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Magnesium deficiency of tomato in calcareous soil under solar greenhouse

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Introduction

Magnesium (Mg) deficiency is usually common in plants growing on coarse-texture acidic soils. However, its deficiency becomes common in recent years for tomato grown in solar greenhouse in Loess Plateau, China, where the soil is calcareous one. To find the reasons, the compositions and proportion of ions and activities of Mg^{2+}, Ca^{2+} and K^{+} ions were determined in solar greenhouse soils with different ages and different degrees of Mg deficiency of tomato, and their relationships with Mg deficiency of tomato were also analyzed.

Picture1 Solar greenhouse and tomato with Mg deficient symptoms

Materials and methods

The soil samples (0–20cm) were taken from the different farmers' solar greenhouses with different ages and different degrees of Mg deficient symptoms of tomato, in Xian, and Yangling, Shaanxi, China. The concentrations of soluble ions, their ions activities, mole ratios and activity ratios of Ca^{2+}/Mg^{2+} and K^{+}/Mg^{2} were determined.

Results

Compositions of soluble ions in soils

The concentrations of Ca^{2+}, K^{+}, NO_3^{-} ions in soil increased linearly as the aging of solar greenhouse. There were significant relationships between Ca^{2+} and NO_3^{-} ions, and total salts and NO_3^{-} ions in soil, indicating that NO_3^{-} ion was the main reason for soil salinization. The contents of Ca^{2+}, K^{+}, NO_3^{-} ions, and total salts in soil significantly increased as the severity of the Mg deficiency of tomato.

Table1 Compositions of soluble ions in soils where tomato displayed different degrees of Mg deficiency

Degree of Mg deficiency	Soluble ion(g kg^{-1})									Total salt (g kg^{-1})
	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	NH_4^{+}	NO_3^{-}	SO_4^{2-}	Cl^{-}	HCO_3^{-}	
PC(*n*=4)	0.049c	0.018ab	0.005c	0.018ab	0.002a	0.033d	0.185a	0.027b	0.186a	0.522b
ND (*n*=15)	0.078c	0.021ab	0.009c	0.033a	0.002a	0.140c	0.176a	0.047b	0.186a	0.691b
LD (*n*=2)	0.285b	0.024ab	0.015c	0.026ab	0.002a	0.490b	0.053a	0.060ab	0.203a	1.159a
MD (*n*=5)	0.235b	0.031a	0.042b	0.013b	0.002a	0.418b	0.143a	0.024b	0.194a	1.102a
SD (*n*=4)	0.437a	0.012ab	0.082a	0.036a	0.004a	0.686a	0.090a	0.097a	0.171a	1.615a

Note： PC= Prior to cultivating tomato; ND=no deficiency; LD=light deficiency; MD=moderate deficiency; SD=severe deficiency

Ca^{2+},Mg^{2+}, K^{+} mole ratios

Mole ratios of Ca^{2+}/Mg^{2+}, K^{+}/Mg^{2+} in soil significantly increased as the severity of the Mg deficiency of tomato.

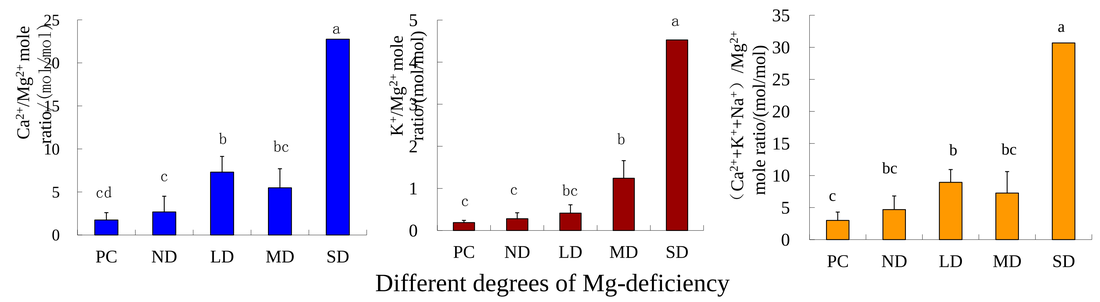

Fig.1 Mole ratios of K^{+}/Mg^{2+},Ca^{2+}/Mg^{2+},$(Ca^{2+}+ K^{+}+Na^{+})/Mg^{2+}$ of the soluble ions in soils where tomatoes displayed different degrees of Mg-deficiency

Ca^{2+}, Mg^{2+} and K^{+} activities and their ratios in soils

As the accumulation of salts in soil, the activities of Ca^{2+} and Mg^{2+} ions decreased exponentially. The activities of Ca^{2+} and Mg^{2+} ions in soil solution of tomato deficient in Mg were significantly lower; The activity ratios of $(K^{+})/(Mg^{2+})$, $(Ca^{2+})/(Mg^{2+})$, and$(K^{+})/(Ca^{2+})$ increased significantly as the severity of tomato Mg deficiency.

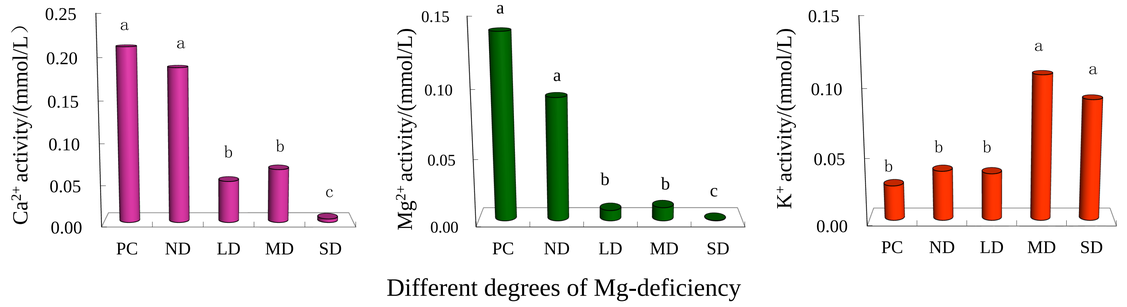

Fig.2 Ca^{2+}, Mg^{2+} and K^{+} activities in soils where tomatoes displayed different degrees of Mg-deficiency

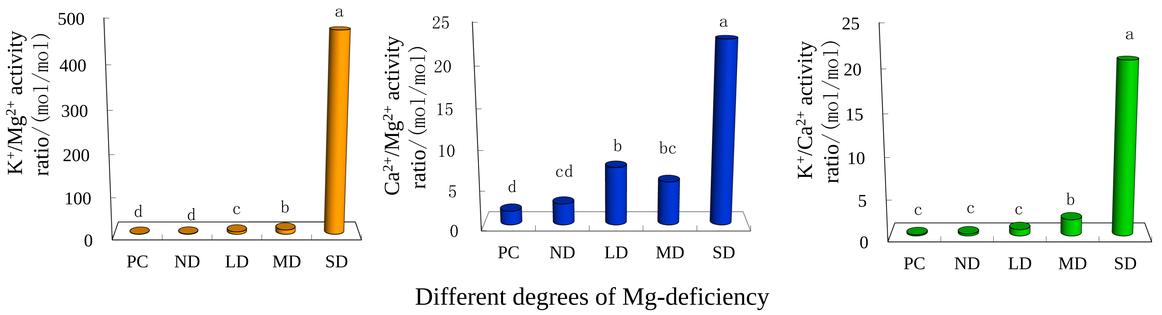

Fig. 3 Ca^{2+}, Mg^{2+} and K^{+} activity ratios in soils where tomato displayed different degrees of Mg-deficiency

Conclusion

The low Mg^{2+} activity due to the salt accumulation in soil and the antagonistic interaction between Mg^{2+} and K^{+} ion were the main reasons for tomato Mg deficiency in calcareous soil under solar greenhouse.