

韩春梅, 李春龙, 叶少平, 潘开文, 吴宁, 李伟. 生姜水浸液对生姜幼苗根际土壤酶活性、微生物群落结构及土壤养分的影响. 生态学报, 2012, 32(2): 489~498

## 生姜水浸液对生姜幼苗根际土壤酶活性、微生物群落结构及土壤养分的影响

Effects of ginger aqueous extract on soil enzyme activity, microbial community structure and soil nutrient content in the rhizosphere soil of ginger seedlings

投稿时间: 2010-12-12 最后修改时间: 2011-6-13

DOI: 10.5846/stxb201012121768

中文关键词: 化感作用 生姜 土壤酶 土壤微生物 HPLC

English Keywords: allelopathy ginger soil enzyme soil microbe HPLC

基金项目: 国家“十一五”科技攻关项目子课题资助项目(2006BAC01A15); 中国科学院知识创新工程重大项目(KZCX2-XB2-02-01-03)

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中文摘要:

以生姜为材料, 研究生姜不同部位(根茎、茎和叶)、不同浓度(10、20、40、80 g/L)的水浸液对生姜幼苗根际土的微生物数量、土壤酶活性及土壤养分含量的影响, 并通过HPLC定量分析了生姜各部位水浸液中所含酚酸类(香草酸、丁香酸、对羟基苯甲酸、香豆酸和阿魏酸)、香豆素类(伞花内脂和7-甲氧基香豆素)化合物的含量。结果表明: 3种生姜水浸液对所测6种土壤酶活性均产生了不同程度的影响, 其中影响最大的是酸性磷酸酶和蔗糖酶, 在10 g/L时就达到了显著性差异水平, 并且所有酶均有随着水浸液浓度的增加而呈增大的趋势; 相同部位的水浸液随着浓度的增加, 细菌和真菌的数量呈增加趋势, 而放线菌的数量呈减少趋势; 3种生姜水浸液均随着浓度的增加降低了土壤中有机质的含量, 加剧了土壤中硝态氮含量的积累, 根茎水浸液对土壤有效磷、速效钾和铵态氮均显示出低浓度提高其含量而高浓度降低其含量的趋势, 而茎和叶水浸液则随着浓度的增加均降低了其含量。生姜水浸液中主要化感成分包括: 根茎水浸液主要是丁香酸和伞花内脂; 茎水浸液主要是阿魏酸, 且其含量最高为73.4  $\mu\text{g/g}$ ; 叶水浸液除了阿魏酸, 其他6种物质均被检测出, 但含量较高的主要有丁香酸、伞花内脂和香豆酸。

English Summary:

Ginger (*Zingiber officinale*) is an important horticultural crop in tropical Southeast Asia. However, the main problem for ginger culture is that ginger is not suitable for continuous cropping and ginger yields are low when this species is cultivated consecutively for years on the same land and rotated with other crops for not more than three years. Ginger aqueous extract can inhibit seed germination and seedling growth of soybean and chive, it also can depress the growth of ginger seedlings. However, allelochemicals in this plant species are unclear, and the effects of ginger aqueous extracts on soil enzyme activity, soil nutrient content and microbial numbers are not well-understood. Therefore, the objectives of the paper were to (1) study the effects of rhizome, stem and leaf aqueous extracts of ginger at different concentrations (10, 20, 40 and 80 g/L) on microbe number, enzyme activities and nutrient content in the rhizosphere soil of ginger seedlings using a potted planting experiment, and (2) reveal allelochemicals in the rhizome, stem and leaf of the ginger aqueous extracts by HPLC. The results indicated that the rhizome, stem and leaf ginger aqueous extracts had different effect on six soil enzyme activities (urease, denitrifying, acid phosphatase, proteinase, polyphenol oxidase, invertase). Acid phosphatase and invertase were impacted most strongly, and significantly stimulated when the aqueous extract concentration over 10 g/L. Six soil enzyme activities increased with the concentration of the aqueous extracts. Bacterial and fungi numbers increased, while antinomycetes decreased with the concentration of the aqueous extracts of the identical ginger parts. The ginger aqueous extracts reduced soil organic matter content, and promoted  $\text{NO}_3^-$ -N accumulation in the soil. Rhizome aqueous extract had similar effects on available P, available K and  $\text{NH}_4^+$ -N in the soil, i.e., nutrient content were increased at the lower concentrations, and decreased at the higher concentration. The main allelopathic components of three types of the aqueous extracts were as follows: syringic acid and vmbelliferone were mainly contained in the rhizome extract, while frulic acid was mainly in the stem extract where whose content was the highest (73.4  $\mu\text{g/g}$ ). The other six substances were detected, except for frulic acid in the ginger aqueous extracts, but the contents of syringic acid, vmbelliferone and p-coumaric acid were relatively higher. The result suggested that allelochemicals released from the ginger deteriorated chemical and biological properties in the soils of ginger land and resulted in the continuous cropping obstacle of ginger plants. The study could benefit for the development of sustainable management in the ginger planting.

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