rice Res. Inst.* **3**: 80.

YOSHIDA, S. (1972). Physiological aspects of grain yield. *A. Rev. Pl. Physiol.* **23**: 437-64.