The soil inorganic phosphorus distribution of vegetation-growing concrete substrate in the disturbed engineering area

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Abstract: This work presents the field and experimental studies conducted in China Three Gorges University, Yichang City, Hubei Province that reveal the distribution of inorganic phosphorus in four vegetation concrete samples and one natural forest sample. Several results of these studies have general application and include the following: (1) The total content of phosphorus in the five sample soil is 880~4,870 mg/kg. (2) The phosphorus content of seat earth from all samples is all greater than that of topsoil and the content of total inorganic phosphorus is 258.194~1,591.084 mg/kg, which accounts for 18.809%~38.364% of total phosphorus. (3) The contents of inorganic phosphorus in four forms are orderly: Ca-P>O-P>Al-P>water-soluble P, and the content of Ca-P reaches 230.76~579.85 mg/kg. For the fact that the five slopes restored in the disturbed area of China Three Gorges University, the contents of water-soluble P, Al-P, O-P, Ca-P in the vegetation concrete soil are greater than that in the natural forest. This means that the content of P in the soil restored by manpower is higher than that in the natural forest, but the P contents in topsoil is lower than that in the seat earth at the same site caused by natural weathering, vegetation destruction and other problems.

Introduction

Phosphorus is one of the major and indispensable nutrition elements for plants growth and development. Its abundance ranks 11th in the earth's crust and its content of 1,180mg/kg-1 follows behind aluminum[1]. According to a report, the low- phosphorus cultivated land accounts for about 43% of 1.319 billion cultivated land in the world; 74% of 0.107 billion hm2 cultivated land in China lacks phosphorus[2,3]. As a result, phosphorus content is one of direct factors to influence plants growth and soil fertility. Phosphorus exits in soil in many different forms which mainly include water-soluble P, Al-P, O-P, Ca-P and Fe-P. For phosphorus in soil, different forms have different chemical properties and functions. Scholars at home and abroad had made a lot of researches and explorations on the form of phosphorus and mainly focused on the exploration and improvement in grading methods of phosphorus in soil[4,5,6,7]. The purpose of grading phosphorus in soil is to evaluate its scale of effective phosphorus and supply situation[8,9,10].

Material and method

Sample collection and collection method. All soil samples were collected respectively in reception center, administrative building, computer building, library and Cuiping hill in China Three Gorges University. The five sites were respectively marked by A, B, C, D and E, which are all vegetation concrete slopes. Every sample soil were collected in surface layer and root in S shape and

collected in five points in every sample site. The samples were dried in the shade and the root system in them were removed . Then they were grinded and screened by 2mm mesh screen. Finally, we collected 2kg soil sample in every site using the point-quarter method. All samples were sacked for reserve.

Total P content of the soil was determined by digesting samples with concentrated H2SO4 and HClO4 and measuring it by colorimetric method, grouped soil inorganic phosphorus was measured by the method proposed by Zhang Shoujing and Jackson (year 1957), and rapidly available phosphorus was determined by using 0.5mol·L-1NaCO3 to extract the phosphorus in the soil and showed color of the phosphorus in the sample under test by using molybdenum antimony anti reagent, and then measured the content of phosphorus as per spectrophotometry.

Results and analysis

The content distribution of total phosphorus and inorganic phosphorus in all sorts of forms in two kinds of restored slopes in the disturbed area of China Three Gorges University

The research was made on the distribution features of inorganic phosphorus on four vegetation concrete slopes and one natural forest site of China Three Gorges University by adopting the inorganic phosphorus distribution system proposed by Zhang Shoujing and Jackson. Table 1 and Table 3 show that the content of total inorganic phosphorus in the five sample sites is between 258.19 and 1,591.08mg/kg, which accounts for 18.81%-38.36% of total phosphorus. According to some scholars' researches, the inorganic phosphorus in soil is the main source of nutrition needed by plants and that accounts for 60%-80% of the total phosphorus[11]. In the five slopes in two restored modes of China Three Gorges University, the inorganic phosphorus only accounts for a little of the total phosphorus, which obviously lower than normal level. In table 1, the content of total inorganic phosphorus in vegetation concrete soil is between 263.335mg/kg and 1591.08mg/kg and its average content is 1,123.81mg/kg. The content of total inorganic phosphorus in natural forest soil is between 258.194mg/kg and 317.076mg/kg and its average content is 287.64mg/kg. Among the samples, the content of inorganic phosphorus in root soil in four vegetation concrete sample sites is 322.82-1591.08 mg/kg and its average content is 1,183.15mg/kg; the content of inorganic phosphorus in non-root soil in four vegetation concrete sample sites is 253.33-1426.51mg/kg and its average content is 1,064.47mg/kg. Although the content of inorganic phosphorus in root soil is greater than that in the non-root soil, the difference is not obvious. Table 2 shows the content distribution of inorganic phosphorus in all sorts of forms of five sample sites under test. The distributions are as follows: water-soluble P: slope of administrative building > slope of library > slope of computer building > slope of reception center > Cuiping mountain; Al-P: slope of computer building > slope of library > slope of administrative building > slope of reception center > Cuiping mountain;O-P: slope of computer building > slope of administrative building > slope of library > slope of reception center > Cuiping mountain; Ca-P: slope of library > slope of administrative building > slope of computer building > slope of reception center > Cuiping mountain. The content order of phosphorus in four forms in the five sample sites under test is Ca-p>O-P>Al-P> water-soluble P. The content of Ca-P is up to 230.76-579.85mg/kg, which accounts for the highest percentage among the four forms; the content of water-soluble P is 4.18-77.95mg/kg, which accounts for the lowest percentage among the four forms. This shows that Ca-P is the most effective among the four forms and the soil-fixing strength of slope is very strong due to the lowest content of water-soluble P[12].

Table 1 The contents of total phosphorus, total inorganic phosphorus and rapidly available phosphorus in two kinds of slopes in the disturbed area of China Three Gorges University

No.	Sample site name	Soil type	Total phosphorus[mg/kg]	Total inorganic phosphorus[mg/kg]	Rapidly available phosphorus [mg/kg]
A-1	Cuiping mountain	Natural forests	1.058	317.0763	54.474
A-2	Cuiping mountain	Natural forests	0.672	258.194	65.368
B-1	Administrative building	Vegetation concrete	4.475	1365.972	350.450
B-2	Administrative building	Vegetation concrete	4.871	1591.084	325.029
C-1	Computer building	Vegetation concrete	4.427	1426.505	499.346
C-2	Computer building	Vegetation concrete	4.539	1588.764	513.872
D-1	Library	Vegetation concrete	3.761	1202.077	470.293
D-2	Library	Vegetation concrete	4.294	1229.947	453.951
E-1	Reception center	Vegetation concrete	0.880	263.3347	130.737
E-2	Reception center	Vegetation concrete	1.399	322.8203	65.3689

Note: -1 stands for non-root soil, -2 stands for root soil

Table 2 The contents of inorganic phosphorus in all sorts of forms in soil

No.	Sample site name	Water-soluble P [mg/kg]	Al-P [mg/kg]	O-P [mg/kg]	Ca-P [mg/kg]
A-1	Cuiping mountain	5.871	1.806701	72.26811	237.1297
A-2	Cuiping mountain	4.177	0.677378	22.57928	230.7602
B-1	Administrative building	74.193	364.4068	646.9294	505.555
B-2	Cuiping mountain	77.949	343.608	383.5415	560.873
C-1	Computer building	50.813	379.9722	537.494	458.225
C-2	Computer building	58.884	379.7061	573.0561	577.1171
D-1	Library	59.868	374.0095	188.3501	579.8492
D-2	Library	61.604	372.6736	221.1445	574.5243
E-1	Reception center	12.381	10.8057	50.52138	259.1117
E-2	Reception center	6.772	10.49727	62.029908	237.0351

Note: -1 stands for non-root soil, -2 stands for root soil

Table 3 The ratio of total inorganic phosphorus and inorganic phosphorus in all sorts of forms in soil

No.	Sample site name	Total inorganic phosphorus [%]	Water-soluble P [%]	Al-P [%]	O-P [%]	Ca-P [%]
A-1	Cuiping mountain	29.969	0.554	0.170	6.830	22.413
A-2	Cuiping mountain	38.364	0.620	0.100	3.355	34.288
B-1	Administrative building	35.547	1.657	8.141	14.453	11.294
B-2	Administrative building	28.037	1.599	7.052	7.872	11.512
C-1	Computer building	31.427	1.119	8.371	11.841	10.095
C-2	Computer building	35.888	1.330	8.577	12.944	13.036
D-1	Library	31.961	1.591	9.944	5.007	15.417
D-2	Library	28.643	1.434	8.678	5.150	13.379
E-1	Reception center	36.684	1.406	1.227	5.604	29.444
E-2	Reception center	18.809	0.483	0.749	6.644	16.931

Note: -1 stands for non-root soil, -2 stands for root soil

Conclusions

The content of total inorganic phosphorus in the five sample sites of China Three Gorges University is between 258.19 and 1,591.08mg/kg and the content of total phosphorus is 0.672-4.871g/kg, among which inorganic phosphorus accounts for 18.81%-38.36% of total phosphorus. The content of inorganic phosphorus is lower than normal level. Although the content of inorganic phosphorus in root soil is greater than that in the non-root soil, which may be caused by the negative physiological activity of plants' roots due to the decrease in phosphorus in the vegetation concrete with rainfall, weathering and other natural factors, the difference is not obvious. The content of total inorganic phosphorus in four vegetation concrete slopes is between 263.335mg/kg and 1591.08mg/kg and the content of total inorganic phosphorus in one natural forest slope is between 258.194mg/kg and 317.076mg/kg. Their average contents in these two kinds of slopes respectively are 1,123.81mg/kg and 287.64mg/kg. Through comparison, the content of inorganic phosphorus in restored vegetation concrete slope is greater than that in natural forest soil.

The content order of phosphorus in four forms in the five sample sites under test is Ca-p>O-P>Al-P> water-soluble P. Ca-P is the most effective phosphorus source in restored vegetation concrete slope among the four forms, and the soil-fixing strength of slope is very strong due to the low content of water-soluble P.

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