

【Grant-in-Aid for Specially Promoted Research】

Science and Engineering



Title of Project : Science of fairy chemicals and their application development

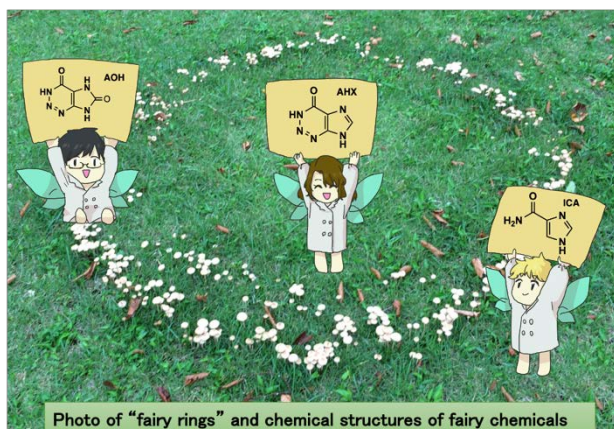
KAWAGISHI Hirokazu
(Shizuoka University, Research Institute of Green Science and Technology,
Professor)

Research Project Number: 20H05620 Researcher Number : 70183283

Keyword : fairy rings, fairy chemicals, plant hormone, mushroom, natural products chemistry

【Purpose and Background of the Research】

“Fairy rings” is a phenomenon that turfgrass grows as a ring that is more prolific or inhibited than the surrounding area, and later mushrooms develop. We discovered the two plant-growth regulators responsible for this phenomenon, 2-azahypoxanthine (AHX) and imidazole-4-carboxamide (ICA), from a fairy ring-inducing mushroom, and a metabolite of AHX, 2-aza-8-oxohypoxanthine (AOH), from rice. Subsequently, these three compounds were found to be universally endogenous in plants and significantly increased the yields of crops in field experiments. The three compounds, collectively called fairy chemicals (FCs), have been shown to be biosynthesized in the purine metabolic pathway. In this study, we will elucidate the full picture of the biosynthetic and metabolic pathways of FCs and figure out a new purine metabolic pathway common to all plants and fungi. In addition, we will elucidate the molecular mechanism of FCs activity by identifying their signaling factor(s) and receptor(s) and generating biosynthetic enzyme-deficient strains. Furthermore, we will clarify effects of FCs on crops and their mechanism of action through cultivation experiments, and create safer and more potent FCs derivatives by synthetic organic chemistry. The above studies will prove FCs as a new family of plant and fungus hormones.



- Proof of fairy chemicals as a new family of plant hormones
- Establishment of the foundation for practical application in agriculture of fairy chemicals

Figure. Overview of the project

【Research Methods】

1. Proof of FCs as a new family of plant and fungal hormones
 - 1.1. We will isolate further FCs metabolites, determine the structures, and map out the biosynthetic pathways of the compounds.
 - 1.2. We will search for and identify signaling factor(s) and receptor(s) for which FCs show biological activity. We will use strains of rice and Arabidopsis that are deficient in biosynthetic routes of the identified signaling factor(s) or receptor(s) for FCs to elucidate the signaling pathways.
2. Basic research for the practical application of FCs in agriculture
 - 2.1. We will elucidate the molecular mechanisms that FCs confer resistance to adverse environmental conditions (high temperature, low temperature, drought, high salt concentration, etc.) to plants.
 - 2.2. We will create safer and more active FCs derivatives by synthetic organic chemistry.

【Expected Research Achievements and Scientific Significance】

There are seven plant hormones (the Obunsha Biological Dictionary). If FCs is recognized as a new family of plant hormones, it will be the second plant hormone original to Japan after gibberellin. If the molecular mechanism of the yield-increasing effect of FCs on staple crops such as rice, wheat and potatoes is clarified in this study, it will pave the way for the practical application of FCs in agriculture.

【Publications Relevant to the Project】

- Choi, J-H., Kawagishi, H. *et al.*, Disclosure of the "fairy" of fairy-ring forming fungus *Lepista sordida*, *ChemBioChem*, 11, 1373-1377 (2010)
- Kawagishi, H., Fairy chemicals – a candidate for a new family of plant hormones and possibility of practical use in agriculture –, *Biosci. Biotechnol. Biochem.*, 82, 752–758 (2018)
- Kawagishi, H., Are fairy chemicals a new family of plant hormones?, *Proc. Jpn. Acad., Ser. B*, 95, 29-38 (2019).

【Term of Project】 FY2020-2024

【Budget Allocation】 474,500 Thousand Yen

【Homepage Address and Other Contact Information】

https://www.agr.shizuoka.ac.jp/abc/biochem/index_en.html
kawagishi.hirokazu@shizuoka.ac.jp