https://doi.org/10.29321/MAJ.10.A02725

Madras agric. J. 69 (5) 329—338 May,, 1982

Magnesium Fereilization in Acid Soils for Potato Crops

K. K. MATHAN[1], and K. CHIRANJIVI RAO[2],

Magenisium fertilization studies were conducted for two seasons in magnseium deficient and potassium high soil of Titukkal (near Ootacamund, in the Nilgiris District with Sixteen treatments (combination of two levels of/lime, two levels of K_2 O and four levels of magnesium in a spilt-plot design with lime and potassium in the main plots and with potato (*Solanum tuberosum* L. Var. Kufri jyothi) as the test crop.

The results indicated that applicantion of magnesium at the rate of 50 kg Mg/ha was the optimum in incresing the yield of potato crops under Nilgiris conditions. However the relationship between Manesium application and yield was quadratic. Under high calcium content in the soil, lower aviiability of magnesium and phosperous and was observed. Further lower uptake of magnesium, phosphorus and potassium under high calsium content was observed These were some of the reasens depressed Mg uptake in addition to widening of Ca: Mg ratio. In the presouce of magnesium the tuber yield variations due to potassium application was non-significant indicatint that.magenisium could, to certain extent, alleviate the adverse effects of K fertilization.

Since an incrase in yield was obtained with magnesium application the soil available magnesium was inferred to be limiting pota.o yield.

Though magnesium is required by all crops, special attention has to be bestowed in the case of certain crops ike potatoes with regard to magnesium nutrition especically in acid soils. Considerable area of acid soils exists in the Nilgiris. Nearly 13600 hectares are under annual crops like potato, wheat, ragi, and vegetables. Out of this nearly 8300 hectares are mainly under potatoes the principal food crop of the area. Magnesium deficiency symptoms in potato fields ('farmers holdings) was observed by Mathan et *al.* (1973) and Mathan (1977). Therefore attempts were made to study the effect of Magnesium fertilization on the yield of potatoes.

MATERIALS AND METHODS

The field trial was conducted in a farmer's holding in Titukkall (Octacamund) Nilgiris district. The soil was loamy in texture. The organic matter content was 7.4 per cent The exchangeable magnesium content was very low (0.99 me/100 g). The following Sixteen treatments involving different combinations of lime, Potassium and magnesium were tried The treatments were replicated 6 times and were as follows :

1. Associate Prof. Dept. Soil Sceince, TNAU Coimbatore.
2. Senior Agcl Chemist, Sugarcane Breeding institute. Coimbatore.

1. L_0 K_0 Mg_0	9 L_1 K_0 Mg_0
2 L_0 K_0 Mg_1	1 . L_1 K_0 Mg_1
3. L_0 K_0 Mg_2	11 L_1 K_0 Mg_2
4. L_0 K_0 Mg_3	12. L_1 K_0 Mg_3
5 L_0 K_1 Mg_0	13 L_1 K_1 Mg_0
6. L_0 K_1 Mg_1	14 L_1 K_1 Mg_1
7 L_0 K_1 Mg_2	15. L_1 K_1 Mg_2
8. L_0 K_1 Mg_3	16 L_1 K_1 Mg_3

L_0 No lime

L_1—Lime was applied as per Lime requirement (Black, 1965) —as $CaCO_3$ (16.8) tonnes/ha

K_0—No Potassium

K_1—Potassium applied as muriate of Pottash at the rate of 100 kg K_2O

Mg_0—No Magnesium

Mg_1—50 Kg Mg/ha as $MgSO_4.7H_2O$

Mg_2—100 Kg Mg/ha as $MgSO_4.7H_2O$

Mg_3—150 Kg Mg/ha as $MgSO_4.7H_2O$

Constant doses of nitrogen (60 kg N/ha) and phosphorus (240 kg P_2O_5/ha) were applied in the form of ammonium sulphate and superphosphate The design of the experiment was spilit plot with L and K combinations as the mainplot reatments and doses of magnesium as the sub plot treatments. The treatments were randomised. The variety Kufri Jyothi of potato *Solanum tuberosum* L) was the test crop. Two crops were taken up

The crop was harvested at maturity and yields were recorded (Tables 1 and 2) Tuber samples were anlaysed for N,P,K, Ca and Mg and the uptake of the above nutrients were calculated Pre-planting and post-harvest soil samples were ananlysed for exchangeable cations (K, Ca and Mg) following the standard methods of analysis (Jackson. 1973). The parmeters recorded were subjected to analysis of variance.

RESULTS AND DISCUSSION

Yield : Tuber yield was obsesved to decrease by liming while a statistically significant interactions of Mg X L was obtained in the present investigation (Table 3) At L_0, magnesium fertilization did not significantly influence the yield This is in line with the findings of walker *et al*. (1955) and Yamagnchi et *al* (1960) Likewise at Mg_1 level (Mg application at the rate of 50 kg/ha) alone, liming significantly increased the yield, but at higher levels than Mg1 liming again decreased the yield. This might have been due to the disturbance of the Ca/Mg ratio as reported by Berry and ulrich (1970) and , Krishnappa (1974). In the present investigation exchangeable Ca/Mg in soil was positively correlated with Ca/Mg content (r=0.679**) and uptake by potatoes (r=0 690**) while negatively correlated with Mg content (r=-0.742**) Mg uptake (r=-0 770**) and tuber yield (r=0.498**) Thus the depressed yield was due to lesser utilization of Mg and a change in the Ca : Mg ratio. The above observations indicated that liming was beneficial in the presence of Magnesium only, that too at a particular level. Similar observations were made by Chucka and Brown (1938), Mazayeva (1967) and Loganathan (1973).

Potasium application significantly decreased the tuber yield in both the crops. Similar results were obtained by Holmes 1962 and Simson *et al* (1973). High levels of potassium fertilizers have been traditionaly used for potatoes in the Nilgiries. Post-harvest soil analysis further confirmed that the available K status in the plants were on the higher side (Table 4 and 5) In both the crops exchangeable K was negatively correlated with Mg uptake ($r=-0.20^*, n=0.96$) and tuber yield ($r=-0.734^{**}$, $n=32$). Similar antagonistic effect between Magnesium and potassium was reported by Salmon (1963) and Bolton (1977).

Thus it appears that the question is not the simple one of a balancing of lime with magnesium, but a balancing of lime and magnesium, with other nutrients especially potassium.

Magnesium fertilization increased the potato tuber yield. The relationship between the levels of magnesium, application and yield was quadratic ($R^2 = 0.824$ $Y = 281.71 + 16.81$, $X - 5.77X^2$) the highest yield being obtained from application of 50 kg Mg per hectare. Increased potato yield from magnesium application was obtained by Holmes (1962) and Hassrer and Doll (1970) Siaficant Mg X K interaction was recorded in the present study which indicated that at both K_0 and K_3 level application of 50 kg Mg/ha gave the highest yield and was significantly superior to others, without magnesium, K fertilization significantly decreased the tuber yield by 5.52 per cent, while the decreased was only 2.63 per cent under Mg_1 level and at higher levels of Magnesium, K fertilization did not significantly influence the tuber yield. This indicated that Magesium could, to a certain extent alleviate the adverse effects of K fertilization. Similar K/Mg antagonisms were seen the Simpson *et al.* (1973) Thus there seems to be a need for revisionof the present fertilization practice in the area.

Exchangeable Mg of soil was observed to be positively correlated with Mg uptake by tuber as well as Mg yield Further Mg uptake was positively correlated with tuber yield ($r=0.870^{**}$), $Y=17.18 + 50.49$ for first crop and $r=0.490^{**}$ $Y=74.65X - 880.2$). Similar observations were recorded by Hogg (1960), Holmes (1962) and Bolton (1973). As indicated by the pooled analysis, variations in yield due to crop in different reasons was significant.

Nutrient uptake : Liming decreased N,P and Mg uptake by tubers; but increased K and Ca uptake by tubers. However at Mg^1 level, liming increased Mg uptake, Potassium application did not influence the uptake of N, P, K and Ca but depressed Mg uptake, Boswell and Parks (1957), Jokinen (1969) and Grime *et al.* (1977) recorded similar observations. Magnesium application did not influence the N uptake but increased significantly P,K, Ca and Mg uptake. The influence of treatments on uptake of nutrient by potato is illustrated.

Thus in this study, the application of lime resulted in suppression of Mg uptake by the potato plants. Application of K also suppressed Mg uptake by potota tubers. Since an increase in yield was obtained with magnesium application, the soil available magnesium was limiting potato yield. Lee (1978) obtained similar data with Kalahdin, Kennelbec and Sebago varieties of potatoes in canada.

ACKNOWLEGEMENT

We wish to express our gratitude to the Tamilnadu Agricultural University Coimbatore for according permisson to publish the work which formed part of the first author's Ph. D. Thesis.

LITERATURE

BERRY, W. L. and A. ULRICH. 1970. Calsium, nutrition of sugar beets as affected by potassium Soil Sci. 110 : 339-394.

BLACK, C. A. 1965. Methods of soil analysis, part 2 chemical and microbiological properties, Amer. Soc. Agron. Inc. Publisher Madison. U. S. A

BOLTON, J. 1973. source of magnesium for sugarbeet, potatoes and wheat grown on an acid sandy soil at wobum beds. J. agric. Sci Camb 81 553 –556.

BOLTON, J. 1977 Liming effects on the response of potatoes and Oats to phosphorous, and magnesium fertilizers J. agric. Sci. Camb. 89 : 87—93

BOSWELL, F. C. and W. L. PARKS. 1957. The effect of soil potasium levels on yields, loading and mineral composition of corn Soil. Sci. Soc. Amer Proc. 21 : 301—305.

GRIMME, H., L. C. BRAUNSCHWEIG and K. NEMETH. 1977. Potassium, Calsium and magnesium interaction in relation to uptake and yield. Natural Resources and Development. 5 : 84—94.

HOGG, D. E. 1960 Magnesium losses from. Horotiu sandy loam following application of pottasium chloride. New Zealand J. Agri. Res. 3 : 377—383.

HOLMES, M. R. J. 1962 a. Field expotients on the requirements of potatoes in Great Britain. J. agric. Sci. Canb. 58 : 281—282.

HOLMES, M. R. J. 1962 b. The magnesium requirements of arable crops. J. Sci. Fd. Agric. 13 : 553—556

HOSSNER, L. R. and E. C. DOLL. 1970. Magnesium fertilization of potatoes as related to liming and potassium. soil. Sci. Sco. Amer. Proc. 34 : 772—774.

JACKSON, M.L. 1973. Soil Chemical Analysis, Prentice Hall of India (Pvt.) Ltd. New Delhi.

JOKINEN. R. 1969. The magenesium status of soil and the magnesium content of cultivated plants J. Sci agric. Soc. Finland. 41 : 290 —297.

KRISHNAPPA., M., G. N. GAJANAN, M. S. MITHYANTHA and N. G. PERUR. 1974 Calsium-magnesium exchange equilibrium in three soils of Karnataka. Mysore J. agric Sci. 8 : 97—102.

LEE, C. R. 1978. Personal communication. Ecosystem Research and simulation Division. Department of the Army, Vicksburg, Mississippi

LOGANATHAN, S. 1973. Studies on certain aspects of calsium in the soils of South India. Ph. D. Thesis. Tamil Nadu Agrl. Univessity. Coimbatore. India.

MATHAN, K. K. 1977. A note on the magnesium defficient potato plants. Madras. agric. J 64 :765—766

MATHAN, K. K. S. SAMBOORNARAMAN N, BALAKRISHNAN and M.S. NEHRU. 1973. Magnesium fertilization of Nilgiris soils. Madras agric. J. 60 : 1069—1070.

MAZAYEVA, M. M. 1967: Critical magnesium content of soils Agrokhimiya No. 10 : 93—105

SALMON, R. C. 1963. Magnesium relationship in soils and plants. J. Sci Fd. Agr. 14 : 605—610.

SIMSON K., P. CROOKS and S. MCINTOSH. 1973. Effects of potassium and magnesium fertilizers on yield and magnesium fertilizers on yield and size distribution of potatoes. J. agric. Sci. Canb. 80 : 369—373

WALKER, R.B., H. M. WALKER and P. R. ASHWORTH. 1955. Calsium magnesium nutrition with special reference to serpentine soils. Plant Physiol. 30 : 214—221.

YANAGNCHI, M., F.H. TAKATORI and O. A. LORENZ. 1960. Magnesium deficiency of celery. Proc. Amer. Soc. Hort. Sci. 75 : 456—462.

TABLE 1. Effect of Treatments on nutrient uptake by Potato Tubers (*Solanum tuberosum* L.) Ist Crop (kg/ha) (Mean of six replications – oven dry basis)

T. No.	Teatment	Total tuber yield (q/ha)	N	P	K	Ca	Mg	Ca/Mg
1	L_0 K_0 Mg_0	198.6	72.2	12.0	83.3	12.7	2.9	4.38
2	L_0 K_0 Mg_1	206.3	68.4	12.5	79.3	17.2	2.6	5.93
3	L_0 K_0 Mg_2	203.5	70.5	12.0	73.1	11.7	2.8	4.18
4	L_0 K_0 Mg_3	207.3	68.0	12.3	90.8	12.7	3.0	4.23
5	L_0 K_1 Mg_0	191.3	73.5	10.9	75.3	13.0	2.7	4.81
6	L_0 K_1 Mg_1	182.9	65.3	10.8	78.8	14.0	2.6	5.38
7	L_0 K_1 Mg_2	214.9	80.7	12.9	85.4	17.4	3.1	5.61
8	L_0 K_1 Mg_3	194.6	67.5	10.9	83.9	12.4	2.8	4.43
9	L_1 K_0 Mg_0	185.4	61.1	9.6	83.4	14.9	2.6	5.73
10	L_1 K_0 Mg_1	197.4	66.7	10.8	102.3	14.7	2.8	5.25
11	L_1 K_0 Mg_2	195.8	71.2	9.8	97.3	14.2	2.9	4.90
12	L_1 K_0 Mg_3	200.1	65.2	9.4	97.6	14.8	2.8	5.29
13	L_1 K_1 Mg_0	178.5	65.5	9.0	93.8	12.9	2.6	4.96
14	L_1 K_1 Mg_1	214.3	79.1	10.7	121.4	19.9	3.0	6.63
15	L_1 K_1 Mg_2	191.7	58.3	10.6	82.8	13.7	2.8	4.89
16	L_1 K_1 Mg_3	165.3	59.4	8.8	74.9	13.8	2.4	5.75
	Mean	195.6	68.3	10.9	87.8	14.4	2.8	5.15

TABLE 2. Effects of Treatments on Nutrient uptake by Potato Tubers (*Solanum tuberosum* L.) II Crop (kg/ha) (Mean of six replications, oven dry basis)

T. No.	Treatments	Total tuber yield (q/ha)	N	P	K	Ca	Mg	Ca/Mg
1	L_0 K_0 Mg_0	321.4	118.8	25.2	106	21.8	5.3	4.11
2	L_0 K_0 Mg_1	325.6	112.2	26.8	121	23.2	5.5	4.22
3	L_0 K_0 Mg_2	299.2	89.1	24.6	104	16.6	5.6	3.32
4	L_0 K_0 Mg_3	296.8	90.9	26.7	95	18.9	4.9	3.86
5	L_0 K_1 Mg_0	311.0	108.0	27.1	118	21.8	5.1	4.27
6	L_0 K_1 Mg_1	339.5	152.1	31.2	141	23.8	5.7	4.18
7	L_0 K_1 Mg_2	323.6	99.6	28.9	117	25.4	5.5	6.62
8	L_0 K_1 Mg_3	322.1	98.7	30.4	118	19.0	5.4	3.52
9	L_1 K_0 Mg_0	320.0	80.7	23.5	125	26.2	5.3	4.94
10	L_1 K_0 Mg_1	351.9	103.2	28.7	120	25.3	5.9	4.29
11	L_1 K_0 Mg_2	324.2	74.4	25.7	108	23.7	5.4	4.39
12	L_1 K_0 Mg_3	332.5	90.3	27.1	119	25.7	5.6	4.59
13	L_0 K_1 Mg_0	296.0	89.7	23.7	103	19.6	4.8	4.08
14	L_1 K_1 Mg_1	324.2	107.1	29.0	135	26.5	5.4	4.91
15	L_1 K_1 Mg_2	302.7	101.7	25.1	112	22.5	5.0	4.50
16	L_1 K_1 Mg_3	297.1	82.5	24.0	106	19.6	5.0	3.92
	Mean	318.1	100.2	26.8	116	22.5	5.3	4.23

TABLE : 3 Potato Tuber Yield (Pooled Analysis) — (q/ha)

a. *Crop*	*Tuber yield*
I Crop	195.49
II Crop	317.91
S. E.	1.24
C. D. (P=0.05)	3.57

b. *K levels*	*Tuber yield*
K_0	260.37
K_1	253.03
S. E.	1.24
C. D. (P=.05)	3.57

b. *Lime levels*	*Tuber yield*
L_0	258.64
L_1	254.76
S. E.	1.24
C. D. (P=.05	3.57

d. *X K Interaction*	*Tuber yield*
L_0 K_0	257.32
L_0 K_1	259.96
L_1 K_0	263.42
L_1 K_1	246.10
S. E.	1.75
C. D. (P=0.05)	5·04

e. *Crop X lime interactions*	*Tuber yield* L_0	L_1
I Crop	199.91	191.06
II Crop	317.36	318.45
S. E.	1.75	
C. D. (P=.05)	5.04	

f. *Crop X] interactio*	*Tuber yield* K_0	K_1
I Crop	199.30	191.67
II Crop	321.44	314.38
S. E.	1.75	
C. D. (P=0.05)	5.04	

g. *Mg levels*	*Tuber yield*
Mg_0	260.15
Mg_1	267.75
Mg_2	256.93
Mg_3	251.97
S. E.	1.32
C. D. (P=.05)	3.70

Mg X lime Interactions	*Tuber yield* L_0	L_1
Mg_0	256.56	244.74
Mg_1	263.55	271.95
Mg_2	260.26	253.60
Mg_3	255.19	248.76
S. E. (Mg at lime)	1.87	
C. D. (P=0.05)	3.70	
S. E.	2.0[illegible]	
C. D. (P=0.05)	5.7[illegible]	

Mg X K Interactions	*Tuber yield* K_0	K_1
Mg_0	256.36	243.94
Mg_1	270.27	265.22
Mg_2	255.68	258.18
Mg_3	259.18	244.76
S. E. (Mg at K)	1.87	
C. D. (P=0.05)	5.23	
S. E. (K at Mg)	2.04	
C. D. (P=0.05)	5.76	

Crop X Mg Interactions	*Tuber yield* I Crop	II Crop
Mg_0	188.52	311.85
Mg_1	200.21	335.28
Mg_2	200.46	312.39
Mg_3	191.82	312.11
S.4. (Mg at crop)	1.87	
C. D. (P=0.05)	5.23	
S. E. (Crop at Mg)	2.04	
C. D. (P=0.05)	5.76	

TABLE 4. Treatmental Effects on the available Nutrients, Ca/Mg Ratio and ph in field trial. — I Crop
(Mean of six replications – moisture free basis)

T. No.	Treatments	Available nutrients					Ca/Mg	ph
		Nitrogen (ppm)	Phosphorus (ppm)	Potassium (ppm)	Calcium me/100g)	Magnesium (me 100g)		
1	$L_0 K_0 Mg_0$	134	113	522	16.5	0.35	47.1	5.6
2	$L_0 K_0 Mg_1$	141	81	543	18.7	0.32	58.4	5.5
3	$L_0 K_0 Mg_2$	168	40	413	15.8	0.34	46.5	5.3
4	$L_0 K_0 Mg_3$	132	70	417	15.3	0.37	41.4	5.3
5	$L_0 K_1 Mg_0$	145	72	500	17.0	0.32	53.1	5.7
6	$L_0 K_1 Mg_1$	240	67	420	16.1	0.35	46.0	5.6
7	$L_0 K_1 Mg_2$	154	79	502	17.8	0.36	48.4	5.7
8	$L_0 K_1 Mg_3$	149	60	435	17.3	0.37	46.8	5.6
9	$L_1 K_0 Mg_0$	173	62	542	33.8	0.36	93.9	6.6
10	$L_1 K_0 Mg_1$	154	62	470	32.7	0.35	93.4	6.7
11	$L_1 K_0 Mg_2$	174	67	323	27.8	0.34	81.8	6.4
12	$L_1 K_0 Mg_3$	171	30	485	31.8	0.35	90.9	6.7
13	$L_1 K_1 Mg_0$	148	62	435	33.1	0.34	97.4	6.9
14	$L_1 K_1 Mg_1$	188	62	467	25.5	0.33	77.3	6.4
15	$L_1 K_1 Mg_2$	179	32	455	28.3	0.33	85.8	6.8
16	$L_1 K_1 Mg_3$	146	40	403	31.5	0.34	92.7	6.7
Mean		142	62	458	23.7	0.37	68.9	

TABLE 5 Treatmental Effects on the available Nutrients Ca/Mg Ratio, and ph in field trial - II Crop

T. No.	Treatments	Available nutrients					Ca/Mg	ph
		Nitrogen (ppm)	Phosphorus (ppm)	Potassium (ppm)	Calcium (me/ 100g)	Magnesium (me/ 100g)		
1	L_0 K_0 Mg_0	166	23	303	8.4	0.31	27.1	5.4
2	L_0 K_0 Mg1	174	81	310	7.1	0.24	22.4	5.3
3	Lo K_0 Mg_2	153	88	347	6.4	0.32	22.0	5.2
4	Lo K_0 Mg_3	166	100	267	6.4	0.32	20.0	5.1
5	Lo K_1 Mgo	220	79	317	6.3	0.32	19.7	5.2
6	Lo K_1 Mg_1	196	74	317	6.3	0.32	19.7	5.4
7	Lo K_1 Mg_2	199	53	382	13.2	0.31	42.6	5.7
8	Lo K_1 Mg_3	207	65	325	13.2	0.35	37.7	5.5
9	L_1 Ko Mgo	201	60	420	8.8	0.33	26.7	6.5
10	L_1 K_0 Mg_1	171	58	420	12.0	0.35	34.3	6.6
11	L_1 Ko Mg_2	179	66	450	12.0	0.34	35.3	6.7
12	L_1 Ko Mg_3	156	70	418	11.2	0.36	31.1	6.6
13	L_1 K_1 Mgo	163	50	405	12.8	0.33	38.8	6.8
14	L_1 K_1 Mg_1	157	60	380	14.4	0.33	43.6	6.8
15	L_1 K_1 Mg_2	184	36	43[illegible]	12.4	0.28	44.3	6.7
16	L_1 K_1 Mg_3	123	38	39[illegible]	12.0	0.34	35.3	6.8
Mean		176	62	36[illegible]	10.2	0.33	31.3	