

## EVALUATION OF LABORATORY INDICES OF MAGNESIUM AVAILABILITY

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**Abstract:** A study was conducted to evolve a suitable extractant of available Mg in soil. Twenty soils were selected for the study assuring wide variation in their properties in relation to Mg availability. The various extractants in the final screening showed the following decreasing order in their efficiency for extracting Mg: 0.005 M DTPA + 0.005 M CaCl<sub>2</sub>, Mathew's triacid > 0.1 M acetic acid + 0.04 M Ca lactate > Reith's reagent > 0.0125 M CaCl<sub>2</sub>, 1 N NH<sub>4</sub>OAc > 0.05 M HCl > 0.005 M DTPA. The amount of Mg extracted by various extractants failed to correlate significantly with the Mg uptake of test crop (rice) as well as the per cent of Mg in the crop. The performance of 0.05 M HCl was promising with respect to the pattern of release, degree of variability due to varying periods of equilibration and the magnitude of Mg extracted at the optimum period of equilibration.

**Key words:** Available Mg, Mg extractants, Mg indices

### INTRODUCTION

Very often, the amount of Mg extracted by the widely accepted and presently followed method viz., neutral 1 N ammonium acetate (which extracts exchangeable Mg) varies in its correlation with the plant responses when different soils and varying climatic conditions are considered. The exchangeable Mg in soil is considered available to plants but the attempts to correlate it with Mg removal by crops have not been successful (Kanwar, 1976). It may indicate potential supply over a long term, but does not indicate the amount which will become available to the root over a short term. Hesse (1971) gives a review of extractants used by various scientists for the evaluation of laboratory index of Mg availability. The present study was planned in order to evolve a suitable extractant of available Mg for Kerala soils.

### MATERIALS AND METHODS

Magnesium extracted by various chemical agents were correlated with uptake of Mg by a test crop (rice) grown under modified Neubauer seedling technique. Twenty selected soils were used for this purpose. The soils were selected assuring maximum variation in characteristics relating to the behaviour of Mg in soil (Table 1). After an initial study, eight extractants were selected for the preliminary screening, within the workable limits, at six

periods of equilibration viz., 10, 20, 30, 40, 50 and 60 min with one soil and a single soil : solution ratio of 1:10 (Table 2). In each case, the extraction was repeated thrice and the mean value was adopted. The performance of these eight extractants viz., Reith's reagent (2.5% acetic acid + 0.04 M NH<sub>4</sub>OAc), 0.05 M HCl, Mathew's triacid (0.06 N H<sub>2</sub>SO<sub>4</sub> + 0.06 N HCl + 0.06 N oxalic acid), 1 N NH<sub>4</sub>OAc, 0.0125 M CaCl<sub>2</sub>, 0.1 M acetic acid + 0.04 M Ca lactate, 0.005 M DTPA, 0.005 M DTPA + 0.005 M CaCl<sub>2</sub> was studied using the 20 soils with the selected equilibration period of each extractant (Table 3). Magnesium in solution was estimated using versenate titration method (Hesse, 1971).

### RESULTS AND DISCUSSION

In the initial study with 10 extractants, at two equilibration periods, 0.01 M and 0.0025 M DTPA could not extract any appreciable quantity of Mg. Hence these two were eliminated and the rest were carried over for further screening. Relative stability, in the extraction of Mg was attained with an equilibration period of 30 min in the case of 0.05 M HCl, 0.025 M CaCl<sub>2</sub> and Mathew's triacid. A period of 40 min appeared to be optimum for 1 N NH<sub>4</sub>OAc. Reith's reagent, 0.005 M DTPA + 0.005 M CaCl<sub>2</sub>, 0.005 M DTPA and 0.1 M acetic acid + 0.04 M Ca lactate required longer periods of equilibration and therefore the longest period tried namely

Table 1. Properties relating to the behaviour of Mg in soils selected for evaluation of laboratory indices of Mg availability

SI No	PH	Total Mg, ppm	Available Mg, ppm	cmol(+) kg <sup>-1</sup>		Uptake of Mg, mg pot <sup>-1</sup>
				Exch. Mg	CEC	
1	4.64	1000	117.7	0.816	17.44	5.24
2	5.85	1500	143.9	1.836	15.38	4.23
3	5.58	500	52.3	0.286	3.59	2.34
4	6.45	2000	130.8	0.449	3.08	4.27
5	6.02	500	52.3	0.408	16.41	4.18
6	6.06	130	26.1	0.082	12.82	5.41
7	5.73	250	26.1	0.082	9.23	3.88
8	5.71	500	52.3	0.408	16.92	5.76
9	6.02	1600	274.7	1.632	17.95	5.60
10	8.56	10880	915.6	5.304	25.64	6.02
11	8.29	5990	758.6	9.383	14.87	4.34
12	4.49	1950	575.4	3.264	20.00	6.24
13	6.12	1700	470.9	1.224	9.74	3.38
14	5.56	2000	235.4	0.816	7.18	0.45
15	6.50	1000	235.4	2.448	24.10	3.27
16	5.06	500	26.1	0.204	1.54	5.79
17	5.38	400	287.8	0.816	3.59	10.30
18	6.00	500	287.8	0.816	6.15	3.09
19	5.93	800	209.3	1.224	8.20	3.62
20	4.41	1500	313.9	1.632	4.10	3.01
Mean	5.92	1760	259.6	1.657	11.90	4.52

60 min was taken as optimum for these extractants. Among these extractants, the performance of 0.05 M HCl was promising with respect to the pattern of variability due to varying periods of equilibration and the magnitude of Mg extracted at the optimum period of equilibration (Table 2).

For the final screening, these extractants were tried at their optimum period of equilibration at constant soil: solution ratio of 1:10 in all the 20 soils (Table 3). The various extractants showed the following decreasing order in their efficiency for extracting Mg : 0.005 M DTPA + 0.005 M CaCl<sub>2</sub> (374.1 ppm) > Mathew's triacid (300.9 ppm) > 0.1 M acetic acid + 0.04 M Ca lactate (296.9 ppm) > Reith's reagent (272.1 ppm) > 0.0125 M CaCl<sub>2</sub> (259.6 ppm) > 1 N NH<sub>4</sub>OAc (242 ppm) > 0.05 M HCl (213.2 ppm) > 0.005 M DTPA (160.9 ppm).

The amount of Mg extracted by these extractants was finally evaluated based on its relationship with uptake in Mg by plants. The data on uptake of Mg by rice are given in Table 1. Though wide variation was observed in the available Mg content of the different soils selected as determined by chemical extraction methods, the Mg uptake by rice failed to correlate significantly with the Mg extracted by the chemical agents (Table 4). This may be due to the fact that the growth of the plant and hence the dry matter accumulation was not decisively influenced by the available Mg content of the soil. Probably, the amount of available Mg in these soils was sufficient to allow the growth of the test crop (rice) without itself manifesting as a limiting factor. The total duration of the crop under the modified Neubauer technique was only 35 days and the amount of Mg removed by the

Table 2. Pattern of Mg release by selected extractants, ppm (mean of three replications)

Sl No	Name of extractant	Period of equilibration, min					
		10	20	30	40	50	60
1	1 <i>N</i> NH <sub>4</sub> OAc	95.9	104.6	148.2	165.7	104.6	104.6
2	0.05 <i>M</i> HCl	113.4	122.1	139.5	139.5	131.8	131.8
3	0.1 <i>M</i> acetic acid + 0.04 <i>M</i> Ca lactate	61.0	122.1	104.6	87.2	131.8	174.3
4	0.0125 <i>M</i> CaCl <sub>2</sub>	104.6	87.2	95.9	113.4	131.8	87.2
5	Mathew's triacid	226.7	139.5	183.1	183.1	183.1	200.6
6	Reith's reagent	45.6	87.2	139.5	157.1	173.2	191.8
7	0.005 <i>M</i> DTPA + 0.005 <i>M</i> CaCl <sub>2</sub>	37.2	52.3	87.2	115.2	139.5	157.2
8	0.005 <i>M</i> DTPA	28.6	56.8	78.5	98.5	105.2	130.8
	Mean	89.1	96.5	122.1	138.5	137.6	147.3

Table 3. Mg extracted by selected extractants at their optimum period of equilibration, ppm

Sl.No	Mg, ppm							
	Mathew's triacid	Reith's reagent	1 <i>N</i> NH <sub>4</sub> OAc	0.05 <i>M</i> HCl	0.005 <i>M</i> DTPA + 0.005 <i>M</i> CaCl <sub>2</sub>	0.005 <i>M</i> DTPA	0.1 <i>M</i> acetic acid + 0.04 <i>M</i> Ca lactate	0.0125 <i>M</i> CaCl <sub>2</sub>
1	78.5	78.5	Traces	104.6	157.0	52.3	104.6	117.7
2	52.3	235.4	130.8	418.6	418.6	235.4	366.2	143.9
3	130.8	130.8	26.2	52.3	235.4	104.6	183.1	52.3
4	313.9	104.6	157.0	287.8	366.2	130.8	78.5	130.8
5	235.4	52.3	26.2	130.8	183.1	52.3	130.8	52.3
6	157.0	26.2	Traces	52.3	183.1	104.6	52.3	26.2
7	104.6	52.3	Traces	104.6	130.8	104.6	157.0	26.2
8	104.6	130.8	52.3	235.4	575.5	104.6	261.6	52.3
9	209.3	130.8	104.6	235.4	313.9	183.1	261.6	274.7
10	1648.0	1596.0	994.1	167.4	863.3	497.0	1491.0	915.6
11	1413.0	1282.0	1256.0	120.3	680.2	313.9	1256.0	758.6
12	601.7	392.4	601.7	601.7	601.7	287.8	444.7	575.5
13	157.0	78.5	26.2	261.6	313.9	183.1	130.8	470.9
14	183.1	235.4	130.8	235.4	392.4	183.1	183.1	235.4
15	78.5	287.8	183.1	392.4	366.2	157.0	157.0	235.4
16	26.2	78.5	Traces	130.8	261.6	26.2	104.6	26.2
17	78.5	209.3	26.2	209.3	313.9	130.8	52.3	287.8
18	78.5	130.8	104.6	104.6	340.1	130.8	130.8	287.8
19	235.4	157.0	26.2	235.4	418.6	183.1	209.3	209.3
20	130.8	52.3	26.2	183.1	366.2	52.3	183.1	313.9
Mean	300.9	272.1	242.2	213.2	374.1	160.9	296.9	259.6

Table 4. Correlation matrix showing inter-relationship of Mg extracted by various extractants, Mg uptake by rice and per cent Mg in rice

Sl No	Mg availability indices	2	3	4	5	6	7	8	9	10
1	Mathew's triacid, 30 min	0.963 **	0.951 **	0.954 **	0.800 **	0.842 **	0.962 **	0.857 **	0.134	0.081
2	Reith's reagent, 60 min		0.939 **	0.979 **	0.830 **	0.871 **	0.979 A*	0.856 **	0.148	0.105
3	1 N NH <sub>4</sub> OAc, 40 mill			0.928 **	0.809 **	0.820 **	0.936 **	0.855 **	0.119	0.098
4	0.05 M HCl, 30 min				0.874 **	0.910 **	0.969 **	0.881 **	0.169	0.089
5	0.005 M DTPA + 0.005 M CaCl <sub>2</sub> , 60 min					0.845 **	0.838 **	0.808 **	0.141	0.049
6	0.005 M DTPA, 60 min						0.864 **	0.862 **	0.105	0.003
7	0.1 M acetic acid + 0.04 M Ca lactate, 60 min							0.836 **	0.107	0.025
8	0.0125 M CaCl <sub>2</sub> , 30 min								0.139	0.150
9	Mg uptake by rice									0.907
10	Mg % in rice									

\*\* Significant at 1% level

crop was rather negligible as compared to the total amount of Mg present in these soils or even available Mg estimated by chemical extractants. On an average, the amount of total Mg contained by the soils was 176 mg per 100 g of soil. The quantity of available Mg was 25.96 mg per 100 g of soil whereas the amount of Mg removed by the crop on an average was only 4.52 mg.

As no significant correlation was observed between Mg uptake and Mg extracted by any of the extractants tried, it was not possible to effect the final selection. However, as already mentioned, the performance of 0.05 M HCl

was promising with respect to the pattern of release. Mg release by 0.05 M HCl shows that initial release following the quadratic function is completed within 30 min and thereafter, variation due to increasing period of equilibration was minimum.

## REFERENCES

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