https://doi.org/10.29321/MAJ.10.A02647

Madras Agric. J. 70, (7) : 458—461 July 1983

PHOSPHORUS AND POTASSIUM NUTRITION OF RICE AS INFLUENCED BY ZINC AND IRON APPLICATION

R. SAKAL[1] and R. B. SINHA[2]

Application of zinc significantly increased the dry matter production and its efficiency was magnified in the presence of iron. Addition of 5ppm Zn with 10ppm Fe through ferric citrate was even superior than 20 ppm Fe through ferrous sulphate applied with 5 ppm Zn to enhance the dry matter yield. Zinc and Fe applications significantly decreased the P concentration in all the plant parts and maximum reduction in P concentration was noted when 5 ppm Zn was applied alongwith 20 ppm Fe through ferrous sulphate. Zinc and Fe have more depressive effect on P absorption at the site of roots. Potassium concentration in all the plant parts was increased by Zn application. The lowest K concentration value in roots and highest in shoots reflects the higher mobility of K from roots to shoots. Ferrous sulphate has relatively more depressing effect on K concentration than ferric citrate.

Zinc and iron deficiencies are widespread in the high yielding rice varieties grown in calcareous belt of north Bihar (Anon, 1981). Application of zinc and iron carriers alleviated the deifciency symptoms on crop and increased the yield remarkably. The absorption and translocation of other nutrients are expected to be influenced in plants when zinc and iron are applied to mitigate the zinc and iron nutrition problems. The present investigation was, therefore, undertaken to explore the effect of zinc and iron applications on the absorption and distribution of phosphorus and potassium in different parts of rice plant.

MATERIAL AND METHODS

A pot culture experiment was conducted in green house with sandy loam calcareous soil having pH, E. C, O, C, free $CaCO_3$, DTPA-extractable Zn and Fe, 8.3, 0.22 mmhos/cm, 0.45%, 30.6%, 0.56 and 4.50 ppm respectively. Standard procedures were followed for the determination of soil properties (Jackson, 1967). Available Zn and Fe were extracted with DTPA-extracting solution (Lindsay and Norvell, 1978). Zinc and iron were determined in the clear extract on atomic absorption spectrophotometer.

Polythene lined earthen pots were filled with 15kg processed soil. The treatments consisted of three levels of zinc viz. O, 2.5 and 5.0 ppm applied through reagent grade zinc sulphate and three levels of iron viz. O, 10 and 20 ppm applied through ferrous sulphate and ferric citrate. These fifteen treatments were replicated thrice in a completely randomized design. Rice variety I. R-20 was grown as test crop. A basal dose of 100 ppm N, 50 ppm P_2O_5 and 33 ppm K_2O was applied through ammonium sulphate and potassium dihydro-

1 and 2. Department of Soil Science and Agricultural Chemistry, College of Agricultural Rajendra Agricultural University, Pusa, Samastipur, Bihar.

gen orthophosphate respectively. The crop was grown upto full maturity. The roots were taken out by washing the soil with a jet of water. The grain was separated from straw and both the grain and straw were dried in oven at 65°C. The oven dry weight was recorded and the straw was separated into stem, leaf sheath and leaf blades These plant parts were digested in triacid mixture (Piper, 1950) and analysed for total P by Vanadomolybdophosphoric yellow colour method in nitric acid system (Jackson, 1967) and K by flame photometer (Jackson, 1967).

RESULTS AND DISCUSSION

Dry matter yield: Application of Zn @ 2.5 ppm in absence of Fe markedly increased the dry matter yield of roots, straw and grain. At 5 ppm Zn level the dry matter yield of roots, tended to decrease whereas straw and grain yield slightly increased. The per cent response in dry matter yield of root, straw and grain at 2.5 ppm applied Zn was 34, 28 and 29% respectively. The efficacy of Zn to enhance the dry matter production progressively increased in presence of Fe. This shows that for increasing the dry matter yields a judicious combination Zn and Fe level is essential in such soils. It was furthur observed that in presence of 5 ppm Zn the application of 10 ppm Fe through ferric citrate was superior than 20 ppm Fe applied through ferrous sulphate to augment the dry matter production. The superiority of ferric citrate over ferrous sulphate may be due to the fact that in former the Fe is present in chelated from which is efficiently utilised by the plants (Mortvedt and Giordano, 1971). The magnitude of Zn and Fe response is related to the inherent supply of these elements in soil. The available Zn and Fe in soil are quite below to their respective critical limits of 0.75 ppm (Sakal *et al*, 1981) and 6.0 ppm (Boer and Reisenauer, 1973) respectively.

Concentration and uptake of P: Application of Zn and Fe significantly decreased the P content in all the plant parts (Table 1). In absence of Fe, the application of 5 ppm Zn reduced the P concentration in roots, stem leaf sheath leaf blade and grain by 14, 18, 14, 17 and 14% respectively. Maximum reduction in P concentration in these plant parts was recorded when 5 ppm nZ was applied in combination with 20ppm Fe through ferrous sulphate. The percent reduction in P concentration at this Zn and Fe combination level in roots and grain was 29 and 20% respectively. This shows that Zn and Fe have more depressive effect on P absorption by roots. These results are in accordance with the findings of Tiwari and Pathak, 1978. They have suggested that increasing levels of Zn might block the absorption of P in root cells. The effect of Fe on decreasing P content in rice plants perhaps may be due to coating of iron oxide on the root surface (Howeler, 1973).

Concentration and uptake of K: Application of zinc in absence of Fe increased the concentration of K in all the plant parts. Maximum K concentration was recorded at 5 ppm applied

Zn. It increased the K concentration in roots, stem, leaf sheath, leaf blade and grain by 18, 30, 28, 27 and 50% over their respective controls. Similar results were reported by serveral workers (Pathak *et al*, 1975). The lowest concentration of K in roots and highest in shoots reflects the higher mobility of K from roots to shoots as reported by Agarwala and Sharma (1976). Iron application decreased the K concentration in all the plant parts which was magnified in the absence of Zn. Ferrous sulphate relatively has more depressing effect on K concentration than ferric citrate. Tanaka *et al*. (1966) found that higher concentration of Fe was associated with the lower K content in the plants.

REFERENCES

AGARWALA, S. C. and C. P. SHARMA. 1978. Distribution of elements in different parts of a plant and in a Cell in J. S. KANWAR (Ed.) *Soil Fertility Theory and Practice*. I. C. A. R. Pub. New Delhi.

ANONYMOUS. 1981. Annual Progress Report of the All India Coordinated Scheme of Micronutrients in Soils and Plants (I.C.A. R).R. A. U; Pusa, Bihar.

BOER, G. T. DE, H.M. REISENAUER. 1973. DTPA as an extractant of available soil iron *Communications in Soil Sci. and Plant Analysis* 4 (2) : 121-28 (c. f. Soils and Fert. 36 : 4707.

HOWELER, R. H. 1973. Iron induced oranging disease of rice in relation to physico-Chemical changes in a flooded oxisol. *Soil Sci. Soc. Amer. Proc.* 37 : 898-903.

JACKSON, M. L. 1967 Soil Chemical Analysis. Prentice Hall of India, Pvt. Ltd., New Delhi.

LINDSAY, W. L. and W. A. NORVELL. 1978 Development of DTPA soil test for zinc, iron) mangenese and copper. *Soil Sci. Soc. Amer. Proc.* 42 : 421-28.

MORTVEDT, J. J. and P. M. GIORDANO. 1971. Response of grain sorghum to iron sources applied alone or with fertilizers. *Agron. J.* 63: 758 - 61.

PATHAK, A. N.; K. N. TIWARI and K. SINGH. 1975. Zinc-phosphate inter-relationship in rice *J. Indian Soc. Soil Sci.* 23: 47-83.

PIPER, C. S. 1950. Soil and Plant Analysis. Univ. of Adelaide, Austraha.

SAKAL, R; A. P. SINGH and B. P. SINGH. 1981. Evaluation of critical limit of zinc in calcareous soils for predicting response of maize to applied zinc fertilizer. J agric. Sci. Camb. 97: 493-95.

TANAKA, A R. LOE, S. A. NAVASERO, 1966. Some mechanisms involved in the development of iron toxicity symptoms in rice plant Soil Sci. Pl. Nutr. 12, 32-38.

TIWARI, K. N. and A. N. PATHAK. 1978. Zinc-phosphate relationship in submerged rice in an alluvial soil. *J. Indian. Soc. Soil Sci.* 26 : 385-89.

Table 1. Effect of zinc and iron applications on the concentration phoshorus and potassium in different parts of rice plant

Treatment (ppm)			Phosphorus concentration ppm)					Potassium concentration (%)				
Zn	Fe*	Fe**	Root	Stem	Leaf sheath	Leaf blade	Grain	Root	Stem	Leaf sheath	Leaf blade	Grain
0	0	0	700	1350	1160	1200	4300	0.22	4.00	1.44	0.90	0.80
0	10	0	670	1280	1120	1140	4100	0.20	3.70	1.28	0.80	0.70
0	20	0	600	1200	1060	1050	3850	0.19	3.50	1.11	0.74	0.60
0	0	10	680	1300	1140	1150	4150	0.20	3.80	1.30	0.82	0.70
0	0	20	620	1250	1100	1080	3950	0.20	3.70	1.16	0.78	0.60
2.5	0	0	660	1250	1100	1120	4050	0.24	4.70	1.64	1.02	1.00
2.5	10	0	630	1190	1050	1070	3900	0.22	4.30	1.48	0.94	0.90
2.5	20	0	570	1120	1000	1000	3700	0.21	4.10	1.30	0.88	0.80
2.5	0	10	640	1200	1070	1100	3950	0.22	4.20	1.50	0.96	0.97
2.5	0	20	590	1150	1030	1020	3800	0.21	4.10	1.30	0.86	0.87
5.0	0	0	600	1100	1000	1000	3700	0.26	5.20	1.84	1.14	1.20
5.0	20	0	570	1040	960	950	3600	0.24	4.60	1.68	1.04	1.00
5.0	10	0	500	1000	920	900	3450	0.23	4.40	1.46	0.96	0.90
5.0	0	10	580	1060	980	1000	3650	0.24	4.50	1.68	1.06	1.10
5.0	0	20	540	1020	940	950	3500	0.22	4.30	1.52	0.96	1.09
C. D. at 5% (Zn levels) =			14	33	21	22	42	0.001	0.05	0.03	0.5	0.05
C. D. at 5% (Fe level) =			13	30	19	20	38	0.001	0.04	0.03	0.5	0.04
C. D. at 5% (Fe source) =			13	N. S.	19	20	38	N. S.	N.S.	N.S.	N.S.	0.04
C. D. at 5% (Zn x Fe) =			N. S.	N. S.	N. S.	N. S.	N. S.	0.002	0.10	N.S.	N.S.	N.S.

Fe* — Iron through ferrous sulphate
Fe** — Iron through ferric citrate