

论文

以盒维数法分形分析水稻根系形态特征及初探其与锌吸收积累的关系

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摘要:

利用特定根盒装土, 培养4个水稻品种(MADHUKAR、IR8192-200、IR26、IR8192-31)植株, 用钉板法结合透明塑料膜固定获得近似原位根系样品, 扫描得到根系的二维平面图像, 以分形理论为基础, 利用盒维数法结合根系图像分形分析程序计算根系构型的分形维数和分形丰度, 比较各品种根系的形态特征, 并对分形参数、根系长度和植株锌含量间的相关关系做了初步探讨。结果表明, 根系分形维数和分形丰度以MADHUKAR最大, IR8192-200最小, 说明MADHUKAR根系分支多, 在土壤中拓展体积大。分形维数、分形丰度与根系总长度之间均呈明显正相关, 而且根系总长度与分形丰度相关系数高于与分形维数的相关系数。分形维数和分形丰度与植株地上部干重、单位Zn浓度所产出的地上部生物量、地上部Zn吸收总量之间均呈显著正相关, 与地上部Zn浓度呈负相关。水稻根系形态和构型的变化影响植株生长, 影响植株Zn吸收积累及体内Zn的利用效率。盒维数法分形分析模型可用于研究水稻根系形态和构型, 为其提供新方法。

关键词: 分形 根系 水稻 锌分形 根系 水稻 锌

Fractal Analysis of Root System Architecture by Box-Counting Method and Its Relationship with Zn Accumulation in Rice (*Oryza sativa* L.)

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Abstract:

The analysis on the characterization of root system architecture would assist to better understand the functional and growth strategies of root systems of rice plants, which is closely related to rice plant's adaptation to insufficient supply of soil water and nutrient. The fractal analytical method was used to examine the difference of the root systems of four rice genotypes (MADHUKAR, IR8192-200, IR26, and IR8192-31) and the relationship between root length and plant Zn uptake was explored. The root systems were grown for one month in root boxes with 25 cm in length, 2 cm in width and 40 cm in depth, which were filled with soil. The root systems were harvested following the needle-pinboard method, and then spread on the transparent plastic films with nets after carefully washing out the soils. The two-dimensional images of root systems were digitized by using a scan-ner. The digitized images were used for analysis based on fractal geometry with the box-counting method. The fractal parameters differed among the four selected rice genotypes. Variety of MADHUKAR had the greatest values of fractal dimension (FD) and fractal abundance (FA). IR8192-200's roots had the smallest FD and FA. It was suggested that MADHUKAR had a higher capacity of root branch and a larger volume of soils explored by the whole root systems than other three rice genotypes. The FD and FA had significant correlations with total root length. Moreover, the correlation coefficient between FA and total root length was higher than that FD and total root length. The FD and the FA of rice roots were observed to positively correlate with shoot dry weight, shoot biomass per unit of Zn concentration, and Zn accumulation in shoot. However, shoot Zn concentration was negatively correlated with FD and FA. Root configuration changes might affect the growth of rice plants, plant Zn uptake and Zn use efficiency. The fractal analysis of root structure by box-counting method can be used to evaluate root system of different rice genotypes.

Keywords: Fractal analysis Root systems Rice (*Oryza sativa* L.) Zn

收稿日期 2007-08-22 修回日期 1900-01-01 网络版发布日期 2008-09-12

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基金项目:

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