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Studies on Phosphatase Activity Change Rule in NaCl Stress Maize of Soil

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Abstract: Taking the structure of asphalt concrete pavement in actual running as the test object, a kind of actual measurement project for temperature field pavement structure was put forward. Based on the abundant measured temperature data, distribution rules of asphalt pavement temperature field were studied in detail, and the dependency relations between the air temperature and pavement temperature field were discussed with regression analysis. Considering the effect difference to asphalt pavement temperature field which was applied by temperature rise period and temperature fall period of air, the dependency relations between air temperature and different temperature changing periods were researched respectively and the prediction models on asphalt pavement temperature based on different temperature changing periods were established. The comparison between measured and predicted asphalt pavement temperatures indicates that these models have good applicability and accuracy. In this paper, adopting the method of field experiment of salt pond, studying change rules of phosphatase activity in the soil of two kinds of maize with different concentration of NaCl stress. Test results show that the two maize varieties soil phosphatase activity decreased, with the increase of the concentration of NaCl stress corn soil phosphatase activity in different periods, efficiency in seedling stage and mature stage is low, different concentration of NaCl treatment of maize rhizosphere soil phosphatase activity is significantly higher than non rhizosphere soil. Phosphatase activity and various forms of phosphorus correlation analysis showed that Ca8 -P and alkali type, acid phosphatase activities were very significant positive correlation;Ca2 -P, effective phosphorus and acid, alkali phosphatase activities were significantly related. Ca10 -Pand acid type, alkaline phosphatase activity showed a negative correlation; Al - P, Fe, P, O - P and total phosphorus, and acid, alkali phosphatase activity not related. In addition, phosphatase activity can affect the effectiveness of soil P, P uptake of corn and corn production.

Keywords: NaCl solution stress ; Acid phosphatase; Alkaline phosphatase; Rhizosphere

1. Introduction

Phosphorus is one of the plant growth and development necessary nutrition elements, it is a component of the structure of the macromolecular material, such as nucleic acids, nucleoprotein, phospholipids, ATP and other important compounds, it is also involved in the metabolic process, such as participate in the metabolism of carbohydrate, fat and starch metabolism, energy supply and energy, etc., so the phosphorus element is indispensable to plant growth. Plants absorb from the soil p is the mechanism of phosphorus removal. Effective phosphorus supply reorganisation has very important significance for the growth of plant early. Studies show that plant demand for phosphorus removal is produced by the phosphatase and the mineralization of phosphorus, phosphorus availability and negatively correlated with phosphate rock to change role(McGill WB and Cole CV1981).And salt treatment can increase the phosphorus concentration of seedlings and roots, which may be increase the availability of soil phosphorus, salt or sodium synergies, related to p uptake and transport(Turan MA et al.2007).

Phosphatase is a kind of adaptive enzyme, influenced by plant phosphorus requirements, and phosphatase also affects the result of phosphorus supply adjustment process, the phosphorus cycle plays a vital role(Ge et al. 2011). Phosphatase activity changes with high salt concentration cell caused by physical changes or pH changes. Phosphatase catalytic organophosphorus after hydrolysis and mineralization, organic phosphorus compounds can be hydrolyzed to the inorganic phosphorus forms that can be utilized by plant(Findenegg G R and J A Nelemans 1993;Tarafdar J C and Claassen N 1988).The study found that organic phosphate rock rate and plant rhizosphere positively related acid and alkaline phosphatase, crop phosphorus availability and acid phosphatase activity negatively correlated(Bhadraray S, et al. 2002).

Corn is one of the world's third-largest cereal crop after wheat, rice(Wattoo FM et al. 2009), and is also sensitive to salt stress moderate plant(Mass, et al. 1977), its production height is controlled by many factors such as soil nutrient, salt, research has shown that corn soil salt concentration can cause phosphatase activity in the process of change, which affects the plants on phosphorus ab-

sorption and utilization(Richard H.Nieman and Robert A.Clark 1976).

2. Test Materials and Methods

2.1. Experimental material

The tested soil collected from Agriculture and the resources environment college of Tianjin Agriculture University, test site fluvo-agvic soil salt pond. The basic physical and chemical properties as: organic matter 15 g/kg; total phosphorus (P) 0.61 g/kg; effective phosphorus (P) of 15.17 mg/kg; rapidly-available potassium (K) of 70.86 mg/kg; alkaline hydrolysis n 29.8 mg/kg ;pH 7.0 (H2O).

Maize variety tested,Zhengdan958 and Danyu92, from Tianjin Agriculture University seed science and engineering center lab. Tested fertilizer is resin urea fertilizer .

2.2. Experimental method and data processing

Salt Lake field experiment in the cell area are 5.7 m2 (length of 2.85 m, a width of 2 m) carried out on the use of two maize varieties (Zhengdan958, Danyu92), set up four levels of NaCl concentrations (0,2 , 4,6 ‰), a total of eight treatment combinations, twice repeated. Before starting the test, in soil samples from each plot was measured salt content respectively, and add the appropriate amount of NaCl solution according to the test setup and measurement results, the specific method is a one-time NaCl solution quantitatively different concentrations applied uniformly into the cell, while controlling Field capacity is maintained at around 70%.Test on May 14, 2013 planting, each plot planted corn 35 plants,in the whole growth period of corn points and the five sampling soil samples time was June 29 (I), July 10 (II), 7 May 31 (III), August 21 (IV) and September 19 (V), five-point method using soil samples and soil drill get soil near the roots, and the last sample will maize dug, shake off the roots above the soil non-rhizosphere soil, attached to the root surface cannot afford to shake rhizosphere soil, with p-nitrophenyl phosphate content Determination of soil phosphatase. Data processing using Microsoft Excel (Office 2003) software, data processing using SPSS 17.0 software and dps.

3. Different NaCl Concentration on the Influence of Variation During the Soil Phosphatase Activity

From Table 1 and Table 2, June 29 to August 21, two maize varieties with the NaCl concentration increases, the soil acid and alkaline phosphatase activity were significantly decreased, indicating that soil phosphatase activity by inhibition of salt. At the same time it can be seen, at different growth stages of corn, for acid and alkaline phosphatase activity effects of different by different NaCl concentration .Under treatment in different NaCl concentration, soil acid and alkaline phosphatase activity as plant growth and increases, which may be related to the growth of plant roots of plants increases, increased secretions, rhizosphere microbial population increased; September 19, acid and alkaline phosphatase activity in maize maturation decrease, probably due to corn plant of the maturity growths and metabolisms slowly, root exudates reducing and other reasons make activity decreased.

Table 1. The Activity of Acid Phosphatase in Soil after Planting Maize at Various Growth Stages

Variety	Date/Concentration (‰)	0	2	4	6
Zhengdan958	I	113.21Aa	75.75Bb	70.87Bb	67.21Bb
	I I	122.08Aa	108.23Bb	98.41Cc	89.25Dd
	I I I	168.10Aa	113.56Bb	87.61Cc	79.24Cc
	IV	213.40Aa	176.80Bb	156.90BCc	129.11Cc
	V	117.65Aa	154.65Aa	124.83Aa	115.66Aa
Danyu92	I	106.10Aa	65.92Cc	72.13Bb	68.34BCbc
	I I	127.86Aa	113.70Aab	106.76Aab	94.65Ab
	I I I	188.23Aa	110.87Bb	82.84BCc	80.14Cc
	IV	244.10Aa	157.80Bb	158.80Bb	157.60Bb
	V	115.17Aa	110.67Aa	119.24Aa	111.06Aa

Table 2. The Activity of Alkaline Phosphatase in Soil after Planting Maize at Various Growth Stages

Variety	Date/Concentration (‰)	0	2	4	6
Zhengdan958	I	173.25Aa	147.17Bb	146.31Bb	137.66Bb
	I I	126.96Aa	135.60ABb	123.10Bb	124.43Bb

	I I I	198.95Aa	148.75Bb	124.42Bc	120.58Bc
	IV	201.14Aa	168.05Bb	153.21Bb	125.67Cc
	Ⅴ	118.80Aa	158.63Aa	125.33Aa	114.05Aa
Danyu92	I	182.91Aa	143.17Bb	144.87Bb	145.58Bb
	I I	134.23Aa	126.11Aa	134.32Aa	130.37Aa
	I I I	235.01Aa	138.48Bb	132.24BCc	116.95Cc
	IV	246.58Aa	147.46Bb	153.08Bb	157.86Bb
	Ⅴ	111.70Aa	107.23Aa	116.28Aa	101.12Aa

4. In different Concentrations of NaCl Stress Maize Rhizosphere Soil and Non-rhizosphere Phosphatase Activity

Phosphatase is an adaptive enzyme, demand for phosphorus plants directly affects the intensity of plant root secretion(Silberbush M et al. 1981).As shown in Table 3 and Table 4, after different NaCl concentrations corn rhizosphere soil acidic, alkaline phosphatase activity was significantly higher than non-rhizosphere soil, indicating that plant roots can improve phosphatase activity, and soil rhizosphere phosphatase activity improve effectiveness and promote the conversion of phosphorus in rhizosphere nutrients conducive to plant growth, thus forming a virtuous circle can be beneficial to increase soil salinization phosphorus.Different concentrations of NaCl stress conditions, different maize varieties acid, alkaline phosphatase activity are different, each processing Zhengdan958 rhizosphere soil acid phosphatase activity were greater than alkaline phosphatase activity, and Danyu 92 is acid phosphatase activity greater than the alkaline phosphatase activity, indicating that different root exudates of different maize varieties, resulting in different soil conditions of rhizosphere.

Table 3. The Influence of the salt Concentration to the Activity of Acid Phosphatase in Rhizosphere and the Bulk Soil

Variety	NaCl Concentration (‰)	0	2	4	6
Zhengdan958	Rhizosphere	117.65	154.65	124.83	115.66
	Non-rhizosphere	112.51	123.01	118.01	110.40
	Rhizosphere-Non-rhizosphere	5.14	31.64	6.82	5.26
Danyu92	Rhizosphere	115.17	110.67	119.24	111.06
	Non-rhizosphere	114.80	108.43	113.60	109.43
	Rhizosphere-Non-rhizosphere	0.37	2.24	5.64	1.63

Table 4. The Influence of the Salt Concentration to the Activity of Alkaline Phosphatase in Rhizosphere and the Bulk Soil

Variety	NaCl Concentration (‰)	0	2	4	6
Zhengdan958	Rhizosphere	118.80	158.63	125.33	114.05
	Non-rhizosphere	112.45	128.24	118.53	109.77
	Rhizosphere-Non-rhizosphere	6.35	30.04	6.80	4.28
Danyu92	Rhizosphere	111.70	107.23	116.28	101.12
	Non-rhizosphere	108.95	102.02	111.12	98.91
	Rhizosphere-Non-rhizosphere	2.75	5.21	5.16	2.21

5. Relationship between Phosphatase Activity and Inorganic Phosphorus Forms, Maize uptake and so on

With determination of Jiang Baifan, Gu Yichu (Jiang and Gu,1989) to grouping measure soil inorganic phosphorus forms (see Table 5), from which to see, content of total phosphorus is 610.00 mg / kg, which is the main inorganic phosphorus content 345.90 mg / kg, 58.18% of the

total phosphorus,the following is organic phosphorus, 225.10 mg / kg, 41.82% of the total phosphorus, various forms of inorganic phosphorus content of the highest 24.48% Ca10-P total phosphorus content, following Fe-P, Ca8-P, Al-P total phosphorus content of 11.84%, 11.75%, 5.28%, Ca2 -P and O-P content accounted respectively for almost 2.39% and 2.26%.

Table 5. Content of Soil Phosphorus（mg/kg）

	Ca2-P	Ca8-P	Ca10-P	Al-P	Fe-P	O-P	Available P	Inorganic phosphorus	Organic phosphorus	Total phosphorus
Content (mg/kg)	17.90	71.70	149.30	32.20	70.00	13.80	7.90	345.90	255.10	610.00
Total phosphorus (%)	2.39	11.75	24.48	5.28	11.84	2.26	1.30	58.18	41.82	--

Plants absorb phosphorus directly affect the growth of plants, and phosphatases play an important role in the phosphorus cycle. In soil - root surface phosphatase is mediated transformation of organic and inorganic phosphorus between phosphorus nutrition of plants and entire ecosystems phosphorus cycle(Khan et al. 2001).To further explore the relationship between phosphatase and soil phosphorus,we correlation analysis it(see Table 6), it was found, a significant positive correlation between Ca8-P and basic, acid phosphatase activity ; Ca2-P,phosphorus and acid, alkaline phosphatase activity have reached a significant level of correlation;Ca10-P and acidic, alkaline phosphatase activity was negatively correlated; Al-P, Fe-P, O-P total phosphorus and acid, alkaline phosphatase activity not related. Research shows that calcareous soil phosphorus, Ca2-P and Ca8-P plant can absorb phosphorus, which in turn affected the content of phosphatase activity, salt content impact of the phosphatase activity, so the lack of soil salinization phosphorus is a main reason of crop phosphorus nutrition and growth inhibition.We analyzed the correlation relationship between maize P uptake, yield and phosphatase activity, derived that correlation coefficients between P uptake of maize, maize yield and acid, alkaline phosphatase activity were 0.981,0.985 and 0.913,0.940 ,which were very significant level of correlation, further validates the acid and alkaline phosphatase may affect the effectiveness of soil phosphorus uptake and yield of maize and phosphorus, further validates the acid and alkaline phosphatase may affect the effectiveness of soil phosphorus and uptake of phosphorus and yield of maize.

Table 6. The Correlation Coefficient between Soil Phosphatase Activity and Various Forms of Phosphorus, Corn Phosphorus uptake and so on

	Ca2-P	Ca8-P	Al-P	Fe-P	O-P	Ca10-P	Inorganic phosphorus	Organic phosphorus	Available P	Total phosphorus	Uptake of phosphorus	Yield
Content (mg/kg)	0.722*	0.816**	0.623	0.559	0.195	-0.647	0.645	0.769*	0.719*	0.423	0.985**	0.913**
Total phosphorus (%)	0.721*	0.834**	0.611	0.569	0.189	-0.616	0.652	0.778*	0.728*	0.426	0.981**	0.940**

6. Conclusion and Future Direction

Each treatment from June 29 to August 21 as the date of the plant growth soil phosphatase activity increased, which may related with plant roots increase, secretions increased and rhizosphere microbial population increase,plants grown in maturity (September 19) slows down metabolism and enzyme activity decreases.Corn different saline-treated rhizosphere phosphatase activity was significantly higher than non-rhizosphere soil,shows that plant roots can improve the phosphatase activity, and soil rhizosphere phosphatase activity improved the conversion of phosphorus in rhizosphere nutrients, conducived to the growth of plants, forming a virtuous circle, in favor of salinization of soil improvement. With increasing salt concentration, the maize yield, soil available phosphorus decreased significantly.

In addition, phosphatase activity by various forms of phosphorus impacts, Ca8-P and basic, acid phosphatase activity were highly significant positive correlation;Ca2-P, available phosphorus and acid, alkaline phosphatase activity have reached a significant level of correlation;Ca10-P and acidic, alkaline phosphatase activity was negatively correlated;Al-P, Fe-P, O-P total phosphorus and acid, alkaline phosphatase activity was irrelevant.Meanwhile phosphatase activity also affect the P uptake of maize and maize yield.However, plant roots can improve the phosphatase activity, so looking for a way to increase plant root exudates, improve phosphatase activity thereby increasing the P uptake of maize and maize yield is a new research direction.

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