Evaluating toxin effects in stressed environments: Normalization supports comparisons between species and contaminants

Aki Sinkkonen*[1] and Jeffrey Weidenhamer

[1]Department of Environmental Sciences, University of Helsinki, Finland – Department of Environmental Sciences University of Helsinki, Finland, Finland

Abstract

Current ecotoxicological laboratory techniques test toxin effects on plants in standardized laboratory conditions where other stress factors are virtually absent. It is challenging to estimate and compare how different toxins affect plants in natural environments where stress, such as resource competition is present. As multiple stressors may amplify or reduce toxin effects in the field, a method that reliably estimates changes in growth by toxin stress regardless of the level of non-toxin stress would be highly useful.

Here we utilize the density-dependence of plant response to toxins and develop a method that allows comparisons between species and toxins under competitive stress. We first normalize the biomasses at each toxin level so that mean biomass at a selected reference plant density equals to one at all toxin levels. Thereafter, we divide the real biomass at any higher plant density at a certain toxin level with the real biomass at the selected reference density at the same toxin level. This allows us to observe the relative change in plant biomass as plant density increases, i.e. in the presence of competitive stress. As an example, we normalize biomasses of lettuce and barley exposed to copper sulfate. We observe that lettuce growth is more severely inhibited than barley growth, and that the difference is hard to observe without normalization. We conclude that barley is more tolerant than lettuce under high competitive stress.

This approach may facilitate comparisons how toxins change plant growth under competitive stress, and whether the changes are similar in different plant species as competitive stress increases. Further studies are needed to investigate if toxin effects should be routinely tested at various plant densities and different species, and if upcoming ecotoxicological test standards should utilize the density-dependence of toxin effects while environmental threshold values are determined.

Keywords: modelling, competition, toxin, stress, comparisons between species

*Speaker