

专论与综述

禾草内生真菌生物碱的研究进展

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摘要 综述了国内外近20a以来在禾草内生真菌生物碱方面的研究进展。目前, 已发现至少4大类10余种生物碱与内生真菌有关。各类生物碱中典型代表物的分子结构已完全清楚, 部分内生真菌在离体条件下可产生除黑麦草碱外的生物碱, 但产碱量较其在植物体中所产生的低很多, 可相差150余倍之多。随着生物技术的发展, 美国、新西兰等国在波胺、麦角碱和loline的生物合成途径方面已有了初步的进展, 对个别具有重要功能基因以及其所编码的酶已有了深入研究。各种生物碱的致毒机理尚未完全清楚, 除饱和吡咯化合物为新陈代谢类毒素和神经性毒素外, 其余3类生物碱均为神经性毒素。生物碱可增加禾草对40余种害虫的抗性, 并可增加对某些线虫和病害的抗性。诸多因素均可影响寄主植株中生物碱的种类和浓度, 包括寄主植株: 种群和生态型, 植物品种和基因型, 植株的部位和生长期; 环境: 气候因素, 土壤养分, 季节和年度变化; 内生真菌菌株和草地管理利用方式等。用于生物碱检测的主要方法为预分离检测法和直接检测法, 其中高效液相色谱法以其分离能力强、选择性高、测定灵敏度高, 操作简单, 可在室温下进行, 应用范围极广的优点而广泛应用。目前, 国际关于禾草内生真菌生物碱研究的重点包括创造不含对家畜有毒素的有益禾草-内生真菌共生体, 开展基因工程研究以及合理利用生物碱, 使其成为新一代的“生物农药”。

关键词 内生真菌 禾草 生物碱

分类号 Q143, Q948, S154

A review of bioprotective alkaloids of grass-fungal endophyte symbioses

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Abstract Symbiotic interactions of C_3 grasses with fungal endophytes, *Epichloa* species and their asexual relatives *Neotyphodium*, often provide the grass hosts with major fitness enhancements. The endophytes protect host plants from both biotic and abiotic environmental stresses. Documented enhancements to host fitness include greater resistance to mammalian herbivores and over 40 species of insects, pathogens and nematodes. Endophyte-infected plants exhibit several morphological and physiological responses to drought stress compared with E- plants. Drought-induced leaf rolling, leaf senescence, stomatal closure, and osmotic adjustment are more prevalent in E+ than in E- plants and may be mediated through endophyte enhancement of the production of phytohormones such as abscisic acid. Endophyte-infected plants have been shown to be more productive and competitive than E- plants through improvement of germination, tillering, and biomass production per tiller. The increase in tiller production associated with endophyte infection may be due to fungal secretion of indoleacetic acid. Our understanding of the mechanisms responsible for all of these effects on improved host fitness enhancements are largely attributable to the accumulation of four groups of alkaloids: lolines, peramine, ergot alkaloids and lolitremes. The type and concentrations of alkaloids in grass-endophyte symbiotes are affected by several factors. (a) host related factors such as gene-type, population, species, tissue and growth stages of plant; (b) environmental factors, such as climate factors (e.g. temperature and precipitation), nutrients in soil, seasons changes; (c) other factors, such as fungal strains and field managements. The objective of this paper is to present the current status of knowledge on these alkaloids, focusing on their biological activities, the potential for genetically manipulating their expression in grass-endophyte symbiote, and the

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e determining methods.

Future perspectives in endophyte research, including synthesis of specific alkaloids, which can kill pest insects and are safe to livestock, genetic engineering to enhance the alkaloids production and biocontrol applications of alkaloids in agricultural and natural ecosystems are also discussed.

Key words [endophyte](#) [fungi](#) [grass](#) [alkaloids](#)

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