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# The Content and Uptake of Magnesium by Ragi *(Eleusine Coracana Gaertn.)* as Influenced by Soil Type and Application of Magnesium, Potassium and Lime

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Magnesium content and uptake of root and shoot were positively correlated with their corresponding root and shoot yield. At $Mg_0$ level liming increased Mg uptake by the crop while at other levels liming decreased Mg uptake. Likewise at $K_0$ level Mg increased the Mg uptake while at $K_1$ level Mg application decreased Mg uptake. What may be called a one-way competition with the uptake of Mg (magnesium being reduced by an increase in nutrient K whereas D absorption was hardly affected by the presence of nutrient Mg) was also noticed in the present study.

The content and uptake of a nutient by a plant is a function of the nutrient concentration at the root surface, the rate of uptake and the rate of at which the nutrients are supplied to the root. Schachtschabel (1956) reported that cation competitive effects in uptake were of particular importance for magnesium as much effects frequently led to deficiency in the field. The capacity of a soil to supply magnesium is affected by the levels of other exchangeable cations that may have an antagonistic effect on magnesium uptake. In the present investigation, therefore, attempts were made to study the influence of application of magnesium potassium and lime on the content and uptake of the nutrients by *ragi* (*Eleusine coracana Gaertn.*), a widely grown cereal crop of the Nilgiris. The soils of Nilgiris are distinctly acidic and magnesium deficient areas were recorded (Mathan et al. 1973). The exchangeable Ca content was observed to be low (Mathan *et al*. 1977).

## MATERIAL AND METHODS

A pot culture experiment was conducted in two different soils with CO 7 ragi as the test crop. The details of the sixteen treatment combinations of potassium, lime and magnesium are furnished in Table 1. The crop was harvested at maturity, separated into roots, shoots and grains. The samples were analysed for N, P, K, Ca and Mg contents and the uptake of the above nutrients was calculated.

## RESULTS AND DISCUSSION

### Contents

*Root*: The mean Mg content of root was 42.2 and 46.5 mg/100 g in Titukkal and Doddabetta soils respectively. Applied Mg fertilizers did

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not influence the Mg content of roots significantly. Exchangeable Mg of soil was correlated with Mg content of root ($r = 0.620^{**}$).

*Shoot*: The mean Mg content in the shoot was 338.2 and 301.6 mg/100 g in Titukkal and Doddabetta soil respectively. In both the soils, liming significantly decreased the Mg content of shoot (Table 1). Similar results were obtained by Pope and Munger (1953). In Doddabetta soil alone, magnesium application at 50 kg Mg/ha level significantly increased Mg content of shoot over control.

*Grain*: The mean Mg content of grain was 49.3 and 47.0 mg/100 g in Titukkal and Doddabetta soil respectively. In Titukkal soil, none of the treatments influenced the Mg content of grain significantly, while in Doddabetta soil liming significantly decreased Mg content. Habibullah *et al.* (1977) made similar observations. Magnesium content of grain was positively correlated with Ca and P content of grain, shoot and total dry matter yield.

Uptake

The data are furnished in Table 2.

*Root*: The mean Mg uptake was 6.77 and 4.29 mg/pot in Titukkal and Doddabetta soils respectively. In both the soils, liming and potash fertilization did not influence the Mg uptake (Table 3). In Titukkal soil, $Mg_3$ level registered significantly higher Mg uptake than $Mg_0$, $Mg_1$, and $Mg_2$ levels which were on par. A similar trend was observed in Doddabetta soil.

Interaction of Mg x L, and Mg x K were found to be significant. At $Mg_1$, $Mg_2$ and $Mg_3$ levels, there was a decrease in Mg uptake. However, this did not reach statistical significance. At $K_0$ level, $Mg_1$ and $Mg_2$ treatments registered significantly higher Mg uptake than control. At $K_1$ level, the increase in Mg uptake over control was not significant at any of the Mg levels. Magnesium uptake of root was positively correlated with the yield of root ($r = 0.956^{**}$), shoot ($r = 0.236^{**}$), grain ($r = 0.315^{**}$) and total dry matter ($r = 0.722^{**}$).

*Shoot*: The mean Mg uptake by shoot was 114 and 82.6 mg/pot in Titukkal and Doddabetta soil respectively. Liming in Titukkal soil significantly decreased the Mg uptake by 13.75 per cent. Potash fertilization significantly decreased Mg uptake by 12.52 per cent. $Mg_1$ level recorded significantly higher Mg uptake over control but at the other two levels, the variation was not significant (Table 4). In Doddabetta soil, Mg and K fertilization did not influence Mg uptake. Liming significantly reduced Mg uptake by 19.20 per cent. Magnesium by shoot was positively correlated with the yield of shoot ($r = 0.280^{**}$), grain ($r = 0.488^{**}$) and total dry matter ($r = 0.790^{**}$).

*Grain*: The mean Mg uptake by grain was 5.81 and 3.55 mg/pot in Titukkal and Doddabetta soils respectively. In both the soils, liming significantly decreased Mg uptake (Table 5). In Titukkal soil, $Mg_1$ and $Mg_2$ levels were on par but registered significantly higher Mg uptake over

control and $Mg_3$ treatment which remained on par.

In Doddabetta soil, $Mg_0$, $Mg_1$ and $Mg_2$ levels were on par. The decrease in Mg uptake over others at $Mg_3$ level was significant. Potash fertilization significantly decreased Mg uptake. Mg uptake by grain was positively correlated with the yield of grain ($r=0.931^{**}$) and total dry matter ($r=0.655^{**}$).

*Total Mg uptake* : Total Mg uptake by ragi crop, on an average, was 126.6 and 90.4 mg/pot for Titukkal and Doddabetta soils respectively. Pooled analysis of the two soils (Table 6) showed that total Mg uptake was significantly higher in Titukkal soil than in Doddabetta soil. Liming significantly decrased Mg uptake, the decrease being 15-5 per cent. At both $K_0$ and $K_1$ levels, Mg uptake from Titukkal soil was significantly higher than from Doddabetta soil, but in Titukkal soil K level significantly decreased Mg uptake over control' while the variation due to potash fertilization was not significant in Doddabetta soil. Grimme *et al.* (1977) observed that Mg and Ca were taken by the plant in sufficiently higher amounts even in the presence of a high K level in the soil.

Mangnesium fertilization at $Mg_1$, $Mg_2$ and $Mg_3$ levels registered significantly higher Mg uptake than $Mg_0$. Similar observations were reported by Grunes *et al.* (1968) and Christenson *et al.* (1973). Total Mg uptake by ragi was positively correlated with total dry matter yield ($r=0.820^{**}$).

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TABLE 1

Effect of Treatments of the mean Mg content or various parts of Ragi crop (*Eleucine Coracana Gaertn.*) - Pot culture (mg/100g - mean of five replications-oven dry basis)

| Treatments | | | Titukkal soil | | | Dottabetta soil | | |
|---|---|---|---|---|---|---|---|---|
| | | | Root | Shoot | Grain | Root | Shoot | Grain |
| $L_0$ | $K_0$ | $Mg_0$ | 37.7 | 351.0 | 50.0 | 45.8 | 277.0 | 48.2 |
| $L_0$ | $K_0$ | $Mg_1$ | 51.0 | 372.0 | 50.2 | 47.8 | 341.5 | 48.0 |
| $L_0$ | $K_0$ | $Mg_2$ | 35.8 | 325.0 | 49.6 | 45.2 | 344.5 | 47.4 |
| $L_0$ | $K_0$ | $Mg_3$ | 45.0 | 359.5 | 47.6 | 46.2 | 340.5 | 47.4 |
| $L_0$ | $K_1$ | $Mg_0$ | 42.4 | 368.0 | 49.2 | 46.6 | 300.5 | 47.8 |
| $L_0$ | $K_1$ | $Mg_1$ | 42.6 | 323.5 | 49 0 | 46 6 | 322.5 | 46.6 |
| $L_0$ | $K_1$ | $Mg_2$ | 42.5 | 340.4 | 49 2 | 47.4 | 320.0 | 47.6 |
| $L_0$ | $K_1$ | $Mg_3$ | 42.9 | 364.5 | 49 0 | 47.0 | 340.0 | 46.8 |
| $L_1$ | $K_0$ | $Mg_0$ | 42.4 | 341.0 | 50 2 | 45 3 | 266.0 | 46.4 |
| $L_1$ | $K_0$ | $Mg_1$ | 42.7 | 312.9 | 49.0 | 47 2 | 287.5 | 45 6 |
| $L_1$ | $K_0$ | $Mg_2$ | 43.8 | 324.0 | 49.0 | 47 4 | 264.5 | 47.0 |
| $L_1$ | $K_0$ | $Mg_3$ | 42.5 | 340 5 | 49 4 | 44 4 | 281 5 | 45.6 |
| $L_1$ | $K_1$ | $Mg_0$ | 41.1 | 301.0 | 49.0 | 47.4 | 277.5 | 47 2 |
| $L_1$ | $K_1$ | $Mg_1$ | 43.8 | 341.1 | 48.8 | 45 7 | 302 0 | 48.5 |
| $L_1$ | $K_1$ | $Mg_2$ | 41.9 | 220.5 | 49 4 | 46 6 | 260.0 | 46.2 |
| $L_1$ | $K_1$ | $Mg_3$ | 43 1 | 321 0 | 49.4 | 45.2 | 301 0 | 45.8 |
| Mean | | | 42.2 | 338.2 | 49 3 | 46.5 | 301.5 | 47 0 |

TABLE 2

Effect of Treatments on the mean Mg uptake by Various Parts of Crop (*Eleucine Coracana Gaertn.*) - Pot Culture (mg/pot - mean of five replications)

| Treatments | Tittukkal soil | | | | Doddabetta soil | | | |
|---|---|---|---|---|---|---|---|---|
| | Root | Shoot | Grain | Total dry matter | Root | Shoot | Grain | Total dry matter |
| $L_0$ $K_0$ $Mg_0$ | 4.62 | 118 | 5.73 | 125.45 | 2.62 | 77.3 | 4.53 | 84.44 |
| $L_0$ $K_0$ $Mg_1$ | 5.58 | 149 | 8.05 | 162.63 | 4.69 | 96.4 | 4.80 | 105.86 |
| $L_0$ $K_0$ $Mg_2$ | 4.65 | 120 | 7.12 | 131.77 | 3.65 | 84.7 | 4.16 | 92.51 |
| $L_0$ $K_0$ $Mg_3$ | 7.99 | 125 | 6.68 | 139.67 | 4.73 | 97.8 | 3.89 | 105.92 |
| $L_0$ $K_1$ $Mg_0$ | 7.29 | 100 | 5.20 | 112.49 | 3.86 | 85.7 | 4.14 | 93.70 |
| $L_0$ $K_1$ $Mg_1$ | 7.39 | 115 | 6.98 | 129.37 | 4.40 | 109.5 | 3.15 | 117.05 |
| $L_0$ $M_1$ $Mg_2$ | 6.49 | 121 | 6.50 | 133.99 | 4.87 | 97.0 | 4.84 | 106.71 |
| $L_0$ $K_1$ $Mg_3$ | 9.61 | 136 | 4.77 | 150.38 | 5.98 | 83.0 | 3.15 | 92.01 |
| $L_1$ $M_0$ $Mg_0$ | 6.13 | 109 | 4.71 | 119.84 | 4 61 | 66.0 | 3.02 | 73.63 |
| $L_1$ $K_0$ $Mg_1$ | 6.91 | 119 | 5 04 | 130.95 | 4 57 | 79.3 | 3.94 | 87.81 |
| $L_1$ $K_0$ $Mg_2$ | 7.22 | 113 | 5.43 | 125 65 | 3 20 | 72.2 | 3.57 | 78.97 |
| $L_1$ $K_0$ $Mg_3$ | 7.41 | 117 | 4.38 | 128.79 | 4.97 | 75.2 | 2.61 | 82 78 |
| $L_1$ $K_1$ $Mg_0$ | 7 06 | 88 | 6.71 | 100 77 | 4.72 | 71 2 | 2 89 | 78.81 |
| $L_1$ $K_1$ $Mg_1$ | 6 76 | 125 | 6 21 | 137.97 | 2.91 | 73 6 | 3.07 | 79.64 |
| $L_1$ $K_1$ $Mg_2$ | 6 25 | 88 | 5 89 | 100.14 | 4.58 | 73.9 | 2.87 | 81.45 |
| $L_1$ $K_1$ $Mg_3$ | 6.37 | 86 | 4.47 | 99.34 | 4 33 | 83.3 | 2.05 | 89.69 |
| Mean | 6 77 | 114 | 5 81 | 126.58 | 4.29 | 82.6 | 3.55 | 90.44 |

TABLE 3

MAGESIUM UPTAKE BY RAGI ROOT (mg/pot)

| a. *Mg levels* | *Titukkal soil* | *Doddabetta soil* |
|---|---|---|
| $Mg_0$ | 6.27 | 3.95 |
| $Mg_1$ | 6.66 | 4.14 |
| $Mg_2$ | 6.15 | 4.07 |
| $Mg_3$ | 7.87 | 4.99 |
| S. E. | 0.38 | 0.28 |
| C. D. (P=0.05) | 1.11 | 0.81 |

| b. *Mg x L Interactions* | *Doddabetta soil* | |
|---|---|---|
| | $L_0$ | $L_1$ |
| $Mg_0$ | 3.24 | 4.67 |
| $Mg_1$ | 4.53 | 3 74 |
| $Mg_2$ | 4 26 | 3.88 |
| $Mg_3$ | 5·35 | 4.65 |
| S. E. (Mg at L) | 0,40 | |
| C D. (P – 0.05) | 1.15 | |
| S E. (L at Mg) | 0 40 | |
| C D. (P – 0.05) | 1.17 | |

| c. *Mg x K Interactions* | *Dodabetta soil* | |
|---|---|---|
| | $K_0$ | $K_1$ |
| $Mg_0$ | 3.61 | 4.29 |
| $Mg_1$ | 4.62 | 3.66 |
| $Mg_2$ | 3.42 | 4.72 |
| $Mg_3$ | 4.85 | 5,15 |
| S. E. (Mg at K) | 0.40 | |
| C. D. (P – 0.05) | 1,15 | |
| S. E. (K at Mg) | 0.40 | |
| C. D. (P – 0.05) | 1.17 | |

TABLE 4

MAGESIUM UPTAKE BY RAGI SHOOT (mg/pot)

| a. *Lime levels* | *Titukkal soil* | *Doudabetta soil* |
|---|---|---|
| $L_0$ | 122.64 | 91.37 |
| $L_1$ | 105.77 | 78.83 |
| S. E. | 4.41 | 2.21 |
| C. D. (P=0.05) | 13.60 | 6.80 |

| b. *K levels* | *Titnkkal soil* |
|---|---|
| $K_0$ | 120.93 |
| $K_1$ | 107.47 |
| S. E. | 4.41 |
| C. D. (P=0.05) | 13.60 |

| c. *Mg levels* | *Titukkal soil* |
|---|---|
| $Mg_0$ | 102.92 |
| $Mg_1$ | 126.97 |
| $Mg_2$ | 110.48 |
| $Mg_3$ | 116.45 |
| S. E. | 6.57 |
| C. D. (P=0.05) | 15.83 |

TABLE 5 Magnesium Uptake by Ragi grain (mg/pot)

| a. *Lime levels* | *Titukkal soil* | *Doddabetta soil* |
|---|---|---|
| $L_0$ | 6 38 | 4.08 |
| $L_1$ | 6.23 | 3.02 |
| S. E. | 0.35 | 0.10 |
| C. D. (P=0.05) | 1.07 | 0.31 |

| b. *Mg levels* | *Titukkal soil* | *Doddabetta soil* |
|---|---|---|
| $Mg_0$ | 5.34 | 3.64 |
| $Mg_1$ | 6.57 | 3.74 |
| $Mg_2$ | 6.24 | 3.89 |
| $Mg_3$ | 5.07 | 2.93 |
| S. E. | 0.22 | 0.22 |
| C. D. (P=0.05) | 0.63 | 0.63 |

| c. *K levels* | *Titukkal soil* |
|---|---|
| $K_0$ | 3 82 |
| $K_1$ | 3.28 |
| S. E. | 0.10 |
| C. D. (P=0.05) | 0.31 |

TABLE 6 Magnesium uptake by Ragi crop (mg/pot)

| a. *Lime levels* | *Pooled Analysis* | *Titukkal soil* | *Doddabetta so* |
|---|---|---|---|
| $L_0$ | 117.74 | 135.73 | 99.75 |
| $L_1$ | 89.45 | 117.82 | 61.08 |
| S. E. | 2.65 | 4.80 | 2.28 |
| C. D. (P=0.05) | 7.74 | 14.80 | 6.97 |

| b. *Mg levels* | *Pooled Analysis* | *Titukkal soil* |
|---|---|---|
| $Mg_0$ | 98.64 | 114.63 |
| $Mg_1$ | 118.24 | 140.19 |
| $Mg_2$ | 106.44 | 122.98 |
| $Mg_3$ | 110.97 | 129.29 |
| S. E. | 3.36 | 5.66 |
| C. D. (P=0.05) | 6.66 | 16.14 |

| c. *Soils* | *Pooled Analysis* |
|---|---|
| Titukkal | 126.78 |
| Doddabetta | 90.42 |
| S. E. | 2.65 |
| C. D. (P=0.05) | 7.74 |

| d. *Soil X K* | *Pooled Analysis* | |
|---|---|---|
| *Interactions* | $K_0$ | $K_1$ |
| Titukkal | 133 08 | 120.47 |
| Doddabetta | 88.52 | 92.31 |
| S. E. | 3.78 | |
| C. D. (P=0.05) | 10.94 | |