Influence of Global Warming on Zinc Availability under Highland Soil Order in Turkey

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INTRODUCTION

Ongoing global warming (IPCC, 2007) will increase the frequency of freezing and thawing treated cycles (FTTCs) in cool-temperate and other high-latitude regions previously subject to prolonged winter soil frost periods. The maximum extent of seasonally frozen ground is 55 million km^2 or 55% of the total land area of the northern hemisphere. Although in some areas temperature increase will lead to an overall disappearance of soil freezing, in many regions a reduced snow cover in winter, and the consequentially decreased insulation of the soils against freezing, may increase the FTTC (Groffman *et al*., 2001). Large areas of land at middle and high latitudes are regularly exposed to subzero temperatures, and the soils freeze. Seasonally frozen soil plays a significant role in the management of soil and water resources in northern latitudes. Freezing of soil is known to affect soil conditions through various physical, physico-chemical, and biological mechanisms. This climatic diversity depends on global warming, every region should be considered as unique for agricultural production. Because of its geographical position, climatic changes of Northeastern Anatolia show great variations. Variations in precipitation, freeze-thaw and temperature, affects some physical, chemical and microbiological properties of soils and thus affect productivity. This effect, which varies with different soil types (big group), is especially important for water movement, erosion and nutrient uptake in growing period. Four soil groups were used in field study in Erzurum plain (Turkey). The part above could also deal with global importance of Zn deficiency in crop plants and soils. The part dealing with global warming is extensive and might be shortened.

The present study was carried out to investigate the effects of time of freezing, number of freeze-thaw cycles and freezing temperatures on the zinc availability in four of Turkish major soil groups formed from different parent materials, and compared their effects with multiple freeze-thaw cycles in order to improve our understanding of the management various soil group in these regularly freezing-thawing soils, and to establish relationship between laboratory and field study depend on climatic change variation.

METHODS

The field study area was situated at an altitude between 1880 and 2030 m above sea level in the eastern part of Turkey. The parent materials mostly consist of volcanic, marn and lacustrine residual and transported material.

The major soil orders, Pellustert, Argiustoll, Haplustept, and Fluvaquent in the FTTCs study in the laboratory were subject to long-term temperature cycles in order to simulate the temperature under the field condition. For this purpose, the soil samples were put into small pots, saturated (to the field capacity) and placed in an Environmental Test Chamber (GFL 6485). The soil samples were then subjected to a freeze and thaw process from +20 ^{o}C to -30 ^{o}C. Therefore, the laboratory study was conducted in three steps (Step 1, Step 2 and Step 3).

RESULTS and DISCUSSION

This study was conducted in laboratory and field conditions during 2008-2009. The results demonstrated that the initial Zn concentration increased with increases in FTTCs from 6 to 9, depending on soil type, and was more pronounced with increased moisture contents at freezing. The highest Zn values were determined from Fluvaquent soil followed by Haplustept > Argiustoll > Pellustert.

Table 1. Effects of Zn application and freeze-thaw (Step 3; soil samples obtained from major each soil treated with treated with -10, -15, and -20 °C treatment were subject to refreezing at -10 °C for 15 d, at-5 °C for 15 d and at 0 °C for 15 d then thawed at +2.5, +5, +7.5 and 10.0 °C for 18 h, this cycle was repeated 3, 6, and 9 cycles) on equilibrium solution Zn concentration of four soil major groups (mg Zn L^{-1}) (Mean value n=3)

		Pellustert		Argiustoll		Haplustept		Fluvaquent	
F-T cycles	**F.D mg kg^{-1}**	**Zn mg kg^{-1}**	***Avaliability %***	**Zn mg kg^{-1}**	***Avaliability %***	**Zn mg kg^{-1}**	***Avaliability %***	**Zn mg kg^{-1}**	***Avaliability %***
Initial		***2.97***		***3.04***		***3.01***		***3.63***	
3	0	2.45	33.90	2.67	34.50	2.75	32.90	3.04	38.00
	1	1.97	28.90	2.51	32.20	2.86	31.60	3.71	37.00
	3	2.23	33.60	2.66	32.70	2.65	32.10	3.35	38.40
	6	2.21	30.10	2.95	34.60	2.84	30.80	2.61	27.00
	9	2.23	33.30	2.46	37.10	2.53	32.00	2.45	27.20
6	0	2.54	35.10	2.46	31.90	2.66	31.80	2.25	28.20
	1	2.68	39.40	2.45	31.50	3.29	36.30	2.87	28.60
	3	2.24	33.70	2.12	26.10	2.60	31.60	2.44	28.00
	6	2.29	31.10	2.67	31.30	3.63	39.40	3.47	35.80
	9	2.18	32.60	2.34	35.30	3.14	39.60	2.98	33.10
9	0	2.24	31.00	2.60	33.60	2.95	35.30	2.71	33.90
	1	2.16	31.80	2.82	36.30	2.92	32.20	3.44	34.40
	3	2.17	32.70	3.35	41.20	3.00	36.30	2.93	33.60
	6	2.86	38.80	2.91	34.00	2.74	29.80	3.60	37.20
	9	2.28	34.10	1.83	27.60	2.25	28.40	3.58	39.70

CONCLUSIONS

Based on our results, we emphasize that highland soils are most sensitive to the global climatic change. Increasing air temperature has resulted in the rise of soil temperature and increasing the frequency of soil freeze-thaw cycles during the winter in the cool temperature and other high-latitude regions. If ongoing global warming continues this trend demonstrates that freeze–thaw cycles in highland soils can significantly influence the availability of Zn, after freeze–thaw cycles, the highland soils have more availability for Zn than without freeze–thaw cycles.

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