

农业中植物的异种作用及其生态和生理机制：综述

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【摘要】化感作用是一种常见的现象，生物体产生化学物质来影响其他生物体的生长、发育和繁殖。植物化感作用是受体植物与供体植物之间相互作用的方式之一，可能产生积极或消极的影响。化感作用的研究始于 20 世纪 70 年代，自 20 世纪 90 年代中期以来得到了迅速发展。化感作用的研究涉及生物化学物质（化感物质）的管理、生态学和农业生产。化感物质可能被用作生长调节剂、除草剂、杀虫剂和抗菌作物保护产品。本文我们回顾了农业中实施的植物化感作用管理实践以及文献中描述的潜在化感作用机制。主要内容如下：(1)描述与农业中化感作用和化感物质相关的控制实践。(2)讨论化感物质作用方式和化感作用生理机制的研究进展，包括对细胞微环境的影响。及超微结构、细胞分裂与伸长、膜透性、氧化与抗氧化系统、生长调节结构、呼吸作用、酶的合成与代谢、光合作用、矿物质离子的吸收、蛋白质和核酸的合成。(3)评估化感作用对微生物及其生态环境所施加的生态机制的影响。(4)探讨了本学科目前面临的困境及未来研究方向的思考，以期为植物化感作用的未来研究提供有益的参考。

【关键词】相生相克；生物化学物质；效应；生物体；现象

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Plant allelopathy in agriculture and its environmental and functional mechanisms: a review

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【Abstract】 Allelopathy is a common phenomenon by which organisms produced chemicals that influence the growth, development and reproduction of other organisms. Plant allelopathy is one of the modes of interaction between receptor and donor plants and may exert either positive effects or negative effects. The study of allelopathy increased in the 1970s and has undergone rapid development since the mid-1990s. The study of allelopathy deals with the management, ecology and agricultural production of biochemicals (allelochemicals). Allelochemicals can doubtlessly be used as increase regulators, herbicides, pesticides, and antimicrobial crop protection merchandise. Here we reviewed the plant allelopathy management practices carried out in agriculture and the underlying allelopathic mechanisms described within the literature. The main factors addressed are as follows: (1) Description of control practices related to allelopathy and allelochemicals in agriculture. (2) Dialogue of the progress concerning the mode of motion of allelochemicals and the physiological mechanisms of allelopathy, consisting of the influence on mobile micro- and ultra-shape, mobile division and elongation, membrane permeability, oxidative and antioxidant systems, boom law structures, respiratory, enzyme synthesis and metabolism, photosynthesis, mineral ion uptake, protein and nucleic acid synthesis. (3) Assessment of the impact of ecological mechanisms exerted by way of

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allelopathy on microorganisms and the ecological surroundings. (4) Discussion of present troubles and thought for destiny research directions in this discipline to provide a beneficial reference for destiny research on plant allelopathy.

【**Keywords**】 Allelopathy; Biochemicals; Effects; Organisms; Phenomena

1 介绍

化感作用是化学生态学的一个分支学科，研究植物或微生物产生的化学物质对自然群落或农业系统中其他植物和微生物的生长、发育和分布的影响^[1,2]。化感作用是影响植物群落中物种分布和丰富度的重要因素之一，对入侵植物的成功具有重要意义^[3,4,5,6,7]。化感作用研究是应用化感作用和化感物质为农业生产管理和生态修复提供策略的研究。

1.1 化感作用和化感物质

1937 年莫利什（Molish）首次提出了相生相克的定义。1996 年，国际化感作用学会扩大了化感作用的定义，指任何涉及植物、微生物、病毒和真菌产

生的次生代谢产物影响农业和生物系统生长发育的过程^[8]。化感物质是植物次生代谢产物，微生物分解产生的非营养物质，是植物生长调节剂的活性介质。相生相克^[8]。

1.2 种植制度安排

研究相生相克作用最重要的因素（图 1）。植物抑制杂草的能力是通过作物的化感作用和竞争作用实现的。利用作物的化感作用可以有效地控制田间杂草，并降低化感作物之间的抑制作用。建立合理的轮作和间作制度，提高土地利用率，增加土壤年产量^[9,10,11,12]。



图 1 绿豆和玉米间作，由 Abbas 等人修改^[9]

1.3 秸秆覆盖

化感作用用于控制不同类型的杂草。秸秆覆盖等化感作用应用可以实现可持续的杂草管理，并减少农业对环境的负面影响^[13,14]。化感植物作为地被植物提供了环境友好的选择^[15,16,17]。

1.4 化感品种的培育

等人^[18]所描述的方法，化感作用品种在利用化

感作用有效控制农田生态系统中的杂草方面具有巨大潜力。然而，负面影响是，高化感作用品系的谷物产量降低了 9%^[19,20]。

1.5 植物生长调节系统的作用

化感物质具有植物生长调节剂的作用，可以抑制植物的生长发育，例如种子发芽和幼苗生长。IAA 会影响内源激素水平^[21]。各种植物激素都会抑制植

物的生长、发育以及对植物发育至关重要的植物激素。

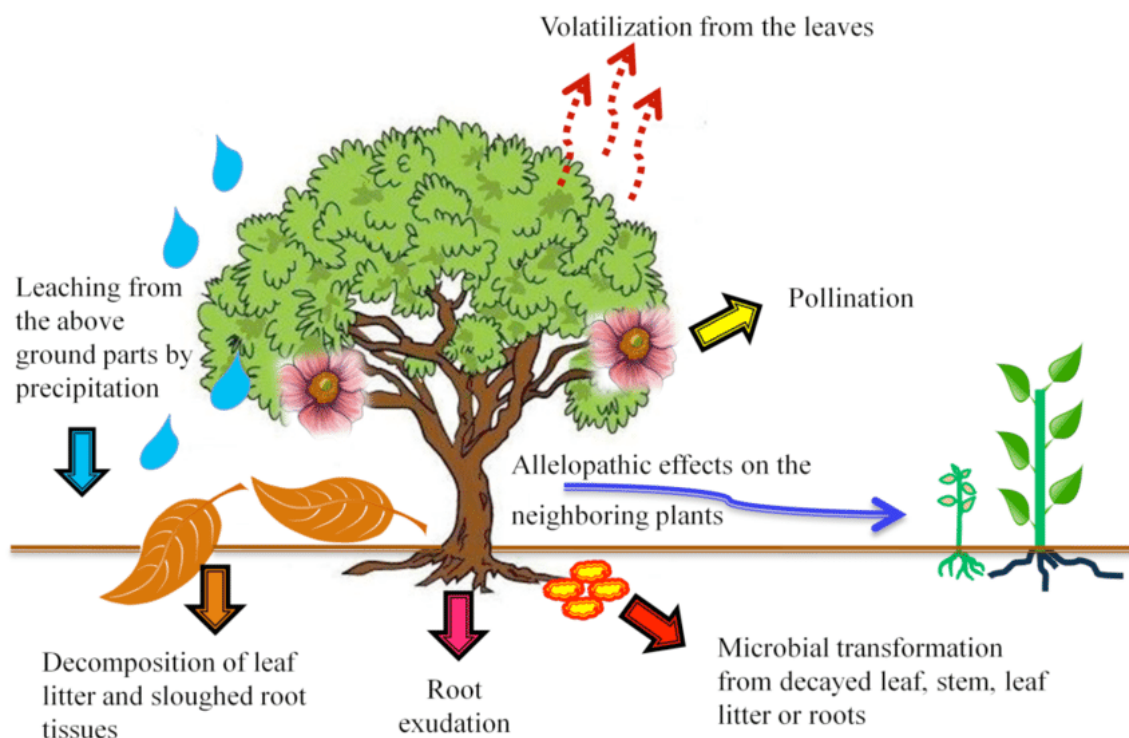
1.6 化感物质对微生物和生态环境的影响

作物生长与土壤微生物之间存在着密切的关系，这是在化感物质的应用下实现的^[21,22,23]。细菌有助于增强对不同类型化学物质的抑制作用。微生物在生态系统中释放化学物质，这些化学物质对植物与植物之间的相互作用至关重要，有助于改善植被组成，并控制生物多样性生态^[24,25]。

2 结论

自古以来，化感作用在农业中就被认识和运用，然而，它在现代农业中的普及和应用却非常有

病虫害、缓解连作障碍以及培育化感品种方面发挥着重要作用。此外，化感物质可以作为环境友好的除草剂、杀菌剂、杀虫剂和植物生长调节剂，在可持续农业中可能具有显著的价值。尽管化感物质（图2）作为环境友好型除草剂已被尝试多年，但市场上很少有源自化感物质的天然除草剂。不过，也有一些研究正在尝试使用草药产品除草剂。随着人们对自然农业和环境安全的日益重视，化感作用的研究越来越受到人们的关注，其生理和生态机制也正在逐渐被阐明。此外，相关分子机制的研究也取得了进展。显然，相生相克需要在世界范围内大力研究，以应用于农业生产。



限。化感作用在研究适宜的耕作制度、控制杂草和

图2 化感物质从 Chick 和 Kielbaso 改良的化感植物进入周围环境的可能途径^[26]

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