Asian Journal of Chemistry Vol. 20, No. 3 (2008), 2156-2162

Amendment of Acid Soils Using Crab Shell Powder

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This research was carried out in order to determine the effects of increasing crab shell powder on some macro and micro element content of maize plant under acid soil conditions. For this purpose, Haploxeralf soil was used according to US Taxonomy. The experiment was done under greenhouse conditions with three replications and maize was grown. Four different doses of crab shell powder (0, 5000, 10000 and 15000 kg ha^{-1}) were applied to each pot. Nitrogen fertilizer was applied to each pot 200 mg kg^{-1} as NH_4NO_3 whereas phosphorus fertilizer was applied to each pot 100 mg kg^{-1} as KH_2PO_4. According to the results, dry matter amount, N, P, Ca, Mg, Fe, Cu and Mn contents of maize plant increased with increasing of crab shell powder applications. Potassium content of maize plant decreased with increasing crab shell powder applications while zinc content was not affected. All these increases and decreases were statistically significant at the confidence level of 1 %.

Key Words: Crab shell powder, Acid soil, Organic fertilizer, Macro elements, Trace elements.

INTRODUCTION

There is a strong relationship between fertility and chemical properties of soils. The main chemical characteristic of soil is pH value. The value of pH directly affects the plant nutrient availability in soil. The decrease and increase of pH value cause the deficiency and toxicities of some mineral nutrients. The decrease of pH value makes acid soils.

The low soil pH value is associated with a number of soil chemical and biological characteristics that manifest themselves as the components of the problem acid soil syndrome. These components may adversely affect plant growth. These specific problems in acid soil conditions as; Al toxicity, Mn toxicity, Mo deficiency, legume nodulation failures, increase in plant disease and Ca and Mg deficiency. Hydrogen ion toxicity, decreased phosphorus availability and toxicities of some other trace elements and heavy metals have also been reported[1].

The effect of increasing rates sewage sludge to Alfisol soils was investigated by Tanu *et al.*[2]. Dry matter amount, N, P, some trace element contents of maize plant increased with sewage sludge application.

Fe, Cu, Zn, Mn, N, P, Ca and Mg contents of hazelnut plant increased with increasing different organic amendments to acid soil[3].

Adiloglu[4] and Aydin *et al.*[5] reported that dry matter amount, N, P, Ca and Mg contents of plants increased, but K, Fe, Cu, Zn and Mn content of plants decreased with increasing rates of lime application to acid soils.

Nyamangara *et al.*[6] investigated the effect of some organic amendments application on some macro and trace element contents of acid soils. They found that N, P, Ca, Mg, Fe, Cu, Zn and Mn contents of acid soil increased with organic amendments application, potassium content of acid soil decreased with this application.

The effect of increasing rates of crab shell powder application to acid soil on some macro and trace element contents of maize plant was investigated in this research.

EXPERIMENTAL

The clay acid soil was used is a Haploxeralf according to US Soil Taxonomy. Soil sample was analyzed for pH[7], organic matter[8], available phosphorus[9], exchangeable potassium[10], exchangeable calcium and magnesium[11], available iron, copper, zinc and manganese[12] and texture[13].

Crab shells collected from Black sea were washed thoroughly with tap water and then steamed. The solid material obtained was dried, milled and sieved to powder with diameters of < 0.149 mm (100 mesh, USA). crab shell powder was analyzed for pH, organic matter, nitrogen, phosphorus, potassium, calcium, magnesium, iron, copper, zinc and manganese according to suitable methods.

The experiment was conducted in a randomized block design under greenhouse conditions with three replications. For this purpose, soil sample was through 4 mm (mesh no: 5, USA), then packed into 2 kg pots. Main pots of the experiment were four treatments: without crab shell powder (CSP) with addition of 5000 kg ha^{-1} CSP; 10000 kg ha^{-1} CSP and 15000 kg ha^{-1} CSP to soil. A 200 mg kg^{-1} N (as NH_4NO_3 form), 100 mg kg^{-1} P_2O_5 (as KH_2PO_4 form) were applied to each pot. Pionner 3377 MF hybrid maize seed was used in this experiment. Two plants were left on each pot after germination. Plants were harvested after 60 d and dried at 70 ºC and ground for analysis. Total nitrogen content of plants were determined by Kjeldahl method, total phosphorus content were determined by vanadomolybdo phosphoric acid yellow colour method, total potassium content were determined by flame photometer, calcium and magnesium contents were determined by EDTA titration method and Fe, Cu, Zn and Mn contents

were determined by atomic absorbtion spectrophotometer[14]. The results of plant analysis were evaluated statistically[15].

The analysis of the soil and crab shell powder used in this experiment are presented in Table-1.

TABLE-1
SOME PROPERTIES OF THE SOIL AND ELEMENTAL COMPOSITION OF THE CRAB SHELL POWDER

Parameter	Soil	Crab shell powder
pH (1:2.5 water extract)	5.800	8.16
Sand (%)	27.200	-
Silt (%)	30.200	-
Clay (%)	42.600	-
$CaCO_3$ (%)	-	27.10
Organic matter (%)	1.300	62.40
P (g kg^{-1})	0.016	30.00
K (g kg^{-1})	0.250	0.80
Ca (g kg^{-1})	1.100	234.00
Mg (g kg^{-1})	0.300	13.00
F (mg kg^{-1})	2.600	780.00
Cu (mg kg^{-1})	0.400	420.00
Zn (mg kg^{-1})	1.020	870.00
Mn (mg kg^{-1})	3.800	660.00

RESULTS AND DISCUSSION

Effect of crab shell powder application on dry matter amount of maize plant: The effect of increasing crab shell powder application on dry matter amount of maize plant is given in Table-2. Dry matter amount of maize plant increased with increasing rates of crab shell powder. This increasing effect of crab shell powder was significant statistically at the

TABLE-2
EFFECT OF INCREASING RATES OF CRAB SHELL POWDER (CSP) APPLICATION ON DRY MATTER AMOUNT OF MAIZE PLANT*

Treatment	Dry matter amount (g pot^{-1})			Average
	1	2	3	
0 kg CSP ha^{-1}	2.89	3.20	3.32	3.13 a
5000 kg CSP ha^{-1}	3.62	3.80	3.46	3.62 b
10000 kg CSP ha^{-1}	3.90	4.05	4.12	4.02 c
15000 kg CSP ha^{-1}	4.50	4.72	5.05	4.75 d

*Same letter signs no statistically significant differences between them at the level of 0.01.

level of 1 % confidence level. Average dry matter amount for without crab shell powder application and 15000 kg CSP ha^{-1} were determined 3.13 and 4.75 g pot^{-1}, respectively. Previous researchers also found that increasing rates of some organic manures application to acid soils increased dry matter amount of different plants[16-20]. This is because with some organic manures application to acid soils, soil acidity was neutralized whereas soil pH increased in comparison to the initial level. Consequently, some macro and trace elements availability in soil and dry matter amount of plants increased in the acid soil.

Effect of crab shell powder application on some macro element contents of maize plant: The effect of increasing crab shell powder application on average N, P, K, Ca and Mg contents of maize plant are given in Table-3. Table-3 shows that nitrogen content of maize plant increased with crab shell powder application. The effect of crab shell powder application on N content of maize plant was found to be statistically significant at the confidence level of 1 %.

TABLE-3
EFFECT OF INCREASING RATES OF CRAB SHELL POWDER (CSP) APPLICATION ON SOME MACRO ELEMENT CONTENTS OF MAIZE PLANT*

Treatment	Some macro elements** (%)				
	N	P	K	Ca	Mg
0 kg CSP ha^{-1}	1.17 a	0.15 a	3.19 a	0.38 a	0.11 a
5000 kg CSP ha^{-1}	2.10 b	0.18 b	2.96 b	0.46 a	0.15 a
10000 kg CSP ha^{-1}	2.25 c	0.20 c	2.82 b	0.62 b	0.21 b
15000 kg CSP ha^{-1}	2.40 d	0.22 c	2.55 c	0.86 c	0.22 b

*Macro elements are evaluated individually and same letter signs no statistically significant differences between them at the confidence level of 0.01; **Values are average of three replications.

Organic matter mineralization of acid soil was increased with calcium compounds application to acid soil. Consequently, N uptake of plants increased under acid soil conditions[21].

Similar results reported by some earlier researchers[2,3,22] under different organic fertilizer application conditions.

Phosphorus content of maize plant increased with crab shell powder application (Table-3). This increasing was found to be statistically significant at the level of 1 %. Acid soil pH increased with crab shell powder application; therefore phosphorus availability was affected positively by this situation[23-25].

Potassium content of maize plant decreased with crab shell powder application. The effect of crab shell powder application on K content of

maize was found to be statistically significant at the level of 1 %. The same observation was also obtained by earlier researchers. Decrease in K content of different plants by organic manure application was also found by some earlier researchers[24,26,27].

Average calcium content of maize plant increased from 0.38 to 0.86 % with crab shell powder application (Table-3). This increase was found to be significant statistically at the level of 1 %.

When Ca compound applied to acid soil, Ca deficiency was hindered and Ca availability increased under acid soil conditions[19].

Magnesium content of maize plant increased with increasing rates crab shell powder application. The effect of crab shell powder application on Mg content of plant was found to be significant statistically at the level of 1 % (Table-3).

Effect of crab shell powder application on some trace element contents of maize plant: The effect of increasing crab shell powder application on average Fe, Cu, Zn and Mn contents of maize plant are given in Table-4, which shows that Iron content of maize plant increased with crab shell powder application. The effect of crab shell powder application on Fe content of maize plant was found to be statistically significant at the confidence level of 1 %. This may be attributable to high Fe content of crab shell powder.

TABLE-4
EFFECT OF INCREASING RATES OF CRAB SHELL POWDER (CSP) APPLICATION ON SOME TRACE ELEMENT CONTENTS OF MAIZE PLANT*

Treatment	Some trace elements** (mg kg^{-1})			
	Fe	Cu	Zn	Mn
0 kg CSP ha^{-1}	50.4 a	13.2 a	41.6 a	52.4 a
5000 kg CSP ha^{-1}	52.7 a	16.8 b	42.8 a	58.6 b
10000 kg CSP ha^{-1}	62.5 b	18.1 b	43.2 a	62.5 c
15000 kg CSP ha^{-1}	68.2 b	21.6 c	43.4 a	70.8 d

*Trace elements are evaluated individually and same letter signs no statistically significant differences between them at the confidence level of 0.01; **Values are average of three replications.

Copper content of maize plant increased with crab shell powder application. This increase was found to be significant statistically at the level of 1 % (Table-4). Zinc content of maize plant increased with crab shell powder application. But, this increase was not found statistically significant (Table-4). This is probably because Zn content of the soil is high and therefore crab shell powder application was not affected by Zn content of maize plant, statistically. Manganese content of maize plant was positively affected by crab shell powder application (Table-4).

The present trace element results are consistent with the earlier observations for different plants under different soil conditions with different organic soil amendments applications[2,28-34].

Conclusion

According to the results of this study, dry matter yield, N, P, Ca and Mg content of maize plant increased with increasing rates of crab shell powder application to acid soil. Potassium content of maize plant decreased with crab shell powder application. While trace element (Fe, Cu, Zn, Mn) contents of maize plant increased with crab shell powder application to acid soil. Acid soil fertility increased with crab shell powder application in this research. These results are very important for acid soil conditions. Because, phosphorus deficiency, Fe, Cu, Zn and Mn toxicities and hindering of nitrogen mineralization were seen frequently in these soils. In conclusion, crab shell powder, a new organic fertilizer and amendment, is suggested for acid soils to increase the fertility and plant nutrition.

REFERENCES

1. G.W. Thomas and W.L. Hargrove, The Chemistry of Soil Acidity, Soil Acidity and Liming, Agronomy Monograph No 12, ASA- CSSA, 677 South Segoe Road, Madison, WI, edn. 2 (1984).
2. P.A. Tanu and A. Adholeya, *Bioresour. Technol.*, **92**, 311 (2004).
3. N. Özenç, D.B. Özenç and G. Çayci, Effects of hazelnut husk compost, peat, farmyard and chicken manure on soil organic matter and N nutrition and hazelnut yield. 18th International Soil Meeting on Soil Sustaining Life and Earth, managing Soil and Technology, 22-26 May, Sanliurfa, Turkey, pp: 937-945 (2006).
4. A. Adiloglu, An Investigation on the Effect of Lime Application on Some Macro Elements Availability in Acid Soils of Trakya Region, M.Sc. Thesis, Trakya University, Graduate School of Natural and Applied Sciences, p. 46 (1989).
5. A. Aydin, Y. Sezen and M. Özgül, Effect of Lime application on Zn Availability and Zn Uptake of Corn in Acidic Soils, I. National Zinc Congress, 6-12 May, Eskisehir, pp. 461- 468 (1997).
6. J. Nyamangara, J. Gotosa and S.E. Mpofu, *Soil and Tillage Res.*, **62**, 157 (2001).
7. G.W. Thomas, in ed.: J.M. Bartels, Soil pH and Soil Acidity, Methods of Soil Analysis, Part 3, Chemical Methods, Book series no: 5, SSSA and ASA, Madison, WI, pp. 475- 490 (1996).
8. D.W. Nelson and L.E. Sommers, in ed.: J.M. Bartels, Total Carbon, Organic Carbon and Organic Matter, Methods of Soil Analysis, Part 3, Chemical Methods, Book Series No: 5, SSSA and ASA, Madison, WI, pp. 961-1010 (1996).
9. S. Kuo, in ed.: J.M. Bartels, Phosphorus, Methods of Soil Analysis, Part 3, Chemical Methods, Book Series No. 5, SSSA and ASA, Madison, WI, pp. 869-919 (1996).
10. P.A. Helmke and D.L. Sparks, in ed.: J.M. Bartels, Lithium, Sodium, Potassium Rubidium and Cesium. Methods of Soil analysis, Part 3, Chemical Methods, Book series No: 5, SSSA and ASA, Madison, WI, pp. 551-574 (1996).
11. D.L. Suarez, in ed.: J.M. Bartels, Beryllium, magnesium, calcium, strontium and barium. Methods of Soil analysis, Part 3, Chemical Methods, Book series No: 5, SSSA and ASA, Madison, WI, pp. 575-601 (1996).
12. W.L. Lindsay and W.A. Norvell, *Soil Sci. Am. J.*, **42**, 421 (1978).

13. G.W. Gee and J.W. Bauder, in ed.: A. Klute, Particle Size Analysis, Methods of Soil Analysis, Part 1, Physical and Mineralogical Methods, Agronomy Monograph no. 9, Book Series No: 5, SSSA and ASA, Madison, WI, edn. 2, pp. 383-411 (1986).
14. N.A. Mills and J.B. Jones Jr., Plant Analysis Handbook II. A Practical Sampling, Preparation, Analysis and Interprotation Guide, Micromacro Publishing, 183 Paradise Blvd. Ste. 104, Athens, Georgia, 30607 (1996).
15. M.I. Soysal, The Principles of Biometry, Trakya University, Tekirdag Agricultural Fac. Pub: 95, Tekirdag, Turkey (2000).
16. J. Nyamangara and J. Mzezema, *Agric. Ecosys. Environ.*, **73**, 199 (1999).
17. E. Madejon, R. Lopez, J.M. Murillo and F. Cabera, *Agric. Ecosys. Environ.*, **84**, 55 (2001).
18. C. Kütük, G. Çayci, A. Baran, O. Baskan and R. Hartman, *Bioresour. Tech.*, **90**, 75 (2003).
19. S.B. Hermo, B.M.T. Silva, G.R.E. Gayso and V.N. Freire, Amendment of Acid Soils using Granitic Powder, Proceedings of the third International Congress Man and Soil at the Third Millennium, 28 March-1April, Valencia, Spain (2000).
20. P. Bhattacharyya, K. Chakrabarti and A. Chakraborty, *Archives of Agron. Soil Sci.*, **49**, 585 (2003).
21. A. Günes, M. Alpaslan and A. Inal, Plant Nutrition and Fertilization, Ankara University, Agricultural Faculty Pub. No: 1514, p. 576 (2000).
22. R. Singh and R.K. Rari, *Indian J. Agron.*, **49**, 271 (2004).
23. K.D. Kim, S. Nemec and G. Musson, *Appl. Soil Ecol.*, **5**, 169 (1997).
24. K. Agyarko, P.K. Kmakye, M. Bonsu, B.A. Osei and K.A. Frimpong, *J. Agron.*, **5**, 641 (2006).
25. A.R. Bah, A.R. Zaharah and A. Hussein, *Commun. Soil Sci. Plant Anal.*, **37**, 2077 (2006).
26. J.W.C. Wong, K.K. Ma, K.M. Frang and C. Cheung, *Bioresour. Technol.*, **67**, 43 (1999).
27. M.A. Bozkurt, H. Akdeniz, B. Keskin and I.H. Yilmaz, *Acta Agric. Scand.*, **56B**, 143 (2006).
28. C.D. Tsadilas, T. Matasi, N. Barbayiannis and D. Dimoyiannis, *Commun. Soil Sci. Plant Anal.*, **26**, 2603 (1995).
29. M. Frang and J.W.C. Wong, *Environ. Pollut.*, **106**, 83 (1999).
30. P. Planquart, G. Bonin, A. Prone and C. Massiani, *Sci. Total Environ.*, **241**, 161 (1999).
31. L.Z. Zhuo and J.W.C. Wong, *J. Environ. Qual.*, **30**, 255 (2001).
32. R. Roman, C. Fortun, L.D. Garcia and M.E. Almenderos, *Arid Land Res. Management*, **17**, 297 (2003).
33. M.A. Bozkurt and K.M. Çimrin, *Fresenius Environ. Bull.*, **11**, 1354 (2003).
34. J. Huang, L. Hanglian and Y. Hongxia, *Crop Protection*, **25**, 1167 (2006).

(*Received*: 17 May 2007; *Accepted*: 19 November 2007) AJC-6090