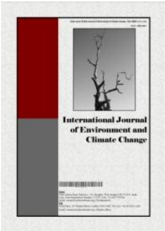

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Maize (*Zea mays*) Yield Response to Application of Calcium, Magnesium and Boron on Acid Soil

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study was carried out at Zonal Agricultural Research Station, Gandhi Krishi Vigyan Kendra, University of Agricultural Sciences, Bengaluru with maize as the test crop. GKVK is located in the Eastern Dry Zone of Karnataka situated at 12° 58' north latitude and 77° 35' east longitude at an altitude of 930 m above mean sea level, the mean annual rain fall is 950 mm. Field experiment was established using three levels of Ca (0, 200 & 400 kg ha^{-1}), two levels of Mg (0 & 60 kg ha^{-1}) and foliar spray of boron at two levels (0 & 0.5 %) combined to give 12 treatments. Results showed that the soil pH, exch.Ca, Mg and base saturation increased with levels of application of calcium and magnesium. While exch. Aluminium content decreased in the soil due to the combined application of Ca and Mg. The uptake of all the nutrients was increased by increasing the levels of application of the three nutrient elements. There was synergistic effect among them when either only two of them were applied together or when all the three of them were applied together. The different combinations of Ca-Mg-B significantly influenced the yield and yield components of maize. The highest were recorded from Ca, Mg and B at 400 kg, 60 kg and 550 g ha^{-1} respectively. The lowest was recorded in control plot (Ca_0-Mg_0-B_0).

Keywords: Maize; acid soil; calcium; magnesium and boron.

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1. INTRODUCTION

Soil acidity is a major reason for low productivity in most of cultivated soils. In India, more than 45 million hectares of land is acidic and Karnataka is one among the several states where the acidic soils are spread over a large area [1]. Out of total cultivated area of 104 lakh hectares in Karnataka, 12.3 lakh hectares of land is acidic. On most acid soils, there are several limiting factors for plant growth, including toxic levels of Al, Mn, and iron (Fe), as well as deficiencies of some essential elements, such as phosphorus (P), nitrogen (N), potassium (K), calcium (Ca), Mg, and some micronutrients such as Mo and B [2], low microbial activity, poor fertility, and low crop yields. To meet the demands of calcium and magnesium, as well as to create favorable conditions for better uptake of other essential nutrients, liming is an important management practice in the acid soils helping in raising the pH and base saturation of the soil and inactivation of iron, aluminium and manganese in the soil solution and minimizing phosphate fixation by iron [3,4,5].

Maize (*Zea mays* L.) is another most important cereal crop of the world. It is a versatile crop as it is grown across a range of agro ecological zones. In India maize crop covers an area of about 71.08 lakh hectares with a production of 17.30 million tons and an average productivity of 2.11 t ha^{-1}. The total area covered under maize in Karnataka is 9.59 lakh hectares with a production of 20 lakh tons and productivity of 3.36 t ha^{-1}. Generally, the productivity of maize is low in acid soils, but it could be enhanced if adequate care is taken to increase the base saturation of the soils (www.netindian.com). These soils may differ in terms of their response to the amelioration measures taken up to rejuvenate them. Hence it is not only important to know the quantity of liming materials that has to be added to the soils originating under different agro-climatic situations, but also to understand the changes some of the ameliorating practices may bring about in the quality of the acid soils that originate due to different reasons and their effect on yield of crops. The present study was undertaken to study the response of different levels calcium and magnesium salts to low pH soil of eastern dry zone in Karnataka, along with foliar applied boron on yield and nutrient uptake of maize.

These soils may differ in terms of their response to the amelioration measures taken up to rejuvenate them. Hence it is not only important to know the quantity of liming materials that has to be added to the soils originating under different agro-climatic situations, but to understand the changes some of the ameliorating practices may bring about in the quality of the acid soils that originate due to different reasons and their effect on yield of crops. The present study was undertaken to study the effect by applying different levels calcium and magnesium salts to low pH soil of Eastern dry zone in Karnataka, along with foliar applied boron on yield and yield components of maize.

2. MATERIALS AND METHODS

The study was carried out in Rabi seasons of 2012 at Zonal Agricultural Research Station (ZARS) GKVK, University of Agricultural Sciences, Bengaluru with maize as the test crop. GKVK is located in the Eastern Dry Zone of Karnataka situated at 12° 58' north latitude and 77° 35' east longitude at an altitude of 930 m above mean sea level, the mean annual rain fall is 950 mm. The soil of the experimental plot was sandy clay loan, acidic in reaction and low in available boron content.

2.1 Experimental Procedure

The experiment was laid out in factorial Randomized Complete Block Design with 3 replications. Experiment were established using three levels of Ca (0, 200 & 400 kg ha^{-1}), two levels of Mg (0 & 60 kg ha^{-1}) and foliar spray of boron at two levels (0 & 0.5 %) combined to give 12 treatments. The treatments were- T1-Ca_0 – Mg_0 – B_0, T2-Ca_0 – Mg_0 – B_1, T3-Ca_0 – Mg_1 – B_0,T4-Ca_0 – Mg_1 – B_1,T5-Ca_1 – Mg_0 – B_0,T6-Ca_1 – Mg_0 – B_1, T7-Ca_1 – Mg_1 –B_0, T8-Ca_1 – Mg_1 – B_1, T9-Ca_2 – Mg_0 – B_0, T10-Ca_2 – Mg_0 – B_1,T11-Ca_2 – Mg_1 – B_0 & T12-Ca_2 – Mg_1 – B_1.Unit plot size was 6m×3.6 m. Calcium carbonate and magnesium carbonate was used as sources of the Ca & Mg elements respectively. Foliar spray of boron was tried with Borax. Maize variety **Hema** was used**.** Recommended fertilizer dose for maize was 150-75-40 kg ha^{-1} N-P-K respectively. Farmyard manure and liming materials were incorporated into the soil 15 and 10 days before sowing of seeds. Fifty per cent of nitrogen fertilizer and 100 per cent of phosphorus and potassium fertilizers were mixed with soil and the ground was levelled. Seeds were sown maintaining 60 cm space between rows and 30 cm space between seeds. The plots were irrigated soon after sowing of seeds. Irrigation was undertaken at 10 to 15 days' interval till maturity of the cobs. Weeds were removed by hand weeding twice during the initial sixty days after sowing. The soil was earthed up after the first weeding in the field. After 30 days of sowing, the crop was top dressed with remaining 50 per cent of N fertilizer. Borax was sprayed after 40 days of sowing using 1000 liters of water. The crop was harvested when the cobs were dried enough. The cobs were removed first and then the stover was cut to the ground level and kept for sun drying. Plant height at harvest, Length of cob, 100 grain weight, Grain and Stover yield of maize were recorded.

3. RESULTS AND DISCUSSION

The soil of the experimental site at ZARS, GKVK, Bengaluru belongs to the order Alfisols and is sandy clay loam in texture. The pH of soil was 5.15, Available N, available P, available K and available S of the soil were 244, 16.5, 62.9 kg ha^{-1} and 13.3 mg kg^{-1} respectively. The exchangeable aluminium, exchangeable calcium, exchangeable magnesium, exchangeable potassium and exchangeable sodium were 1.25, 2.68, 1.15, 0.068 and 0.114 cmol(p+)kg^{-1} respectively. The base saturation was 56.9 per cent. The DTPA extractable Fe, Zn, Cu and Mn were 6.02, 0.45, 0.63 and 2.65 mg kg $^{-1}$ respectively. Available B content was 0.48 mg kg^{-1}.

The results of the experiment revealed that pH was increased from 5.27 (Ca_0-Mg_0) to 6.34 (Ca_2-Mg_1) (Fig. 1). Exchangeable Ca and Mg content of the soil were increased from 2.85 cmol(p+)kg^{-1} in Ca_0-Mg_0 to 4.16 cmol(p+)kg^{-1} in Ca2-mg0) and from 1.15 cmol(p+)kg^{-1} (Ca_0-Mg_0) to 1.67 cmol(p+)kg^{-1} (Ca_0-Mg_1) respectively (Figs. 2 and 3), because of application of Ca and Mg at their highest levels. The decrease in exchangeable Al of the soil was from 1.25 to 1.08 cmol(p+)kg^{-1} due to change from Ca_0-Mg_0 to Ca_2-Mg_1 (Fig. 4). Base saturation of soil rose (57.0 per cent to 74.5 per cent in Ca_0-Mg_0 and Ca_2-Mg_1) by 17.5 per cent (Fig. 5). The overall picture of these related properties implied that the pH of the soil was increased by the application of the two basic cations i.e. Ca and Mg. their positive effects on soil properties were apparent and considerable. The increase in pH of the soil was due to the displacement of H^+ and other acidic cations by Ca and Mg and also due to their higher activity in the soil solution. Application of Ca and Mg caused an increase even in base saturation of the soil. These results are similar to those reported by Shamshuddin and Kapok [6]. The consequence of this effect led to decrease in exchangeable Al, mainly because of the disturbance of the original exchange equilibrium that was existing among them in the soil. Continuous interactions among the cations in the soil, affected also by the presence of other ions and the changing moisture, temperature, microbial and root activity would always lead to change in their respective contents until a new equilibrium is reached [7]. Liming could ameliorate soil acidity to a favorable limit and substantially augment calcium and magnesium status and lime potential in soil, there by decrease the exchangeable Al of soil [8].

However, there was a decrease in the values of all those parameters over the period from 30 Days after transplanting to harvest of the crop, under all the treatments. Because of continuing chemical and biochemical reactions taking place among the different components of the solid and liquid phases of soil, uptake of nutrients by the crop, leaching and other ways of losses of nutrients from the soil. The contents / values even though increased / decreased depending upon the parameters studied, they never reached the initial level.

3.1 Effect of Application of Calcium, Magnesium and Boron on Growth and Yield Parameters of Maize

Effect of treatments was significant on all the growth and yield parameters i.e. plant height at harvest, length of cob, kernel yield, stover yield, but not in the case of 100 kernel weight of maize. All the combinations and main effects of Ca, Mg and B levels also indicated significant differences on all the growth and yield parameters of maize crop (Tables 1a, 1b and 1c).

The plant height at harvest, length of cob, kernel yield, stover yield and 100 grain weight of maize were increased by increasing the levels of application of all the three nutrient elements. There was synergistic effect among them not only when only two of them were applied together but also when all the three of them were applied together. Similar results obtained by Rensburg et al. [9] ascertain the use of various liming materials in reducing soil acidity and improving growth parameters and yield of maize crop. There are other reports also regarding the beneficial effect of Ca and Mg on kernel yield of maize [10,11]. Increase in kernel yield of maize could also be attributed to the significant decrease in exchangeable Al and H^+ and increase in Ca, Mg, CEC and pH of the soil and increase in the contents of all the nutrients [12].

Application of B alone or in combination with Ca and Mg increased the kernel yield significantly. The yield increase was due to the increased chlorophyll content, photosynthetic activity of the leaves, dry matter accumulation, advanced flowering and promoted the reproductive organs there by significantly improving the growth and yield of the crop [13].

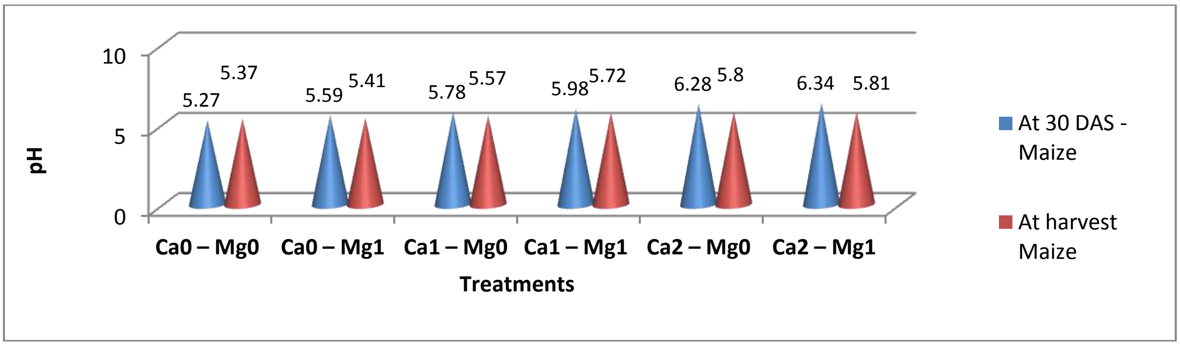

Fig. 1. Effect of different combinations of Ca-Mg levels on pH of soil

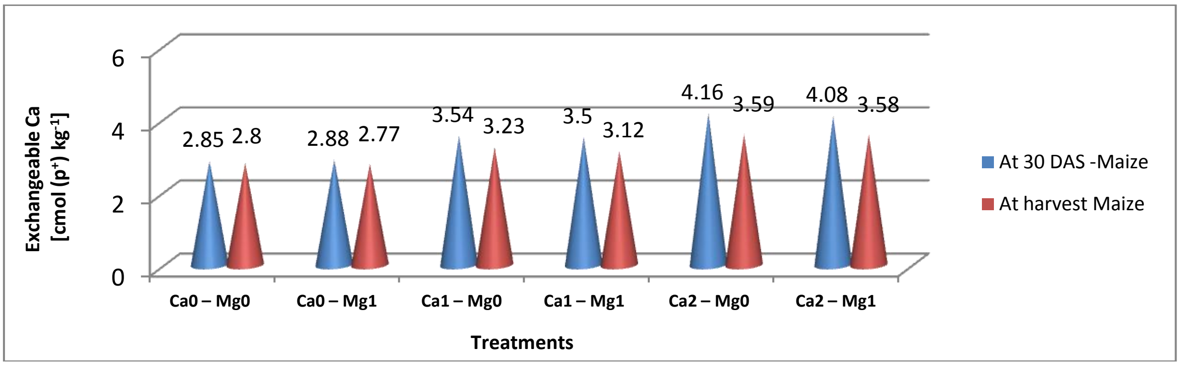

Fig. 2. Effect of different combinations of Ca-Mg levels on Exchangeable Ca of soil

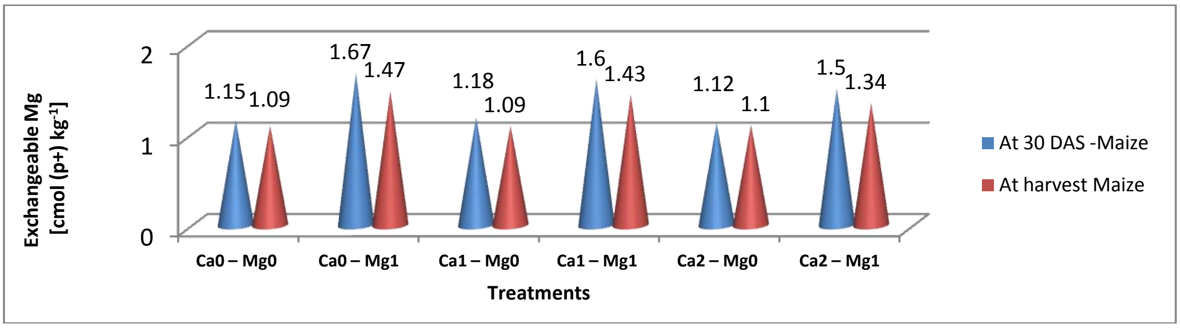

Fig. 3. Effect of different combinations of Ca-Mg levels on Exchangeable Mg of soil

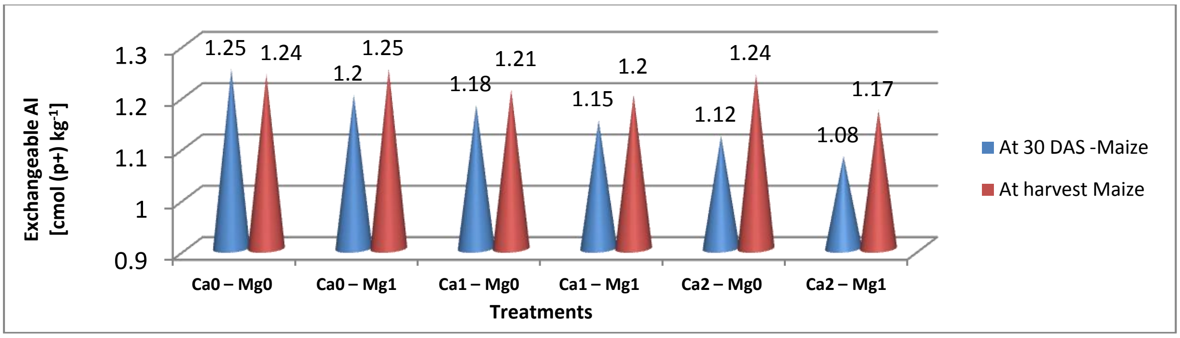

Fig. 4. Effect of different combinations of Ca-Mg levels on Exchangeable Al of soil

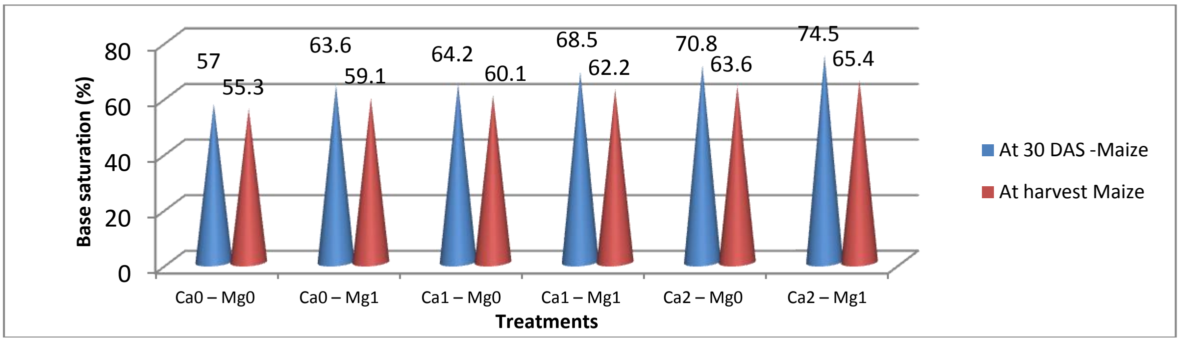

Fig. 5. Effect of different combinations of Ca-Mg levels on base saturation of soil

Table 1a. Effect of different combinations of calcium, magnesium and boron on plant growth and yield parameters of maize

Treatments	Plant height at harvest (cm)	Length of cob (cm)	100 Kernel weight (g)	Kernel yield (q ha^{-1})	Stover yield (q ha^{-1})
$Ca_0 – Mg_0 – B_0$	195	16.7	31.0	55.3	65.2
$Ca_0 – Mg_0 – B_1$	207	18.7	31.3	60.4	69.6
$Ca_0 – Mg_1 – B_0$	210	18.2	31.0	59.0	68.6
$Ca_0 – Mg_1 – B_1$	219	19.2	31.3	63.1	71.9
$Ca_1 – Mg_0 – B_0$	213	18.0	31.3	59.1	69.5
$Ca_1 – Mg_0 – B_1$	228	20.2	31.6	63.5	75.3
$Ca_1 – Mg_1 – B_0$	216	19.3	31.4	65.7	76.5
$Ca_1 – Mg_1 – B_1$	231	22.0	31.8	67.8	81.8
$Ca_2 – Mg_0 – B_0$	214	20.0	31.4	63.9	73.6
$Ca_2 – Mg_0 – B_1$	227	21.3	31.8	66.8	77.4
$Ca_2 – Mg_1 – B_0$	218	20.5	31.5	66.5	75.8
$Ca_2 – Mg_1 – B_1$	236	22.7	32.0	68.0	81.7
SEm±	6.8	0.78	-	1.70	2.23
CD (5%)	20.2	2.30	NS	5.10	6.71

Table 1b. Main effect of varying levels of calcium, magnesium and boron on plant growth and yield parameters of maize

Sl No.	Yield attributes (maize)	Levels			SEm±	CD (5%)
		I	II	III		
I	**Calcium**	**Ca_0**	**Ca_1**	**Ca_2**		
a	Plant height at harvest (cm)	208	222	224	4.4	13.1
b	Length of cob (cm)	18.2	19.9	21.1	0.38	1.10
c	100 Kernel weight (g)	31.2	31.5	31.7	-	NS
d	Kernel yield (q ha^{-1})	59.5	64.0	66.1	0.85	2.55
e	Stover yield (q ha^{-1})	68.8	75.8	77.1	1.11	3.33
II	**Magnesium**	**Mg_0**	**Mg_1**			
a	Plant height at harvest (cm)	214	222		3.5	10.3
b	Length of cob (cm)	19.1	20.3		0.31	0.90
c	100 Kernel weight (g)	31.4	31.5		-	NS
d	Kernel yield (q ha^{-1})	61.5	63.7		0.69	2.08
e	Stover yield (q ha^{-1})	71.7	76.5		0.97	2.92
III	**Boron**	**B_0**	**B_1**			
a	Plant height at harvest (cm)	211	225		3.5	10.3
b	Length of cob (cm)	18.8	20.7		0.31	0.90
c	100 Kernel weight (g)	31.3	31.6		-	NS
d	Kernel yield (q ha^{-1})	61.6	64.9		0.69	2.08
e	Stover yield (q ha^{-1})	71.5	76.3		0.97	2.92

Table 1c. Interaction effect of Ca-Mg, Ca-B and Mg-B combinations on plant growth and yield parameters of maize

Ca –Mg	Plant height at harvest (cm)	Length of cob (cm)	100 Kernel weight (g)	Kernel yield (q ha^{-1})	Stover yield (q ha^{-1})
Ca_0-Mg_0	201	17.7	31.2	57.9	67.4
Ca_0-Mg_1	214	18.7	31.2	59.7	69.1
Ca_1-Mg_0	220	19.1	31.5	61.1	70.3
Ca_1-Mg_1	223	20.6	31.6	61.1	70.7
Ca_2-Mg_0	221	20.7	31.6	61.3	72.4
Ca_2-Mg_1	227	21.6	31.8	64.6	75.9
SEm±	4.9	0.53	-	1.24	1.51
CD (5%)	14.9	1.56	NS	3.72	4.50
Ca –B					
Ca_0-B_0	202	17.4	31.0	57.1	66.9
Ca_0-B_1	213	18.9	31.3	61.8	70.8
Ca_1-B_0	214	18.6	31.4	62.4	69.0
Ca_1-B_1	230	21.1	31.7	65.6	73.6
Ca_2-B_0	216	20.3	31.5	65.2	73.0
Ca_2-B_1	232	22.0	31.9	67.4	78.6
SEm±	4.9	0.53	-	1.24	1.51
CD (5%)	14.9	1.56	NS	3.72	4.50
Mg-B					
Mg_0-B_0	207	18.2	31.2	59.4	69.4
Mg_0-B_1	221	20.1	31.6	63.6	74.1
Mg_1-B_0	214	19.3	31.3	63.8	73.6
Mg_1-B_1	229	21.3	31.7	66.3	78.5
SEm±	4.5	0.43	-	1.00	1.27
CD (5%)	13.6	1.27	NS	3.01	3.71

Table 2a. Effect of different combinations of calcium, magnesium and boron on total uptake of nutrients by maize

Treatments	Uptake										
	(kg ha^{-1})						(g ha^{-1})				
	N	**P**	**K**	**Ca**	**Mg**	**S**	**Fe**	**Zn**	**Cu**	**Mn**	**B**
Ca_0 – Mg_0 – B_0	125	36.0	121	44.9	35.8	30.7	1980	870	270	928	130
Ca_0 – Mg_0 – B_1	128	39.8	123	49.5	36.0	30.5	1970	850	260	952	150
Ca_0 – Mg_1 – B_0	133	36.0	120	48.3	37.1	31.8	1960	870	272	920	139
Ca_0 – Mg_1 – B_1	139	41.2	127	49.8	39.1	32.8	1980	875	266	956	156
Ca_1 – Mg_0 – B_0	132	37.8	123	53.4	36.2	31.8	1900	882	216	940	134
Ca_1 – Mg_0 – B_1	139	45.3	130	55.0	37.2	30.7	1940	825	226	962	163
Ca_1 – Mg_1 – B_0	132	46.7	126	53.0	41.2	34.8	1870	850	230	935	141
Ca_1 – Mg_1 – B_1	147	51.5	134	58.6	42.3	35.8	1990	864	255	975	172
Ca_2 – Mg_0 – B_0	138	41.9	126	60.5	38.1	32.9	1900	882	228	925	152
Ca_2 – Mg_0 – B_1	143	48.1	131	62.6	39.1	33.5	1950	860	220	941	165
Ca_2 – Mg_1 – B_0	140	49.4	129	62.6	42.2	33.9	1910	850	235	922	174
Ca_2 – Mg_1 – B_1	148	52.6	131	64.7	43.2	35.0	1970	855	248	940	170
SEm±	1.1	0.73	1.1	0.82	0.73	0.67	-	-	-	-	6.2
CD (5%)	13.1	2.15	11.3	2.41	2.14	2.01	NS	NS	NS	NS	18.6

There are several reports regarding the beneficial effect of Ca, Mg and boron application on 100 kernel weight of crop. Foliar boron application improved the seed yield and seed quality. Similar results were obtained by Nalini and Bhavana [14] and Saleem et al. [15] on rice.

3.2 Effect of Application of Calcium, Magnesium and Boron on Uptake of Nutrients by Maize

The differences in nutrient uptake due to treatment effects were significant in respect of N, P, K, Ca, Mg, S and B and non-significant in the case of Fe, Zn, Cu and Mn (Tables 2a, 2b and 2c). Results thus indicated that uptake of all the nutrients were increased by increasing the levels of application of the three nutrient elements. There was synergistic effect among them when either only two of them were applied together or when all the three of them were applied together. It is reported that the applications of calcium and magnesium increased the nitrogen availability in the soil mainly by enhancing nitrification and this in turn would increase the nitrogen uptake by the plants. The beneficial effect of application of basic cations to the soil on the uptake of P, K, Ca and Mg have been well documented by Ivica et al. [16] and Rensburg et al. [9].

Table 2b. Main effect of varying levels of calcium, magnesium and boron on total uptake of nutrients by maize at GKVK, Bengaluru

Sl No.	Nutrients	Levels			SEm±	CD (5%)
		I	II	III		
I	**Calcium**	**Ca_0**	**Ca_1**	**Ca_2**		
a	Nitrogen (kg ha^{-1})	131	137	142	3.5	10.6
b	Phosphorus (kg ha^{-1})	38.3	45.3	48.0	0.37	1.07
c	Potassium (kg ha^{-1})	123	128	129	-	NS
d	Calcium (kg ha^{-1})	48.1	55.0	62.6	0.41	1.20
e	Magnesium (kg ha^{-1})	37.0	39.2	40.6	0.37	1.07
f	Sulphur (kg ha^{-1})	31.4	33.3	33.8	0.34	0.99
g	Iron (g ha^{-1})	1970	1930	1930	-	NS
h	Zinc (g ha^{-1})	871	862	864	-	NS
i	Copper (g ha^{-1})	270	235	230	-	NS
j	Manganese (g ha^{-1})	945	950	938	-	NS
k	Boron (g ha^{-1})	144	155	178	3.1	9.0
II	**Magnesium**	Mg_0	Mg_1			
a	Nitrogen (kg ha^{-1})	134	140		-	NS
b	Phosphorus (kg ha^{-1})	41.5	46.2		0.29	0.87
c	Potassium (kg ha^{-1})	125	128		-	NS
d	Calcium (kg ha^{-1})	54.3	56.2		0.33	0.98
e	Magnesium (kg ha^{-1})	37.1	40.8		0.29	0.87
f	Sulphur (kg ha^{-1})	31.7	34.0		0.27	0.81
g	Iron (g ha^{-1})	1940	1950		-	NS
h	Zinc (g ha^{-1})	865	869		-	NS
i	Copper (g ha^{-1})	242	256		-	NS
j	Manganese (g ha^{-1})	941	946		-	NS
k	Boron (g ha^{-1})	155	168		2.2	7.6
III	**Boron**	**B_0**	**B_1**			
a	Nitrogen (kg ha^{-1})	133	141		-	NS
b	Phosphorus (kg ha^{-1})	41.3	46.4		0.29	0.87
c	Potassium (kg ha^{-1})	124	129		-	NS
d	Calcium (kg ha^{-1})	53.8	56.7		0.33	0.98
e	Magnesium (kg ha^{-1})	38.4	39.5		0.29	0.87
f	Sulphur (kg ha^{-1})	32.6	33.1		0.27	0.81
g	Iron (g ha^{-1})	1920	1970		-	NS
h	Zinc (g ha^{-1})	872	854		-	NS
i	Copper (g ha^{-1})	240	255		-	NS
j	Manganese (g ha^{-1})	932	955		-	NS
k	Boron (g ha^{-1})	154	168		2.2	7.6

Table 2c. Interaction effect of Ca-Mg, Ca-B and Mg-B combinations on the total uptake of nutrients by maize-GKVK, Bengaluru

Ca -Mg	Uptake										
	(kg ha^{-1})						(g ha^{-1})				
	N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B
Ca_0-Mg_0	127	37.9	122	47.2	35.9	30.6	1975	860	265	940	140
Ca_0-Mg_1	136	38.6	123	49.1	38.1	32.3	1970	873	269	938	148
Ca_1-Mg_0	135	41.6	126	54.2	36.7	31.3	1920	854	221	951	149
Ca_1-Mg_1	139	49.1	130	55.8	41.7	32.8	1930	857	243	955	157
Ca_2-Mg_0	140	45.0	128	61.6	38.6	33.2	1925	871	224	933	159
Ca_2-Mg_1	144	51.0	130	63.7	42.7	34.4	1940	853	241	931	172
SEm±	4.16	0.517	-	0.580	0.517	0.480	-	-	-	-	4.1
CD (5%)	12.5	1.517	NS	1.703	1.517	1.409	NS	NS	NS	NS	13.3
Ca –B											
Ca_0-B_0	129	36.0	121	46.6	36.5	31.2	1970	870	271	924	135
Ca_0-B_1	133	40.5	125	49.7	37.6	31.7	1975	863	263	954	153
Ca_1-B_0	132	42.3	124	53.2	38.7	33.3	1885	866	223	938	138
Ca_1-B_1	143	48.4	132	56.8	39.7	33.3	1965	845	241	969	168
Ca_2-B_0	139	45.7	127	61.6	40.1	33.4	1905	866	232	924	163
Ca_2-B_1	145	50.4	131	63.7	41.2	34.3	1960	858	234	941	168
SEm±	4.16	0.517	-	0.580	-	-	-	-	-	-	4.1
CD (5%)	12.5	1.517	NS	1.703	NS	NS	NS	NS	NS	NS	13.3
Mg-B											
Mg_0-B_0	132	38.6	185	52.9	36.7	31.8	1927	878	238	931	139
Mg_0-B_1	136	44.4	192	55.7	37.4	31.6	1953	845	235	952	159
Mg_1-B_0	135	44.0	187	54.6	40.2	33.5	1913	857	167	926	151
Mg_1-B_1	145	48.4	196	57.7	41.5	34.6	1980	865	256	957	166
SEm±	3.9	0.422	3.11	0.474	-	-	-	-	-	-	3.0
CD (5%)	10.7	1.239	9.33	1.390	NS	NS	NS	NS	NS	NS	10.0

4. CONCLUSION

The field experiments conducted to know the effect of calcium and magnesium on yield of maize crop treated also with boron in low pH soils of eastern dry zone Karnataka revealed that the application of basic cations to soil before sowing/planting of crops brought about an increase in the contents of exchangeable Ca and exchangeable Mg contents of soils and hence an increase in base saturation of soils with consequent increase in pH of soils that were cultivated maize at GKVK. There was consequent decrease in exch. Al and reserve acidity of soils. The contents of exchangeable calcium and exchangeable Mg of soil, which were increased till 30 days after sowing, started declining thereafter and reached to non-significant levels at harvest of the maize crop. However yield of crops were not affected by this declining trend in the contents of those two important basic cations in the soil towards the later stage of the crop; rather the yield of the crop was increased with increasing levels of application of calcium and magnesium. This would imply that the quantities of calcium and magnesium tried in this experiment are sufficient enough to improve the soil properties and hence crop yields. Application of boron resulted in increased yield when applied alone or along with calcium and magnesium. Calcium and magnesium also played direct positive roles as nutrient elements in improving yields of crops.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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