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RESPONSE OF RICE (Variety 1R-8) TO ZINC AS AFFECTED BY LEVELS OF PHOSPHATIC FERTILISERS*

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Application of high levels of soluble phosphatic fertilisers has been reported to decrease the availability of zinc to various crops and this antagonistic relation between zinc and phosphorus has been demonstrated in several crops (Terman and Braidford. 1966; Burleason *et al*, 1961; Sharma *et al*, 1668). Studies on the available zinc status of the Kayal soils of Kuttanad show that about 50% of them have available zinc values lower than the prescribed critical limit while others have only a content of zinc marginally higher than the critical limit (Aiyer *et al*, 1975). Cultivation of high yielding varieties of rice, on an extensive scale, has revealed the possibility of zinc becoming a limiting factor leading to 'the Khaira disease' (Nene and Srivastava, 1967). In growing the high yielding varieties high rates of phosphatic fertilisers are applied as basal dose and often during the non-availability of straight fertilisers of nitrogen like urea and ammonium sulphate NP complexes are used for top dressing. The effect of such high doses of phosphatic fertilisers on zinc was investigated in a pot culture experiment with the Vellayani Kayal soil which had an available zinc status marginally above the critical limit.

Materials and Methods

A sample of Vellayani Kayal soil with fairly high amounts of total zinc and with an available zinc status only slightly above the critical limit was chosen for the study. The chemical composition of the soil used for the work is given in Table 1. The experiment was laid out in the randomised block design with 18 treatment combinations and with 3 replications. Two replications were kept for recording yield and for the analysis of grain and straw samples after harvest while samples were taken from two replications each at three stages of growth viz., 15 days after transplanting, 30 days after transplanting and at ear head stage for the determination of zinc and phosphorus content of plants,

The phosphorus levels were 0, 20, 40, 60, 80 and 100 kg P_2O_5/ha (P_0, P_1, P_2, P_3, P_4 and P_5 respectivety) and the levels of zinc were 0, 25, and 50 kg $ZnSo_4$/ha (Zn_0, Zn_1 and Zn_2 respeetively).

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Earthenware pots 30x28 cm. size containing 15 kg of air dried Kayal soil from Vellayani was mixed with a basal dose of CaO at 500 kg/ha and MgO at 200 kg/ha. Potassium was applied at the rate of 80 kg K_2O/ha as muriate of potash. Phosphorus was applied in the different treatments as single superphosphate (16 % P_2O_5). The zinc sulphate was applied as a basal dose. Nitrogen at the rate of 80 kg/ha as ammonium sulphate in two split doses, 75 per cent as a basal dose and the balance 30 days after transplanting, was applied. 25 days old IR-8 seedling were planted at the rate of 3 seedlings per pot. P in plant samples were estimated after triple acid digestion using the Vanadomolybdate method.

The zinc present in an aliquot of the triple acid extract was converted into the organic phase using 25 ml of 0.02 N HG1 50 ml of 0.4 M ammonium citrate solution and 3 ml of 0.02% carbonate solution and extracted with 10 ml of dithiozone in CCl_4. The orange colour was estimated using the green filter in a Klett summerson photoelectric colorimeter and expressed in ppm.

Results and Discussion

Table ! presents the data for the yield of grain and straw and the P and Zn content of grain and straw. Fig. 1 presents the response curve for the three levels of Zn. Application of zinc at 25 kg of $ZnSO_4$/ha shows significant increase in yield over no zinc application. However between the yield of grain at the two higher levels of zinc viz., 25 and 50 kg/ha there is no significant difference. Application of phosphorus has resulted in a significant increase in yield; however at higher levels, it has a suppressing effect on yield of grains especially in treatments which had not received any application of zinc Thus at P, O_5 levels of 80 kg/ha and higher doses there is a significant decrease in yield. A similar but less significant effect is observed in the case of straw. From the response curve given in Fig. 1 it is evident that the optimum combination of zinc and phosphorus is 25 kg Zn SO_4/ha and 72.5 kg P_2O_5/ha respectively.

The different levels of P has a significant effect in increasing the phosphorus content of the grain. The effect of zinc is also found to be significant in decreasing the P content. In plants that exhib ted deficiency symptoms a significantly higher content of P in grains was observed than in normal plants. Plants which received 0 kg of Zn/ha along with 100 kg of P, O_5/ha had a mean P content of 68 7 mg/100 g while plants receiving the same level of P with 50 kg of Zn/ha had a P content of 55.8 mg/100g.

The application of Zn had resulted in a higher Zn content for the grains. But here also the effect of P is more pronounced in decreasing the zinc content.

Table 1

Chemical composition of the Vellayani Kayal soil used for pot culture experiment •

pH		5.1
Total nitrogen	. .	0.084%
Total P_2O_5		0.079%
Total K_2O	. .	0.061%
Total CaO		0.210%
Total MgO		0.010%
Total sesquioxides		7.321%
Available P_2O_5		0.0004%
Available K_2O		0.001%
Organic carbon		1.245%
Total Zn		6.3 ppm
Available Zn	. .	0.6 ppm
Insolubles		84.54%

The highest Zn content of grain was recorded in plants receiving 50 kg Zn/ha along with 0 kg P_2O_5/ha and the lowest Zn content of grain recorded in plants receiving 100 kg of P_2O_5/ha along with 0 kg Zn/ha. From these observations it is seen that in the aerial plant parts zinc concentration varied inversely with phosphorus concentration. Similar observations have been recorded by Terman and Braidford (1966).

Results presented in Table 3 show that plants which received 0 kg Zn/ha along with 100 kg of P_2O_5/ha had an average P content of 39.4 mg/100g at earhead stage while plants which received 50 kg Zn/ha along with 100 kg P_2O_5/ha. 100 kg P_2O_5/ha had a mean P content of only 25.3 mg/100 g. Further, at all sampling stages, the Zn content of plants receiving high doses of P is seen to be significantly lower than those of others. As the levels of P increased the Zn content of plants decreased. The lowest mean Zn content of 35.3 ppm is noted in plants receiving 0 kg Zn/ha along with 100 kg P_2O_5/ha at the 15th day of transplanting. The highest mean content of 139.0 ppm is recorded in plants receiving 0 kg P_2O_5/ha along with 50 kg Zn/ha at earhead stage.

Summary

An attempt was made to produce phosphorus induced zinc deficiency in rice plants (var. IR-8) under pot culture conditions with 18 treatments, being the combinations of 6 levels of P and 3 levels of Zn. Yield of grain and straw were significantly increased by the application of both zinc and phosphorus. At higher doses of Phosphorus the yield of grain decreased slightly. The optimum

PIG. 1 RESPONSE CURVE FOR YIELD OP GRAIN

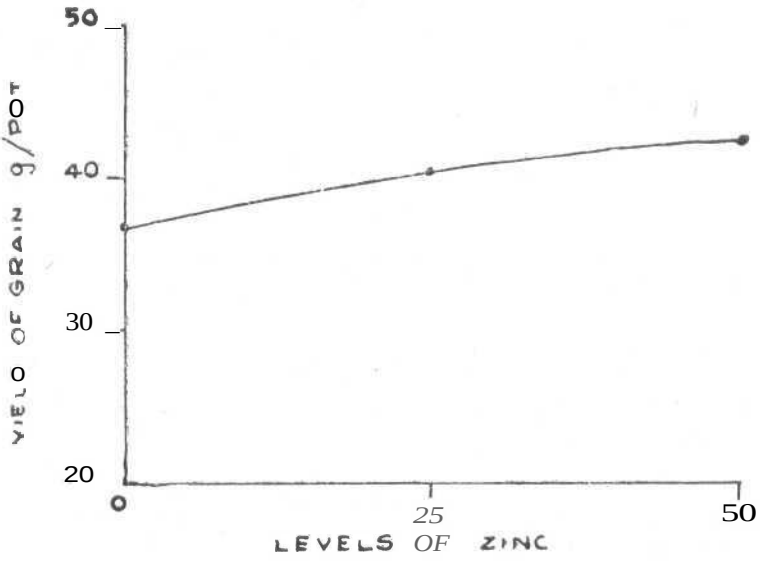

Table 2

Yield and Zn and P content of grain and straw

Levels of P	Levels of Zn	Yield of grain g/pot	Yield of straw g/pot	P content grain mg/100g	Zn content grain ppm	P content straw mg/100g	Zn content straw ppm
	0	23.6	53.9	44.3	49,4	11.0	26.7
0	25	28.2	56.0	42.7	69,4	9.2	31.4
	50	30.0	53.9	41.5	89.2	8.6	42.7
	mean	27.7	54.6	42.8	66.8	9.6	33.6
	0	38.7	56.8	50.3	41.2	13.2	24.4
20	25	37.9	55.8	40.7	55.2	9.7	28.3
	50	41.2	55.5	47.4	74.2	9.4	39.4
	mean	39.2	56.1	45.5	57.2	10.6	30.7
	0	41.4	52.4	54.9	32.3	15.2	19 4
40	25	41.3	54.2	47.8	42.2	10.1	25.3
	50	35.8	54.8	43.2	70.2	9.7	35.3
	mean	39.5	53.8	48.5	48.2	11.6	26.6
	0	43.2	54.7	58.7	25.2	17.3	16.2
60	25	50.3	55.3	52.2	31.7	13.2	22.7
	50	47.3	53.7	46.3	61.2	11.9	29.9
	mean	44.1	54.7	52.4	39.3	14.1	22.9
	0	40.1	54.4	64.3	16.7	19.8	14.2
80	25	48.6	56.8	57.2	25.2	14.2	19.5
	50	43.7	57.0	51.2	50.2	13.3	26.2
	mean	44.6	56.1	57.6	30.7	15.9	19.7
	0	36.8	52.9	68.7	12.2	21.4	12.2
100	25	48.9	56.5	61.2	17.2	16.6	15.3
	50	48.1	57.6	55.8	34.2	15.0	24.3
	mean	46.9	55.7	51.9	21.2	17.7	17.3
	0	37.3	54.2	56.9	29.4	16.3	18.8
moan of	25	40.9	55.8	50.8	40.1	12.1	23.7
levels of Zinc	50	42.7	55.4	46.7	63.3	11.4	32.9
C. D (0.05)							
For treatments		8.8	2.2	2.2	7,0	1.8	7.0
for levels of Zn		3.5	0.6	0.9	3.0	0.7	2.9
for levels of P		5.1	2.2	1.3	3.8	1.0	4.1

Table 3

Zn and P content of rice plants at three different stages of growth

Levels of P	Levels of Zn	Yield of grain g/pot	Yield of straw g/pot	P content of grain mg/100g	Zn content of grain ppm	P content of straw mg/100	Zn content of straw ppm
	0	28.0	54.2	30.2	87.7	32.2	99.2
0	25	24.3	93.3	24.9	112.3	29.7	125.1
	50	22.7	107.1	22.1	120.2	26.1	139.0
	mean	24.6	84.9	25.7	106.2	29.2	121.1
	0	29.2	50.3	33.7	81.1	33.9	87.4
20	25	24.9	87.2	28.6	101.3	30.2	114.2
	50	22.2	101.8	24.1	115.8	27.1	127.1
	mean	25.4	79.7	28.3	99.3	30.4	109.6
	0	30.5	47.7	36.4	124.8	34.8	84.3
40	25	20.7	82.2	29.4	94.4	31 7	103.3
	50	23.3	97.0	26.3	114.2	29.0	114.1
	mean	26.5	75.6	29.9	92.8	31.8	100.7
	0	33.2	47.3	39.8	68.1	36.0	76.2
60	25	26.4	71.0	31.7	89.1	34.3	95.7
	50	23.9	89.6	28.0	101 2	32.1	105.8
	mean	27.8	69.3	31.5	86.1	34.1	92.fi
	0	35.2	43.1	36.4	56.2	37.4	69.1
80	25	27.7	65.2	33.6	83.2	36.2	84.2
	50	24.4	81.1	30.6	97.3	34.1	94.6
	mean	29.1	63.1	35.2	78.9	35,9	82.6
	0	36.2	35.3	37.4	47.3	39.4	57.3
100	25	29.5	60.7	35.2	76.4	36 9	76.2
	50	26.3	38.6	32.7	86.2	25.3	82.4
	mean	30.7	57.7	35.0	70.0	37.2	71.9
Mean for	0	32.6	46.3	35.7	69.2	35.6	78.9
levels of	25	26.3	76.6	30.6	92.4	33.2	99.8
Zinc	50	23.6	92.3	27.3	105.7	30.6	110.4
C. D (0.05) between treatments		2.23	14.91	1.89	12.87	1.75	26.40
between levels of *Zn*		0.84	5.91	1.16	5.69	0.71	10.69
between levels of P		1.26	8.61	1.28	7.38	1.07	14.98

combination of P and Zn was found to be 72.5 kg P_2O_5/ha and 25 kg $ZnSO_4$/ha. The study has revealed that for the proper uptake and utilisation of zinc especially when the soil is poor in available zinc the P levels have to be kept low. High levels of P may lead to zinc deficiency. Such deficiency can be corrected by the application of zinc in the soil.

സംഗ്രഹം

വ്യത്യസ്ത തോതിലുള്ള ഫോസ്ഫറസ് വളങ്ങളും ചേർക്കുന്നതോടൊപ്പം നെൽച്ചെടിയിൽ "സിങ്ക്" എന്ന സൂക്ഷ്മമൂലകം വരുത്തുന്ന വ്യതിയാനങ്ങളെപ്പറ്റിഒരു പഠനം നടത്തുകയുണ്ടായി. ഇതിൽ നിന്നും fixrxsJiiismld&go വയ്ക്കോലും, ഫോസ്ഫറസ്സ്, സിങ്ക് എന്നിവ ചേർക്കുന്നതു കൊണ്ട് ഗണ്യമായി കൂടുതൽ ലഭിക്കുമെന്നു കണ്ടു. അധികരിച്ചതോതിൽ ഫോസ്ഫറസ്സ് ചേർത്തയിടങ്ങളിൽ നെൽമണികളുടെ ഉല്പാദനം കുറയുകയുണ്ടായി. ഈ പഠനത്തിന്റെ വെളിച്ചത്തിൽ ഫോസ്ഫറസ്സ്–സിങ്ക് അനുപാതം നെല്ലിനെ സംബന്ധിച്ചിടത്തോളം 72.5 കി. ഗ്രാം P_2O_5/ഹെക്കാറും 25 കി. ഗ്രാം $ZnSO_4$/ഹെക്കാറും ആണെന്നു കാണുകയുണ്ടായി. അധികരിച്ച ഫോസ്ഫറസ്സ് വളങ്ങളുടെ ഉപയോഗം സിങ്ക് എന്ന സൂക്ഷ്മമൂലകത്തിന്റെ ലഭ്യത കുറയ്ക്കുമെന്നതിനാൽ, ഫോസ്ഫറസ്സ് വളങ്ങളും ക്രമത്തിലധികമായി നെല്ലിനു് ഉപയോഗിക്കുവാൻ പാടുള്ളതല്ല.

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