STUDIES ON POTASSIUM-MAGNESIUM RELATIONSHIP IN THE NUTRITION OF LETTUCE

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INTRODUCTION

The interaction of cations in the nutrition of plants has been the subject of extensive studies in recent years. Competition was found between similar ions as between K and Ca, K and Na and Ca and Sr (Michael and Schilling 1960, Mengel 1963 and Amer 1969). However, Ca was found to enhance K uptake (Overstreet et al., 1952 and Marschner and Guenther 1964). According to Marschner Mg might also enhance the uptake of monovalent cations especially at low supply of Ca.

The work herein performed was designed to study the interaction between K and Mg in Lettuce plants.

MATERIAL AND METHODS

Sterilized seeds of Lactuca Sativa V. Romney were used in this study. Waxed paper pots of capacity 850 gm were filled with acid cleaned sand of grain size 2 mm and used for cultivation. Six seeds were sown in each pot and after complete germination they were thinned and one plant was left in each pot. Long Ashton nutrient solution with 4^2 factorial combination was used for irrigation. Treatments included four levels of K and Mg of 0.5, 1, 2 and 4 meq/L in all possible combinations was used for irrigation. All other macro-and micro-nutrients were kept constant (Hewitt 1965). The pH of all the solutions was about 5.5. Daily addition of distilled water was carried out to keep the sand at 60% of its field capacity: this was simply checked by weighing the containers. Twice a week 10 ml. of the appropriate nutrient was added to each pot to renew its mineral content. The experiment lasted for 6 weeks, then the plants were harvested. Only the shoots were weighed, oven dried at 110°C to a constant weight. Three replicas were performed, their dry weights recorded, and the means presented in Table 1. Dry ashing of 10 mg samples at 500°C was carried out. Potassium was then estimated by photometry and calculated as meq/100 gm dry weight. Mg was estimated by the versinate method and also calculated as meq/100 gm dry weight (Jackson 1958).

RESULTS AND DISCUSSION

The effect of changing the ratio K : Mg on the yield of dry matter is given in Table 1 and presented graphically in Figs 1 and 2. These results show that the increase of nutrient K from 0.5 up to 1 meq/L had a significant effect on the yield at all levels of Mg. Further increase did not cause a significant increase in the yield except at 4 meq/L when the highest value

TABLE 1

The effect of different combinations of nutrient K : Mg on the yield of dry matter

Meq/L nutrient Mg	Meq./l nutrient K			
	0.5	1.0	2.0	4.0
	yield of dry matter (mg./pot)			
0.5	22	38	36	53
1.0	16	33	36	31
2.0	35	39	35	33
4.0	12	22	29	30

L. S. D. for yield of dry matter at 5% level = 19.4

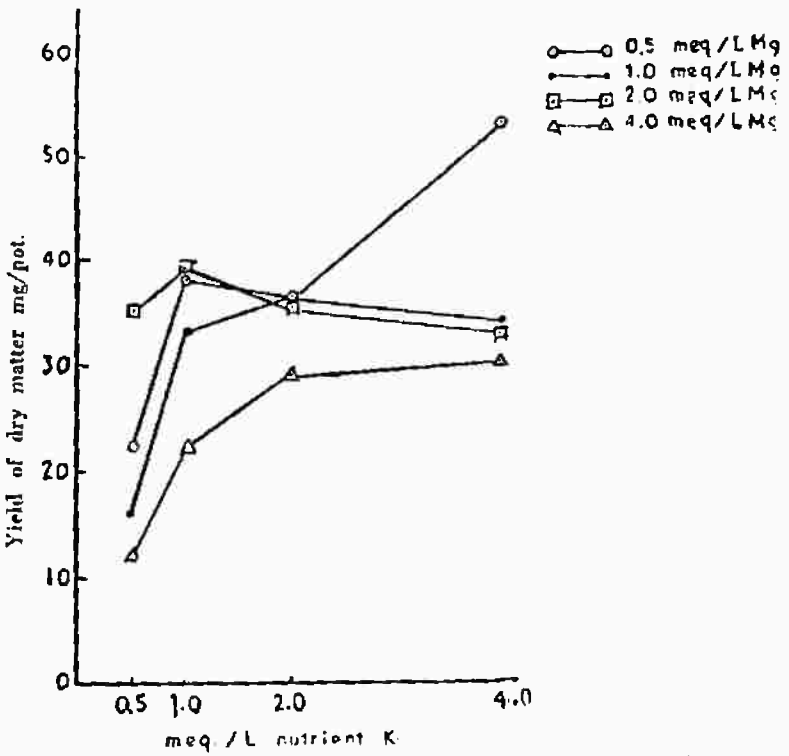

Fig. (1) Effect of nutrients K and Mg on the yield of dry matter of Lettuce plant

of 53 mg plant shoot was recorded; this coincided with the lowest Mg supply of 0.5 meq L (Fig. 1). However, the reciprocal effect of Mg on the yield was inconsistant, the lowest value of 12 mg/plant shoot was obtained at 4 meq/l Mg and 0.5 meq l K. This could be attributed to the high responses to K and its high cropping power and that Mg enhances the uptake and utilization of K even from its lowest concentration.

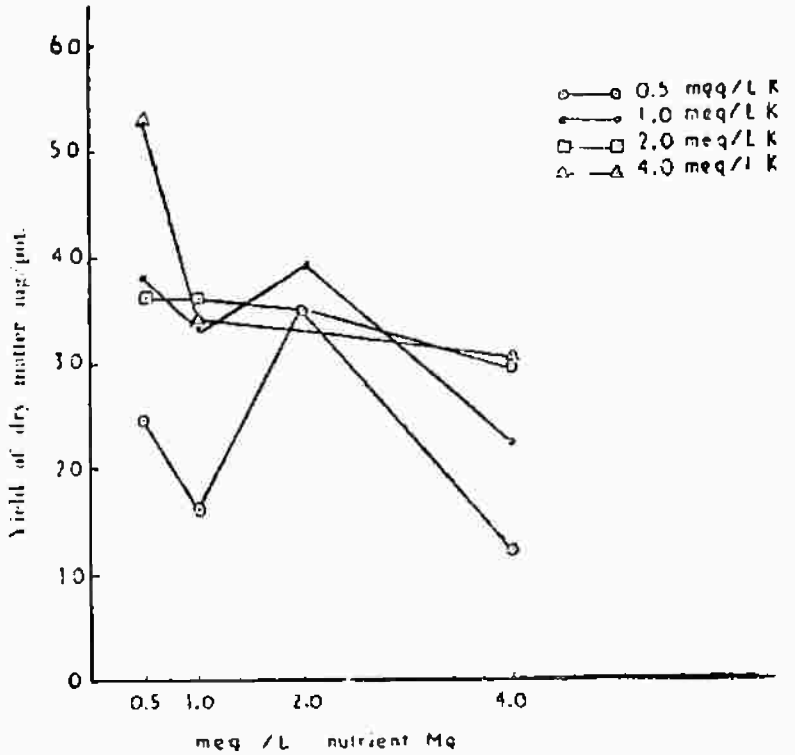

Fig. (2) Effect of nutrients K and Mg on the yield of dry matter of Lettuce plant

It is worth mentioning that K deficiency symptoms were observed in most cases on plants receiving 0.5 meq/L K at all levels of Mg. This indicates that Mg has no effect on the appearence of K deficiency symptoms which appears only due to the low K level. On the other hand Mg deficiency symptoms were observed on plants receiving 0.5 meq/L Mg and 2 and 4 meq/L K and also at the combination 1 : 4 Mg : K. The low Mg accumulation might be due to a high out-flux in the presence of K which increases the permeability of cell membranes. That the presence of K resulted in Mg deficiency was previously observed by Walsh et al. (1945) in Potatoe plants. It was also recorded by Ferrari et al. (1955) that a high Mg is required to eliminate Mg deficiency induced by K application.

As regards K uptake it was found to increase with its increase in the nutrient from 0.5 up to 4 meq L (Table 2, Fig. 3) reaching almost the same maxima of about 50 meq/100 gm dry weight at 4 meq L even when Mg was at 0.5 meq/L. This indicated that Mg favoured the uptake of K which is in close agreement with the results of Omar and El-Kobbia (1965). However, the increase of Mg supply from 0.5 up to 4 meq/L had no obvious effect on K uptake (Table 2, Fig. 4).

If Mg uptake is looked at independently, an increase in its uptake with the increase in the external medium could be observed (Table 3 Fig. 5).

TABLE 2

The effect of different combinations of nutrient K : Mg on the uptake of K

	Meq/l nutrient K			
Meq/L nutrient Mg	0.5	1.0	2.0	4.0
	K content meq 100 gm. dry matter			
0.5	18.93	30.64	36.93	50.15
1.0	19.82	28.21	38.31	49.85
2.0	17.08	28.91	39.89	56.93
4.0	17.56	25.13	48.73	55.17

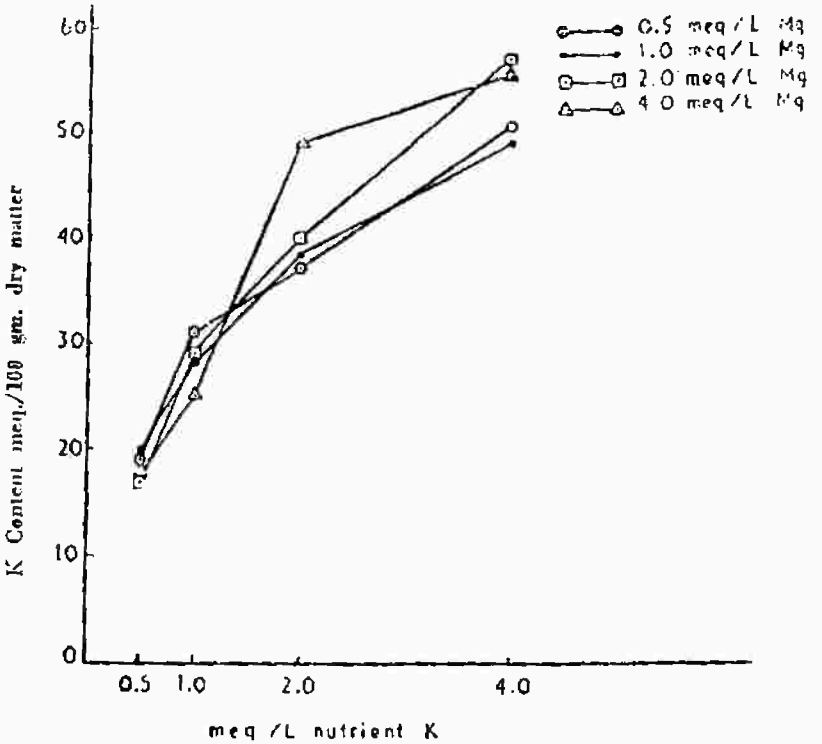

Fig. (3) Effect of nutrients K and Mg on K Content of Lettuce plant

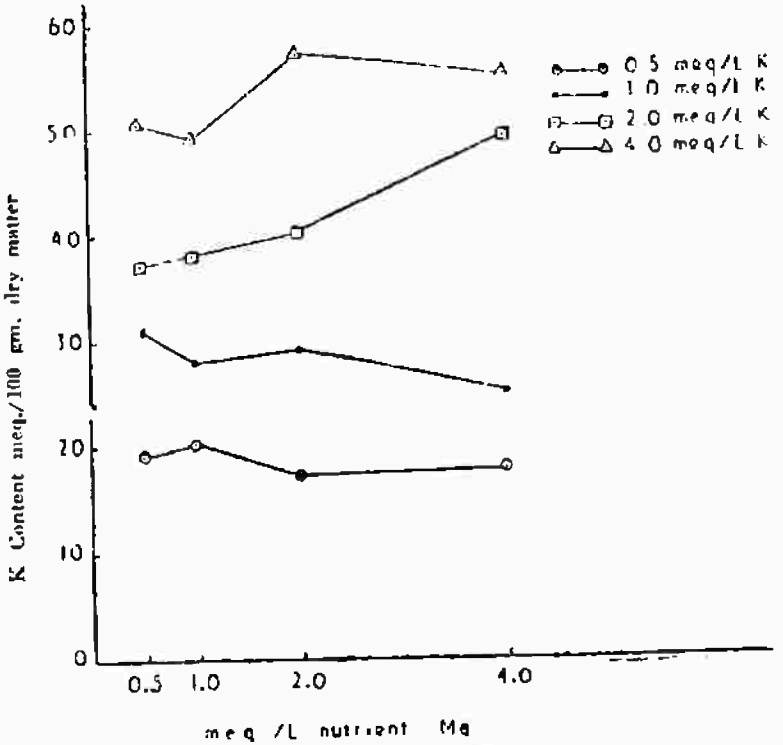

Fig. (4) Effect of nutrients K and Mg on K Content of Lettuce plant

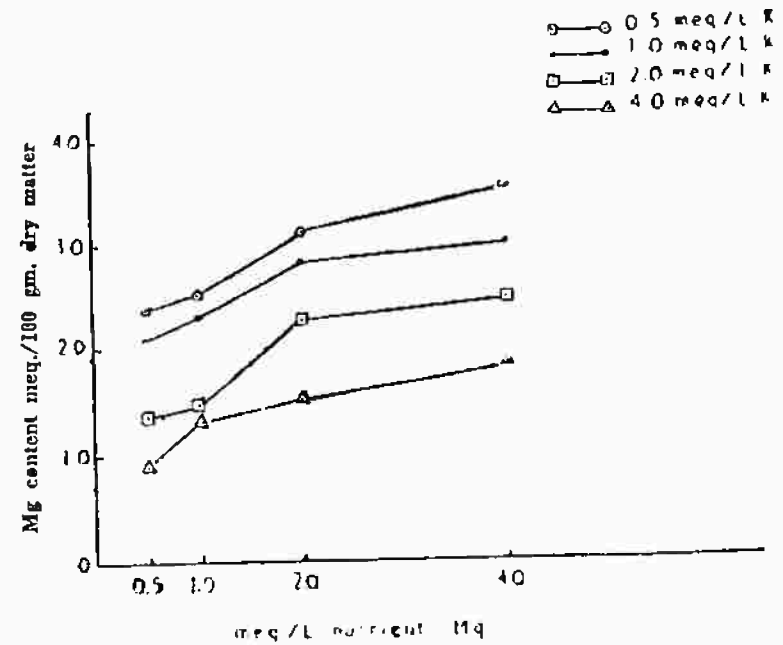

Fig. (5) The effect of nutrients K and Mg on Mg content of Lettuce plant

TABLE 3

Effect of different combinations of nutrient K : Mg on Mg uptake

Meq/L nutrient Mg	Meq/L nutrient K			
	0.5	1.0	2.0	4.0
	Mg content meq. 100 gm. dry weight			
0.5	23.85	20.13	13.56	8.76
1.0	24.66	23.28	14.59	12.85
2.0	31.13	27.11	22.10	14.64
4.0	35.75	29.14	23.71	17.61

When studying the effect of K on this uptake (Table 3, Fig. 6), a clear depressing effect could be seen; the lowest values of Mg are at 4 meq/L nutrient K. This indicated a strong one way competition between the two ions. That K decreases Mg uptake especially when it is present in abundance was previously recorded by Prince et al. (1947) and Hoagland and Caldwell (1963). The explanation put forward by the latter authors was that the addition of K decreases the ease of soil Mg absorption and that K in some way prevents Mg from performing its function in the plant. Such one side competition was also observed by many workers with ions. Bange and Overstreet (1960) and Marchner (1961) observed that Rb strongly depressed Cs while the opposite effect did not exist.

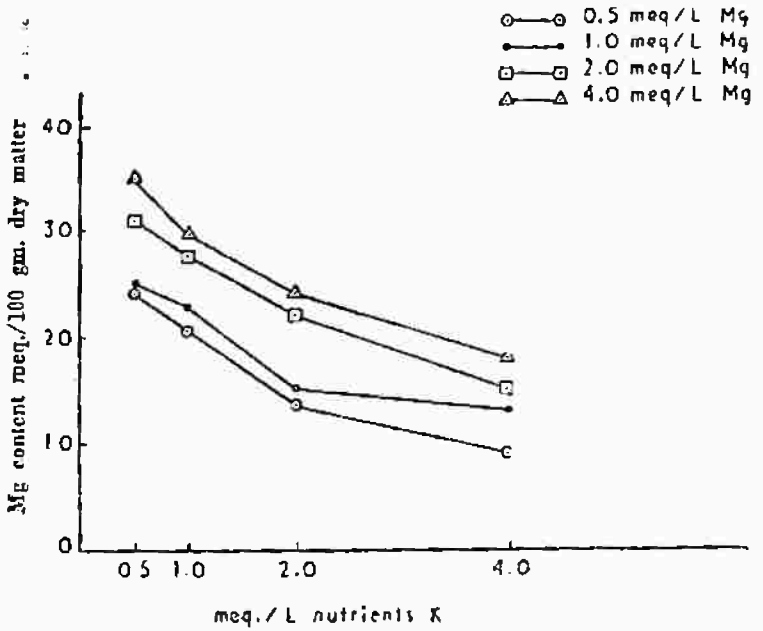

Fig. (6) Effect of nutrients K and Mg on Mg content of Lettuce plant

Another interesting observation was that the increase in the uptake of either ion was not proportional to its increase in the nutrient. Such results are shown in Table 4 where both the ratios of K to Mg in the plant to those in the nutrient referred to as the observed ratio (O. R) are given in the last column. The observed ratio was almost a constant at each level of Mg which indicates the presence of a carrier factor. Its increase with the increase in Mg concentration can only be attributed to the diminishing

TABLE 4

Effect of different combinations of nutrient K : Mg on their observed ratio

Meq./l		Nutrient K : Mg	Plant K : Mg	O. R
K	Mg			
0.5	0.5	1.00	0.79	0.79
1.0	0.5	2.00	1.50	0.76
2.0	0.5	4.00	2.72	0.68
4.0	0.5	8.00	5.76	0.72
0.5	1.0	0.50	0.80	1.61
1.0	1.0	1.00	1.21	1.21
2.0	1.0	2.00	2.62	1.31
4.0	1.0	4.00	3.92	0.96
0.5	2.0	0.25	0.55	2.20
1.0	2.0	0.50	1.06	2.12
2.0	2.0	1.00	1.78	1.78
4.0	2.0	2.00	3.88	1.67
0.5	4.0	0.125	0.49	3.92
1.0	4.0	0.250	0.85	3.40
2.0	4.0	0.500	2.06	4.12
1.0	4.0	1.000	3.15	3.15

increase in Mg uptake as a result of rising nutrient K. Such results when the observed ratio tended to rise in favour of K with rising Mg showed clearly that there is no competitive effect of Mg on K.

The ability of Lettuce to absorb K selectively may be a major reason for the preference of chemical rather than physical theories of ion uptake (Mengel 1963). In respect of the chemical theory (carrier theory) the depressing effect of K on the uptake of Mg must be a result of the competition for a metabolically produced binding compound. That Mg had not affected K could be attributed to its stimulating effect on K as Ca does (Legett et al., 1969 Marschner. 1961 and Overstreet et al. 1952).

SUMMARY

It became clear from the study of the interaction of Potassium and Magnesium in the nutrition of *Lettuce* that the uptake of both ions increases with their increase in the nutrient. Yet such an increase was not proportional to the corresponding one in the nutrient. There was observed a one side competition where Mg favours K uptake while the reverse did not exist. Consequently Mg dificiency symptons were observed when it was present at a lower concentration than K; actually at 1 : 4 Mg/K.

As K is known to increase the synthesis of both proteins and carbohydrates, a clear increase in the yield of dry matter resulted from an increase in K supply and coincided with the increase in its uptake.

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