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INFLUENCE OF ADDED MAGNESIUM SOURCES ON SOIL CHARACTERISTICS UNDER SUBMERGED CONDITION

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Abstract: An incubation study and a potculture experiment were conducted with two acid rice soils of Kerala, using three Mg sources, viz., magnesite, dolomite and magnesium sulphate tried at two levels of Mg (25 and 50 kg MgO ha^{-1}) to study the influence of added Mg on soil characteristics. Available Mg of the karappadam soil was significantly higher than that of the laterite soil. There was no significant difference between the three Mg sources with regard to their contribution to available Mg in the soil. But the Mg availability increased with raised levels of Mg application. A negative relationship was noticed between available K and Mg fractions in the soil. Different sources and levels of applied Mg did not have any significant influence on NH_4OAc extractable Ca. Magnesium application raised the pH of the soils. Efficiency of the different Mg sources in correcting the acidic soil reaction was in the order of magnesite dolomite magnesium sulphate.

Key words: Acid rice soils, Mg sources, magnesite, dolomite, available Mg.

INTRODUCTION

The capacity of a soil to supply nutrients to plants can be expected, in the first instance, to depend on the level of that nutrient in the soil and the rate at which it can be replenished. Secondly, it will be affected by the level of other nutrients having an antagonistic effect on the uptake of that nutrient. A third factor is the nature of the crop. Many of the workers have reported an antagonistic relationship between Mg and K, Mg and Ca and also between Mg and H. Mg depressed the absorption of K by the rice plant (Nayar and Koshy, 1969). Jayaraman (1988) reported that added Mg did not show any marked variations in the available K, Fe and Mn. Edmeades *d al.* (1985) and Myers *et al.* (1988) were of the opinion that liming reduced exchangeable Mg in acid soils. Welte and Warner (1963) suggested that H-Mg antagonism was more intense than the more recognised K- Mg antagonism.

The present study was carried out with a view to study the influence of added Mg sources on available K, Ca and pH of the soils under submerged condition.

MATERIALS AND METHODS

An incubation study and a potculture experiment were conducted with two acid rice soils of Kerala (karappadam and laterite), three sources of Mg (magnesite, dolomite and magnesium sulphate) and two levels of Mg (25 and 50 kg MgO ha^{-1}) to study the influence of Mg on available K, Ca, pH and specific conductance of the soils. The soils were incubated under submerged condition for 180 days in a completely randomised design with two replications. The treatment combinations were as follows:

Treat. No.	Forms and levels of MgO, kg ha^{-1}	Soil
T1	No Mg (control)	Karappadam
T2	Magnesite 25	,,
T3	Magnesite 50	,,
T4	Dolomite 25	,,
T5	Dolomite 50	,,
T6	Magnesium sulphate 25	,,
T7	Magnesium sulphate 50	,,
T8	No Mg (control)	Laterite
T9	Magnesite 25	,,
T10	Magnesite 50	,,
T11	Dolomite 25	,,
T12	Dolomite 50	,,
T13	Magnesium sulphate 25	,,
T14	Magnesium sulphate 50	,,

Soil samples were drawn regularly at 15 days interval throughout the period of incubation for chemical analyses. Available Ca and Mg were determined by EDTA titration method (Hesse, 1971). Available K was determined flame photometrically in the neutral normal NH_4OAc extract of the soil (Jackson, 1958). pH was determined using an Elico pH meter in a soil water suspension of 1:2.5 ratio. Specific conductance of 1:2.5 soil water extract was measured using a conductivity bridge.

Potculture experiment was conducted using rice as the test crop grown continuously for two seasons under waterlogged condition to study the direct and residual effect of Mg fertilizers. The experiment was laid out in a completely randomised design with eight replications and soil samples were drawn regularly at 15 day interval for chemical analyses.

Statistical analysis of the data was carried out by adopting the standard methods described by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Available Mg

During the first fortnight of incubation, there was a marked decrease in NH_4OAc extractable Mg, may be due to the dilution effect consequent to flooding. Then there was an increase, probably due to the release of exchangeable Mg from theapplied sources. Similar observations were made during the potculture experiment also. At first there was a decrease in

Table 1. Mean values of available Mg, K, Ca, pH and EC as influenced by Mg sources and soil (incubation study)

	Soil type	Control (No Mg)	Magnesite	Dolomite	Magnesium sulphate
NH_4OAc extractable Mg, cmol(+) kg^{-1}	Karappadam	2.11	2.54	2.34	2.55
	Laterite	0.55	0.75	0.80	0.98
Available K, kg ha^{-1}	Karappadam	283.3	282.7	276.4	301.4
	Laterite	375.8	365.7	375.4	364.1
NH_4OAc extractable Ca, cmol(+) kg^{-1}	Karappadam	6.64	6.77	7.00	7.80
	Laterite	6.28	5.69	6.62	5.76
PH	Karappadam	5.60	5.70	5.60	5.60
	Laterite	6.30	6.30	6.30	6.20
Specific conductance, dS m^{-1}	Karappadam	0.26	0.24	0.23	0.26
	Laterite	0.10	0.11	0.14	0.20

CD (0.05)	NH_4OAc-Mg	Ava.K	NH_4 OAc-Ca	pH	EC
Soil	1.631	67.679	3.960	0.291	0.048
Source	1.998	82.890	4.848	0.356	0.057
Soil x Source	2.824	117.198	6.852	0.504	0.083

Table 2. Mean values of available Mg, K, Ca, pH and EC as influenced by Mg sources and soil (potculture experiment)

	Soil type	Control (No Mg)	Magne-site	Dolo-mite	Magnesium sulphate
		First crop			
NH_4OAc extractable Mg, cmol(+) kg^{-1}	Karappadam	3.41	3.53	3.76	3.33
	Laterite	1.97	1.95	1.93	2.07
Available K, kg ha^{-1}	Karappadam	212.8	189.8	190.4	190.4
	Laterite	246.4	271.5	255.4	254.2
NH_4OAc extractable Ca, cmol(+) kg^{-1}	Karappadam	8.27	8.21	7.05	7.47
	Laterite	5.93	6.37	5.61	5.97
PH	Karappadam	5.80	5.70	5.60	5.40
	Laterite	6.20	6.50	6.30	6.30
Specific conductance, dS m^{-1}	Karappadam	0.12	0.11	0.12	0.11
	Laterite	0.08	0.10	0.07	0.10
		Second crop			
NH_4OAc extractable Mg, cmol(+) kg^{-1}	Karappadam	3.03	3.95	3.59	3.38
	Laterite	2.06	2.26	2.45	2.67
Available K, kg ha^{-1}	Karappadam	209.4	216.1	196.6	196.6
	Laterite	240.8	212.8	226.3	199.9
NH_4OAc extractable Ca, cmol(+) kg^{-1}	Karappadam	11.00	10.95	9.07	11.26
	Laterite	7.35	5.78	6.91	7.26
PH	Karappadam	6.20	6.10	5.80	5.90
	Laterite	6.30	6.30	6.40	6.50
Specific conductance, dS m^{-1}	Karappadam	0.10	0.08	0.07	0.08
	Laterite	0.09	0.08	0.08	0.08

CD (0.05)	NH_4OAc extr. Mg	Available K	NH_4OAc extr. Ca	pH	EC
		First Crop			
Soil	0.271	14.303	0.55	0.086	NS
Source	• NS	NS	0.680	0.105	NS
		Second Crop			
Soil	0.260	NS	1.214	0.092	NS
Source	NS	NS	NS	0.112	NS

Table 3. Mean values of available Mg, K, *Ca*, pH and EC as influenced by levels of Mg application (incubation study)

	Levels of MgO, kg ha^{-1}	Soil		Source of Mg		
		Karappadam	Laterite	Magnesite	Dolomite	Magnesium sulphate
NH_4OAc extr. Mg, cmol(+) kg^{-1}	25	2.33	0.72	1.48	1.43	1.66
	50	2.63	0.97	1.82	1.72	1.86
Available K, kg ha^{-1}	25	289.7	369.80	328.10	332.4	338.80
	50	283.9	367.00	320.20	329.4	326.70
NH_4OAc cxtr.Ca, cmol(+) kg^{-1}	25	7.41	5.84	6.12	6.59	7.18
	50	6.96	6.20	6.34	7.02	6.38
pH	25	5.60	6.30	6.00	5.90	5.90
	50	5.70	6.30	6.00	6.00	6.00
Specific conductance, dS m^{-1}	25	0.24	0.13	0.18	0.20	0.17
	50	0.25	0.11	0.18	1.74	0.20

CD (0.05)	NH_4OAc extr. Mg	Available K	NH_4OAc extr. Ca	pH	EC
Level	1.631	67.679	3.960	0.291	0.048
Soil x level	2.308	95.713	5.598	0.413	0.068

Mg content of soils, may be due to the absorption of Mg by the plant. The increase observed in the fourth and fifth fortnights can be attributed to the increased release of Mg from native as well as added sources with enhanced period of waterlogging.

Ammonium acetate extractable Mg content of the karappadam soil was significantly higher than that of the laterite soil. There was no significant difference between the sources with regard to their contribution to NH_4OAc extractable Mg in the soil. During the incubation study, magnesite (99.9 per cent) and dolomite (95.3 per cent) were found to be almost as efficient as magnesium sulphate in the karappadam soil. Their suitability in laterite soil was such that magnesite and dolomite were 76.9 and 82.2 per cent as efficient as magnesium sulphate (Table 1). The higher efficiency of carbonate forms of Mg fertilizers in karappadam soil may be

Table 4. Mean values of available Mg, K, Ca, pH and EC as influenced by levels of Mg application (potculture experiment)

	Levels of MgO, kg ha^{-1}	Soil		Source of Mg		
		Karappa-dam	Laterite	Magne-site	Dolo-mite	Magnesium sulphate
First crop						
NH_4OAc extr. Mg, cmol(+) kg^{-1}	25	3.39	1.85	2.69	2.69	2.48
	50	3.69	2.12	2.79	3.00	2.91
Available K, kg ha^{-1}	25	193.40	274.30	241.20	228.50	231.80
	50	187.00	246.40	220.10	217.3	212.8
NH_4OAc extr. Ca, cmol(+)kg^{-1}	25	7.49	5.81	7.03	6.15	6.78
	50	7.65	6.16	7.55	6.52	6.66
pH	25	6.30	6.30	6.10	5.90	5.80
	50	5.60	6.40	6.10	6.00	5.90
Specific conductance, dS m^{-1}	25	0.11	0.08	0.11	0.08	0.95
	50	0.12	0.10	0.11	0.10	0.11
Second crop						
NH_4OAc extr. Mg, cmol(+) kg^{-1}	25	3.57	2.48	3.07	2.98	2.93
	50	3.77	2.44	3.14	3.05	3.12
Available K, kg ha^{-1}	25	196.00	221.8	203.3	217.3	206.1
	50	210.10	204.3	225.6	205.6	190.4
NH_4OAc extr. Ca, cmol(+) kg^{-1}	25	10.64	6.49	8.38	8.17	9.15
	50	10.21	6.80	8.35	7.81	9.36
PH	25	6.00	6.40	6.20	6.20	6.20
	50	5.90	6.40	6.30	6.00	6.20
Spec.conductance,dSm"[1]	25	0.09	0.08	0.09	0.08	0.08
	50	0.07	0.08	0.07	0.08	0.08

CD (0.05) for the comparison of levels for NH_4OAc extractable Mg and available K during the first crop was 0.271 and 14.303 respectively. All other treatment effects were not significant.

attributed to the high acidic condition prevailing in that soil leading to their increased solubility. Magnesium availability of the soils increased on Mg application during the two seasons of crop growth (Table 2); which is understandably due to the increased Mg availability in the soil from added sources. This raise in Mg availability became more conspicuous with higher levels of Mg application (Table 3).

Available K

On Mg addition there was not much change in available K of the karappadam soil, but in laterite there was a decrease in available K content from 375.83 to 368.4 kg ha^{-1} during incubation (Table 1). Available K of the soils decreased with increase in the levels of applied Mg from 25 to 50 kg MgO ha^{-1}. This decrease was from 289.7 to 283.9 kg ha^{-1} in karappadam and from 369.8 to 366.95'kg ha^{-1} in laterite (Table 3). Also it was found that available K in the soil was highly negatively correlated with NH_4OAc extractable Mg (r = -0.948**).

A significant decrease in available K was observed in both the soils on increasing the level of applied Mg from 25 to 50 kg MgO ha^{-1} in the potculture experiment. Available K in the soil was negatively correlated with NH_4OAc extractable Mg (r = -0.728**) in the soil and also with total Mg uptake (r = -0.614**) by the plant confirming K-Mg antagonism.

Available Ca

No significant relationship was observed between the levels of Ca and Mg in the soil during incubation study.

During the first crop season, general trend both in the presence and absence of added Mg was that, NH_4OAc extractable Ca content increased with the advancement of crop growth up to the third fortnight and then decreased. This trend was just the opposite to that shown by NH_4OAc extractable Mg revealing a Ca-Mg antagonism.

Ammonium acetate extractable Ca was found to decrease from 11 to 10.42 cmol(+)kg^{-1} in karappadam soil and from 7.35 to 6.65 cmol(+) kg^{-1} in laterite soil on Mg application during the second crop season. There was no significant difference between the Mg levels with regard to NH_4OAc extractable Ca content.

pH

There was a marked increase in the pH of the soils on incubation under submerged condition. This increase was from 5.0 to 5.6 in karappadam soil and from 5.4 to 6.26 in laterite in the absence of added Mg. On Mg addition, it was further in and to 6.3 in laterite (Table 1). This may be due to the neutralisation of soil reaction under submerged condition as suggested by Ponnamperuma (1972). Magnesium, a basic cation further raised the pH. The same results were observed for the potculture studies also.

On comparing the different Mg sources it was found that pH was maximum in soils supplied with magnesite. Efficiency of different Mg sources in correcting soil reaction was in the order of magnesite dolomite magnesium sulphate. This was in line with the reports of Shich *ct al.* (1965), Vasil'eva (1965) and Jokineu (1982) that the carbonate forms of Mg were more effective on acid soils than the soluble ones.

Increasing the level of Mg raised the pH of the soil indicating the role of Mg source, in correcting the soil reaction in acid soil (Table 3).

Influence of various Mg sources and levels on specific conductance of the soils was found to be inconsistent.

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