New Insights into the Role of Soil Microorganisms in Pesticide Degradation and Nitrogen Cycling in Agricultural Land

Kanako Tago (Institute for Agro-Environmental Sciences, NARO)
tago@affrc.go.jp

Agricultural activities, such as the application of insecticides and fertilizers, affect microbial populations and the way they function in the soil. Repeated applications of pesticides have been shown to induce rapid microbial degradation of the pesticide, thus reducing their efficacy. The application of large amounts of nitrogen fertilizers to agricultural fields influences nitrogen cycling, especially nitrification and denitrification, and results in environmental pollution such as nitrate leaching and the production of nitrous oxide (N_2O). The objective of this study was to reveal the diversity of soil microorganisms and their role in the degradation of insecticides and nitrogen fertilizers.

1. Dynamics of insecticide-degrading bacteria in an agricultural ecosystem

Phylogenetic and functional characteristics of soil bacteria that degrade an organophosphorus insecticide fenitrothion were investigated. The results showed that bacteria involving both complete and partial degradation of fenitrothion exist in soil. Most of the degraders were classified into the genus *Burkholderia*. Metabolism of fenitrotion and its intermediate methylhydroquinone were catalyzed by hydrolase and two oxygenases, respectively.

To understand changes in the composition of the bacterial community during insecticide degradation, population dynamics of the soil bacteria that degrade fenitrothion were examined. The population density of fenitrothion-degraders belonging to the genus *Burkholderia* increased with repeated applications of fenitrothion. The number of dominant species among the degraders declined with the increasing density of the degraders, and eventually one species predominated. This process can be explained by the competitive exclusion principle.

Some of the soil-borne fenitrothion-degrading *Burkholderia* were able to colonize the symbiotic organs of stinkbugs and make the host insects fenitrothion-resistant. The transmission process of the symbiotic degraders from soil to stinkbugs was investigated. The results showed that symbiotic degraders quickly developed in soil as a result of fenitrothion applications [1], and that plants and soils could be permanent reservoirs of these symbiotic degraders in agricultural fields exposed to fenitrothion [2].

2. Ecology of denitrifying bacteria in paddy-soybean rotation fields

It has been observed that a change of land use from rice paddy to soybean results in an increase in N_2O emissions. The phylogenetic and functional features of the denitrifiers that are active in paddy and soybean field soils were compared. The denitrifying communities were composed of phylogenetically diverse bacterial strains. The denitrifiers producing N_2O, N_2, and a mixture of N_2O and N_2 coexisted in the same soil with no relation to the phylogenetic classification or the land use [3].

References

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