Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(5): 1689-1694
Received: 14-07-2017
Accepted: 15-08-2017

Arunkumar BR
Department of Soil Science and Agricultural Chemistry V C Farm, Mandya, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka, India

N Srinivasa
Department of Soil Science and Agricultural Chemistry V C Farm, Mandya, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka, India

SS Prakash
Department of Soil Science and Agricultural Chemistry V C Farm, Mandya, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka, India

R Krishna murthy
Department of Soil Science and Agricultural Chemistry V C Farm, Mandya, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka, India

SB Yogananda
Department of Agronomy, College of Agriculture, V C Farm, Mandya, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka, India

Correspondence
Arunkumar BR
Department of Soil Science and Agricultural Chemistry V C Farm, Mandya, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka, India

Soil chemical properties and micronutrient (Zn & B) content in maize crop at different stage as influenced by gypsum and borax application under different nutrient management practices

Arunkumar BR, N Srinivasa, SS Prakash, R Krishna Murthy, SB Yogananda

Abstract
Maize crop was raised in split plot design with different nutrient management practices as main and different levels of gypsum and borax as sub treatment. The results revealed that pH at tasseling stage was reduced compared to initial soil pH significantly and EC at tasseling stage slightly increased from initial EC in main plots and gypsum treated sub plots, Organic carbon did not change significantly both main and sub treatments at both stage. At harvest significantly higher zinc availability in soil was recorded in 200 kg ha^{-1} gypsum treated plots compared to other plots where gypsum was not applied. Significantly higher boron availability in soil at both tasseling and after harvest was recorded in treatments where 2.5 kg and 5 kg borax were applied. The main treatments observed no significant difference in content of zinc and boron at tasseling stage and at harvest. Zn content at tasseling stage was non significant. But at harvest, content of Zn was highest in S_1 treatment (control). Boron content among subplot treatments at tasseling stage and at harvest was higher in S_4 treatment and it was on par with other treatments except S_1 and S_2.

Keywords: boron, Zinc, Maize, pH, and Nutrient content.

1. Introduction
The productivity of maize is largely dependent on its nutrient management and soil fertility status. Proper nutrient management is an important aspect in its production management systems. Applying the required quantities of nutrient at all stages of growth and understanding the soil's ability to supply those nutrients is critical in profitable crop production. The effective fertilizer recommendation should consider crop needs and nutrients already available in the soil. Among different methods and approaches like STL, POP, critical values to get workable basis for predicting the fertilizer requirements of crop, the fertilizer recommendation based on targeted yield (Ramamoorthy *et al*. 1967) [3] is unique one, which provides the balanced nutrition to crop and helps to maintain soil fertility condition.
Zinc and Boron play a pivotal role in increasing the yields of cereals. Boron is considered important to affect zinc availability and its requirement for plants. The amount of either B or Zn influences the availability and requirement of each other for normal plant growth and development (Teasdale and Richards, 1990). An enhanced B deficiency symptoms in plants by increased Zn supply and B deficiency altered Zn translocation to the shoot (Ramon *et al*., 1990). It indicates the requirement of a balanced supply of Zn and B for normal growth and development of plants. The Zn/B ratio in leaf tissue can be used to assess the optimum supply of Boron to plant.
Keeping in view the above facts, a study was undertaken to know the response of maize (*Zea mays* L.) to gypsum and boron under different nutrient management practices to determine the effect of individual or combined application of gypsum and boron along with recommended dose of fertilizer (RDF) or recommendation based on soil test crop response (STCR) doses on chemical properties and micronutrient (Zn & B) content and uptake under different growth stages of maize.

2. Materials and methods
Field experiment was conducted during the *kharif* season of 2014 at College of Agricultural, V. C. Farm, Mandya, Karnataka. The experimental site was geographically situated at an altitude of 695 m above mean sea level, on 11° 30' to 13° 05' North latitude and 76° 05' to 77°

45' East longitude. It comes under Southern dry zone (Zone-6) of Karnataka. The soil was sandy loam in texture, neutral in soil reaction (pH 7.4) with normal in electrical conductivity (0.23 dS m^{-1}) and 4.5 g kg^{-1} of organic matter, with low available nitrogen (277 kg ha^{-1}), high available phosphorus (61 kg ha^{-1}) and medium potassium (148 kg ha^{-1}). The analytical values for some other nutrients were available sulphur (11.30 mg kg^{-1}), exchangeable calcium (3.4 cmol kg^{-1}), DTPA extractable Zn (2.15 mg kg^{-1}) and hot water extractable boron (0.4 mg kg^{-1}). The experiment was laid out in split plot design with three replications. Three main treatments *viz.* package of practices (RDF) UAS(B) (M_1), STCR dose for targeted yield of 90 q ha^{-1} (M_2) and STCR dose for targeted yield of 110 q ha^{-1} (M_3) and six sub treatments *viz*. control (S_1), 200 kg gypsum ha^{-1} (S_2), 2.5 kg borax ha^{-1} (S_3), 5 kg borax ha^{-1} (S_4), 200 kg gypsum + 2.5 kg borax ha^{-1} (S_5) and 200 kg gypsum + 5 kg borax ha^{-1} (S_6). The quantity of fertilizers required for each treatment was worked out by three approaches such as recommended dose of fertilizer as per package of practices, UAS, Bengaluru, STCR dose of fertilizers for target of 90 and 110 q ha^{-1}. Recommended fertilizer dose for hybrid maize under irrigated condition is 150:75:40 N: P_2O_5:K_2O kg ha^{-1} + zinc sulphate 10 kg ha^{-1}+ 10 t FYM ha $^{-1}$ (package of practice, UAS, Bengaluru).

The following fertilizer adjustment equations developed by AICRP on STCR, UAS, Bengaluru were used to work out the fertilizer dose for 90 and 110 q ha^{-1}yield target.

FN = 3.41T – 0.08 SN ($KMnO_4$ - N)

FP_2O_5 = 1.94T – 0.41 SP_2O_5 (Bray's P_2O_5)

FK_2O = 2.28T – 0.072 SK_2O (NH_4OAC – K_2O)

3. Results

A. Chemical properties and available nutrient status in soil at tasseling stage of maize crop

1. Chemical properties of soil at tasseling

1.1 Soil pH

Soil pH differed significantly due to application of fertilizers based on targeted yield approach. Significantly lowest pH was recorded in STCR dose of fertilizers for targeted yield of 110 t ha^{-1} (6.63) and highest was noticed in UAS, Bengaluru, package of practice (6.96).

Gypsum and borax application had significant effect on soil reaction at tasseling of maize crop. Significantly highest pH 6.99 was recorded in treatment S_2 (200 kg ha^{-1} gypsum) compared to S_1, S_3 and S_4. Which was on par with S_5 and S_6 treatments. The interaction effects were non-significant.

1.2 Electrical conductivity

Significantly lower EC was recorded in (M_1) UAS, Bengaluru, package of practice (0.22 dSm^{-1}) and higher EC (0.26 dSm^{-1}) was recorded with STCR through fertilizers for targeted yield of 110 tha^{-1}(M_3). This was on par with (M_2) STCR through fertilizers for targeted yield of 90 t ha^{-1} (0.25 dSm^{-1}).

EC did not show significant difference due to application of different combination of gypsum and borax and Interaction effect was also non significant (Table 1).

1.3 Organic carbon

Organic carbon content of soil did not differ significantly difference due to different nutrient management treatments and application of different combination of gypsum and borax.

2. Available nutrients status of soil at tasseling

2.1 Available nitrogen

The data on available nitrogen are presented in Table 1.

At tasseling stage of maize available nitrogen in soil was significantly higher in STCR dose of fertilizers for targeted yield of 110 t ha^{-1} (461.84 kg ha^{-1}). Lower available nitrogen content of soil was recorded in UAS, Bengaluru, package of practice followed treatment (315.30 kg ha^{-1}). Available nitrogen did not differ significantly due to gypsum and borax application. However, the highest available nitrogen was recorded with 5 kg borax applied plot (398.34 kg ha^{-1}) and lowest was recorded (392.52 kg ha^{-1}) in control plot (S_1) at tasseling stage of maize.

Different nutrient management approaches and combination of gypsum and borax had no significant effect on available nitrogen in soil.

2.2 Available phosphorus

Among the different nutrient management treatments, the significantly higher available phosphorus (P_2O_5) status in soil was recorded in the STCR targeted yield levels of 110 q ha^{-1} (157.84 kg ha^{-1}) while significantly lower available phosphorus was recorded by UAS, Bengaluru, package of practice (80.58 kg ha^{-1}).

Phosphorus status in soil did not differ significantly between the gypsum and borax application. The interaction between main treatment and sub treatment had no significant effect on available phosphorus in soil.

2.3 Available potassium

The data on main plots revealed that among different nutrient management treatments, the significantly higher available potassium status in soil was recorded with STCR targeted yield levels of 110 q ha^{-1} (253.47 kg ha^{-1}). The lower available potassium was recorded by STCR targeted yield levels of 90 q ha^{-1} (229.77 kg ha^{-1}) followed by UAS Bengaluru package of practices (158.83 kg ha^{-1}).

Among different combinations of subplot treatments involving gypsum and borax application and their interaction with main plot treatments did not show significant differences on available potassium in soil, (Table 1).

2.4 Exchangeable calcium

The data on exchangeable calcium are presented in Table 2.

Exchangeable calcium in soil did not differ significantly due to nutrient management approaches. However, highest calcium content in soil 3.89 $cmolkg^{-1}$ was recorded in UAS, Bengaluru, package of practice (M_1) and numerically lowest in STCR targeted yield levels of 110 q ha^{-1} (M_3) 3.84 $cmolkg^{-1}$.

Among the different combination of gypsum and borax in sub treatments highest calcium content in soil 4.42 cmol kg^{-1} was recorded in 200 kg of gypsum and 2.5 kg of borax ha^{-1} (S_5) and this was on par with 200 kg of gypsum and 5 kg of borax ha^{-1} (S_6) and 200 kg of gypsum ha^{-1} (S_2). Significantly lowest 3.34 $cmolkg^{-1}$was recorded in 5 kg of borax ha^{-1} (S_4).

However, the interaction effect of different nutrient management approaches, gypsum and borax application were non-significant.

2.5 Available sulphur

The available sulphur content of soil at tasseling stage of maize did not differ significantly due to different nutrient management practices, (Table 2).

Gypsum and borax application had significant effect on available sulphur in soil at tasseling stage of maize crop. Significantly highest 18.96 mg kg^{-1} was recorded in treatment S_6 (200 kg gypsum and 5 kg borax ha^{-1}) compared to S_1, S_3 and S_4, But it was on par with S_5 and S_2 treatments.

Non significant interaction effect due to nutrient management treatments and combination of gypsum and levels of boron on available sulphur content in soils at tasseling stage of maize was observed.

2.6 DTPA extractable Zn

Zinc content in soil at tasseling stage of the crop did not differ significantly among the main treatments due to different nutrient management practices and application of gypsum and levels of boron in sub treatments, (Table 2). Interaction effect was also non significant. The zinc content in treatments varied from 3.31 to 3.73 mg kg^{-1}.

2.7 Hot water soluble boron

Different nutrient management practices had non-significant effect on hot water soluble boron content in soils at tasseling stage (Table 2). However, highest boron content was recorded with STCR targeted yield levels of 110 q ha^{-1} (3.26 mg kg^{-1}) and lowest hot water soluble boron was recorded with UAS, Bengaluru, package of practice (3.18 mg kg^{-1}). Among the sub treatment S_6 (200 kg gypsum and 5 kg borax ha^{-1}) recorded significantly higher (4.85 mg kg^{-1}) boron content in soils at tasseling stage than the S_1 (0.32 mg kg^{-1}) and S_2 (0.33 mg kg^{-1}) and it was on par with S_5, S_4 and S_3. No interactions were significant due to main treatments and sub treatments.

B. Chemical properties and available nutrient status in soil at harvest stage of maize crop

1. Chemical properties of soil at harvest

The data pertaining to chemical properties of soil at harvest as influenced by application of gypsum and boron under different nutrient management practices are presented in Tables 3.

1.1 Soil pH

pH of soil after the harvest of maize crop was not influenced significantly due to different nutrient combinations. However, its value in the experimental plots ranged between 6.73 to7.05 (Table 3).

1.2 Electrical conductivity

No considerable change with respect to electrical conductivity was noticed due to application of fertilizers based different nutrient management practices or in combination with gypsum and borax application. However, Electrical conductivity in experimental plot ranges from 0.19 to 0.21 dS m^{-1} (Table 3).

1.3 Organic carbon

Organic carbon did not show significant difference due to different nutrient management treatments and application of different combination of gypsum and borax and Interaction effect was also non significant. However, organic carbon content in experimental plot was ranges from 4.32 to 4.47 g ha^{-1} (Table 3).

2. Available nutrient status in soil at harvest

The data on the available nutrient status in soils at harvest of maize crop as influenced by application of gypsum and borax under different nutrient management practices and are presented in Tables 3.

2.1 Available nitrogen

At harvest of maize crop available nitrogen in soil was significantly higher in M_3 (251.12 kg ha^{-1}) and M_2 (234.4kg ha^{-1}) treatment, Where fertilizers were applied on the basis of STCR for targeted yield approach (Table 3). Lower available nitrogen content of soil was recorded in UAS, Bengaluru, package of practice followed treatment (213.55 kg ha^{-1}). Available nitrogen did not differ significantly due to gypsum and borax application. However, the highest available nitrogen was recorded with 5 kg borax treated plot (241.30 kg ha^{-1}) and lowest was recorded (224.70 kg ha^{-1}) in control plot (S_1).

Different nutrient approaches and combination of gypsum and borax had no significant effect on available nitrogen.

2.2 Available phosphorus

Among the different nutrient management treatments, significantly higher available phosphorus (P_2O_5) status in soil was 44.39 kg ha^{-1} in M_1 plot, which increased significantly to 52.64 kg ha^{-1} with the application of fertilizers on STCR basis targeted yield levels of 110 q ha^{-1} (M_3) followed by treatment M_2 (50.04 kg ha^{-1}) were statistically on par with each other (Table 3).

Phosphorus status in soil did not differ significantly due to gypsum and borax application. The interaction between main treatment and sub treatment had no significant effect on available phosphorus.

2.3 Available potassium

Available K content of soil was 129.00 kg ha^{-1} in M_1 treatment, whereas maximum available K of 137.65 and 141.62 kg ha^{-1} in soil was recorded in M_2 and M_3 treatments, where fertilizers were applied on STCR based targeted approach and these two treatments are on par with each other.

Among different combinations of sub plot treatments involving gypsum and borax application and their interaction with main plot treatments did not show significant differences on available potassium in soil.

2.4 Exchangeable calcium

The data on calcium content in soil at harvest are presented in Table 4.

Among different combinations of sub plot treatments involving gypsum and borax application showed significant difference on available Ca content of soil at harvest. Available soil Ca ranges between 3.17 to 5.38cmolkg^{-1}. Lowest available Ca of 3.17 cmolkg^{-1} was recorded in control plot (S_1) and the highest 5.38 cmolkg^{-1}wasrecorded in 200 kg gypsum ha^{-1} treated plot (S_2).Exchangeable calcium did not differ significantly due to nutrient management approaches and their interaction with sub plot treatments involving gypsum and borax application.

2.5 Available sulphur

Gypsum and borax application had significant effect on available sulphur in soil at harvest of maize crop. Significantly highest 10.43 mg $kg^{-1}$was recorded in treatment S_2 (200 kg gypsum ha^{-1}) compared to S_1, S_3 and S_4. Which was on par with S_5 and S_6 treatments (Table 4).

The available sulphur content of soil at harvest of maize did not differ significantly due to different nutrient management practices and non significant interaction effect due to nutrient management treatments and combination of gypsum and levels of boron on available sulphur content in soils at harvest of maize was observed.

2.6 DTPA extractable Zn

The data on zinc content in soil at harvest are presented in Table 4.

Among different combinations of sub plot treatments involving gypsum and borax application showed significant difference on available Zn content of soil at harvest. Available soil Zn ranges between 1.62 to 2.03 mg kg^{-1}. Lowest available Zn of 1.62 mg kg^{-1} was recorded in control plot (S_1) and the highest 2.03 mg kg^{-1} was recorded in S_6 which was on par with S_5 and S_2 (1.99 and 1.88 mg kg^{-1}, respectively) treatments.

Available Zn did not differ significantly due to nutrient management approaches and their interaction with sub plot treatments involving gypsum and borax application.

2.7 Hot water soluble boron

Different nutrient management practices had non-significant effect on hot water soluble boron content in soils at harvest. However, highest boron content was recorded with STCR targeted yield levels of 110 q ha^{-1} (1.39 mg kg^{-1}) and lowest hot water soluble boron was recorded with UAS, Bengaluru, package of practice(1.22 mg kg^{-1}). Among the sub treatment S_4 and S_6 recorded significantly higher (2.21 and 2.26 mg kg^{-1}) boron content in soil over rest of the treatment. No interactions were significant due to main treatments and sub treatment (Table 4).

C. Micronutrient (Zn & B) content in maize crop at tasseling stage and at harvest

1. Zinc content

The data on zinc content in plant parts of maize at different stages of plant growth are presented in Table 5.

Zinc content in leaf at tasseling stage did not differ significantly due to application of fertilizers based on targeted yield approaches. Sub plot treatments and interaction effect between main and sub treatments also showed non-significant difference on leaf Zn concentration in maize crop. It varied from 10.57 to 12.48 mg kg^{-1}, in sub treatments.

At harvest, Zn concentration in grain and stover did not show significant effect due to different nutrient management practices.

Among sub plot treatments, the higher Zn content was recorded at 5 kg B ha^{-1} (11.47 mg kg^{-1}) in grain and this was on par with S_3, S_5 and S_6treatment. Lowest 9.96 mg kg^{-1} was recorded in S_2 treatment. Higher Zn content in stover was 8.68 mg kg^{-1} in S_4 and this was on par with S_3, S_5 and S_6 treatment and lowest was recorded in S_2 (6.88 mg kg^{-1}) treatment. Interaction effect between different nutrient management practices in main plot and gypsum and borax combination in sub plot had no significant effect on leaf, grain and stover Zn content.

2. Boron content

The data on boron content in plant parts of maize at different stages of plant growth are presented in Table 5. Boron content in leaf at tasseling stage and at harvest in grain and stover was not significantly influenced by the plots treated with fertilizers based on different nutrient management practices.

4. Discussion

1. Soil chemical properties and available nutrient status of soil at tasseling stage and after harvest of maize crop.

1.1 pH, EC and organic carbon

pH at tasseling stage was reduced compared to initial soil pH significantly, which could be due to application of higher dose of fertilizers particularly urea application. EC at tasseling stage slightly increased from initial EC in main plots and gypsum treated sub plots, because of application of higher dose fertilizers on STCR basis and gypsum. Organic carbon did not change significantly both among main and sub treatments at tasseling stage.

Changes observed in soil pH, EC and organic carbon at harvest did not differ significantly both among main and sub treatments.

1.2 Available nutrients

The data clearly indicate that available nutrients in soil at tasseling stage and after the harvest of crop varied significantly due to different treatment combinations.

1.2.1 Major nutrients

At tasseling and at harvest significantly higher soil available nitrogen was observed in M_3 treatment when compared to both M_2 andM_1. This could be due to higher nitrogen fertilizer application on STCR basis.

STCR based fertilizer recommendation has significant effect on available phosphorus status of soil. At both tasseling and after harvest of maize crop higher availability of phosphorus was in targeted yield treatments, because of application higher dose of phosphorus fertilizers for achieving the targeted yield. Rekhi *et al*. (2000) [4] have reported that application of higher dose of phosphorus with organic manures raised the available phosphorus from initial 3 mg kg^{-1} soil to 11.5 mg kg^{-1} soil.

Significantly lower available potassium content at tasseling stage and after harvest (158.83 and 129.85 kg ha^{-1} respectively) was observed in package of practice followed by higher potassium content in STCR based fertilizers application for targeted yields. The increase in the potassium status in soil might be due to the direct contribution to the pool of available potassium in soil due to addition of higher dose of potassium to soil on the basis of STCR targeted yield along with FYM. The build up of potassium due to addition of FYM alone or in combination with fertilizers was reported by Rekhi *et al*. (2000) [4].

1.2.2 Secondary nutrients

Among subplot treatments significantly higher available calcium and sulphur was recorded in 200 kg gypsum ha^{-1} treated plots at both tasseling stage and after harvest of crop. It could be due to addition of higher dose of calcium and sulphur nutrients through gypsum. Similar findings were reported by John *et al*. (2012) [2].

1.2.3 Micronutrients (Zinc and Boron)

Among subplot treatments at tasseling stage zinc status in soil was non- significant but at harvest significantly higher zinc availability in soil was recorded in 200 kg ha^{-1} gypsum treated plots (S_2, S_5 and S_6) compared to other plots where gypsum was not applied. This could be due to lesser uptake of zinc in gypsum treated plots and more zinc remained in soil.

Significantly higher boron availability in soil at both tasseling and after harvest was recorded in treatments where 2.5 kg and 5 kg borax were applied. It could be due to application of higher dose of boron to the soil initially deficient in boron. Similar findings were reported by Sarkaut *et al*. (2013) [5].

1.3 Micronutrients (Zinc and Boron) content in maize crop at tasseling stage and at harvest

The main treatments observed no significant difference in content of zinc and boron content at tasseling stage in leaf and in grain and stover at harvest. But uptake of Zn and B was significantly higher in STCR dose based target yield treatments compared to package of practices.

Among subplot treatments, at tasseling stage Zn content in leaf was non significant. But at harvest, grain and stover content of Zn was highest in S_1 treatment (control). But it was on par with other treatments, except S_2. Boron content decreases the Zn content in maize crop. Adem *et al*. (2011) [1] reported that increased level of boron application, decreased tissue Zn content.

Boron concentration among subplot treatments in leaf at tasseling stage and at harvest in grain and stover was higher in S_4 treatment and it was on par with other treatments except S_1 and S_2 where borax was applied alone compared to combined application of gypsum and borax. In present study boron content was numerically lesser in treatments where gypsum and borax was applied in combination compared to B alone treated plots. This could be due to higher calcium application to soil through gypsum may reduced B content in maize plant

Table 1: Soil pH, EC, Organic carbon (OC) and Available NPK in soil at tasseling stage of maize as influenced by application of gypsum and borax under different nutrient management practices

Treatments		pH	EC (dSm^{-1})	OC ($g\ kg^{-1}$)	N ($kg\ ha^{-1}$)	P_2O_5 ($kg\ ha^{-1}$)	K_2O ($kg\ ha^{-1}$)
M_1		6.94	0.22	4.67	315.30	80.58	158.83
M_2		6.71	0.25	4.62	396.47	139.10	229.77
M_3		6.62	0.26	4.71	461.84	157.84	253.47
S. Em±		0.07	0.007	0.06	4.16	2.14	2.15
CD (p=0.05)		0.29	0.03	NS	16.35	8.40	8.43
S_1		6.67	0.23	4.67	392.52	120.09	213.40
S_2		6.99	0.25	4.73	387.32	117.90	213.53
S_3		6.59	0.24	4.64	398.04	123.10	212.18
S_4		6.58	0.24	4.52	398.34	124.87	212.81
S_5		6.84	0.25	4.76	385.61	125.84	208.51
S_6		6.86	0.25	4.68	385.38	123.24	209.73
S. Em±		0.07	0.008	0.09	7.00	2.56	3.56
CD (p=0.05)		0.21	NS	NS	NS	NS	NS
Interaction M X S	S. Em±	0.45	0.05	0.53	42.22	15.53	21.47
	CD (p=0.05)	NS	NS	NS	NS	NS	NS

Table 2: Ca, S, Zn and B status in soil at tasseling stage of maize as influenced by application of gypsum and borax under different nutrient management practices.

Treatments		Ca ($cmol\ kg^{-1}$)	S ($mg\ kg^{-1}$)	Zn ($mg\ kg^{-1}$)	B ($mg\ kg^{-1}$)
M_1		3.89	17.26	3.37	3.18
M_2		3.86	17.00	3.45	3.25
M_3		3.84	17.12	3.50	3.26
S. Em±		0.05	0.15	0.12	0.04
CD (p=0.05)		NS	NS	NS	NS
S_1		3.39	15.56	3.36	0.32
S_2		4.30	18.60	3.37	0.33
S_3		3.39	15.32	3.31	4.45
S_4		3.34	15.36	3.36	4.60
S_5		4.42	18.95	3.52	4.83
S_6		4.33	18.96	3.73	4.85
S. Em±		0.11	0.40	0.14	0.14
CD (p=0.05)		0.33	1.16	NS	0.40
Interaction M X S	S. Em±	0.69	2.42	0.86	0.83
	CD (p=0.05)	NS	NS	NS	NS

Table 3: Soil pH, EC, Organic carbon (OC) and Available NPK in soil at harvest of maize as influenced by application of gypsum and borax under different nutrient management practices

Treatments		pH	EC (dSm^{-1})	OC ($g\ kg^{-1}$)	N ($kg\ ha^{-1}$)	P_2O_5 ($kg\ ha^{-1}$)	K_2O ($kg\ ha^{-1}$)
M_1		7.05	0.20	4.47	213.55	44.39	129.85
M_2		6.86	0.20	4.42	234.13	50.04	137.65
M_3		6.71	0.21	4.34	251.12	52.64	141.62
S. Em±		0.10	0.005	0.09	4.77	1.29	1.98
CD (p=0.05)		NS	NS	NS	18.73	5.06	7.77
S_1		6.87	0.20	4.39	224.70	47.22	131.84
S_2		6.98	0.20	4.32	226.95	47.47	136.26
S_3		6.82	0.19	4.54	241.00	50.11	138.06
S_4		6.77	0.20	4.37	241.30	50.00	139.76
S_5		6.90	0.21	4.42	234.20	50.96	135.63
S_6		6.87	0.20	4.41	229.45	48.37	136.68
S. Em±		0.09	0.005	0.07	4.50	1.07	2.39
CD (p=0.05)		NS	NS	NS	NS	NS	NS
Interaction M X S	S. Em±	0.50	0.03	0.42	27.42	6.52	14.45
	CD(p=0.05)	NS	NS	NS	NS	NS	NS

Table 4: Ca, S, Zn and B status in soil at harvest of maize as influenced by application of gypsum and borax under different nutrient management practices

Treatments		Ca (cmol kg^{-1})	S (mg kg^{-1})	Zn (mg kg^{-1})	B (mg kg^{-1})
M_1		4.55	8.69	1.71	1.22
M_2		4.41	8.54	1.82	1.30
M_3		4.33	8.66	1.87	1.31
S. Em±		0.01	0.19	0.07	0.08
CD (p=0.05)		NS	NS	NS	NS
S_1		3.17	7.13	1.66	0.27
S_2		5.38	10.43	1.88	0.29
S_3		3.32	7.06	1.59	1.25
S_4		3.33	6.91	1.62	2.21
S_5		5.18	10.21	1.99	1.39
S_6		5.02	10.05	2.03	2.26
S. Em±		0.14	0.43	0.06	0.12
CD (p=0.05)		0.39	1.25	0.17	0.36
Interaction M X S	S. Em±	0.83	2.61	0.37	0.74
	CD (p=0.05)	NS	NS	NS	NS

Table 5: Zinc and boron content in different plant parts of maize as influenced by application of gypsum and borax under different nutrient management practice

Treatments		Zn (mg kg^{-1})			B (mg kg^{-1})		
		Tasseling stage (Leaf, 45 DAS)	Harvest		Tasseling stage (Leaf, 45 DAS)	Harvest	
			Grain	Stover		Grain	Stover
M_1		12.75	11.85	7.46	16.63	16.33	4.44
M_2		12.12	11.35	7.77	16.84	16.38	4.60
M_3		12.05	11.11	7.60	16.93	16.39	4.63
S. Em±		0.61	0.14	0.32	0.37	0.21	0.24
CD (p=0.05)		NS	NS	NS	NS	NS	NS
S_1		12.48	11.68	7.11	10.39	9.41	3.13
S_2		10.57	9.96	6.88	10.63	9.29	3.36
S_3		11.23	11.33	8.40	19.90	20.05	5.89
S_4		11.59	11.47	8.68	20.63	20.49	6.40
S_5		11.07	10.70	7.44	19.26	19.08	4.41
S_6		10.88	10.47	7.16	19.99	19.87	4.13
S. Em±		0.87	0.65	0.44	0.63	0.53	0.30
CD (p=0.05)		NS	1.88	1.26	1.83	1.55	0.87
Interaction M X S	S. Em±	5.28	3.91	2.64	3.81	3.23	1.83
	CD (p=0.05)	NS	NS	NS	NS	NS	NS

*DAS: Days after sowing

5. References

1. Adem G, Nizamettin A, Aslihan E, Oguzha N, Sinan A. and Metin T. Yield and chemical composition of corn (*Zea mays* L.) as affected by boron management. Int. J. Pl. Animal. Environ. Sci. 2011; 1(1):42-53.
2. John S, Brain L, Daniel B. Sulphur fertilization response in iowa corn production. Wisconsin Crop Management Conference, 2012, 51.
3. Ramamoorthy B, Narasimhan RL, Dinesh RS. Fertilizer application for specific yields targets of Sonara 64 (wheat). Indian Farming. 1967; 17:43-48.
4. Rekhi RS, Benbi DK, Bhajan singh. Effect of fertilizers and organic manures on crop yields and soil properties in rice-wheat cropping system. Rice-Wheat Consortium Paper Series. 2000; 6:1-6.
5. Sarkaut S, Salaheddin M, Kaivan AN, Anvar RA. Growth and yield response of maize (*Zea mays* L.) to different rates of potassium and boron. Int. J. Agric. Crop Sci. 2013; 5(3):236-240.