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Perspective

Glyphosate's Influence on *E. coli* Biofilm Development, Mutagenesis and Stress Response

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INTRODUCTION

Glyphosate is the most commonly used herbicide on the planet. There is considerable uncertainty concerning the extent of its genotoxicity and mutagenicity. Furthermore, its impact on bacterial biofilms, the primary life form of soil microbial communities, has not been thoroughly investigated. The Escherichia coli model was used to assess toxicity and mutagenicity, as well as changes in bacterial biofilm biomass, physiological activity and the number of live cells in its composition in the presence of glyphosate. Luminescent whole-cell bacterial lux-biosensors were utilized to measure damage to cellular components caused by this herbicide. The approach of rifampicin mutants was used to study changes in the level of mutagenesis.

The high inherent toxicity of glyphosate, as well as the average degree of enhanced oxidative stress and protein degradation, was demonstrated using bacterial biosensors. All pesticide concentrations tested entirely or partially suppressed the matrix and structure of the *E. coli* CDC F-50 biofilm development, as well as the metabolic activity of the bacterial cells in the biofilm. Glyphosate reduces mutagenesis at doses of 6.7 and 0.67 g/L, most likely due to general metabolic suppression, while at concentration of 0.0067 g/L, it increases mutagenesis by six times above the spontaneous level. Glyphosate's suppression of bacterial biofilm development, toxic effects on microorganisms and promotion of mutagenesis can all have detrimental ramifications for natural microbiomes.

Glyphosate (N-(phosphonomethyl) glycine) is a non-selective broad-spectrum post emergence herbicide that is widely used for weed and vegetation management around the world. This insecticide inhibits the formation of aromatic amino acids in the shikimate pathway by targeting 5-Enolpyruvylshikimate-3-Phosphate Synthase (EPSPS). EPSPS inhibition reduces secondary metabolite and protein production. Glyphosate use is on the rise. Farmers sprayed enough insecticide in 2014 to apply roughly 1 kg per hectare of arable land in the United States and around 0.53 kg/ha of all arable land worldwide.

DESCRIPTION

For a long time, glyphosate was thought to be harmless, but in 2015, new and troubling research emerged on the subject. The pesticide has been designated as "category 2a" by the International Agency for Research on Cancer (IARC), suggesting that it may cause cancer in people. Glyphosate-based herbicides have been linked to a variety of human disorders and diseases, including metabolic changes, DNA damage, kidney damage, reproductive disorders, mental disorders such as attention deficit hyperactivity disorder, Alzheimer's disease, Parkinson's disease, celiac disease, autism, effects on erythrocytes, leaky gut syndrome, non-Hodgkin's lymphoma and others.

At the same time, studies show that the herbicide is safe for human health. It is also uncertain what environmental risks glyphosate poses and the extent to which it affects the microbial ecology of agricultural soils. Glyphosate has been demonstrated to have a month long effect on the abundance of saprophytic microbial communities in soddy podzolic soils. The harmful effects of glyphosate and other herbicides on microorganisms and aquatic creatures have been documented. Furthermore, studies have shown that glyphosate presence is inversely linked with soil microbial community and microbial biomass.

The Ames test revealed that Roundup has mutagenic activity against Salmonella typhimurium. However, studies have shown that glyphosate does not promote mutagenesis in bacteria and, in fact, lowers it in *E. coli* in a dose-dependent way.

Another newly published study shows that using glyphosate at the recommended dosages has no negative effects on the activity of microbial enzymes in the soil. As a result, there are now competing perspectives on glyphosate toxicity and genotoxicity, as well as whether a specific herbicide might disrupt the soil microbial population. More study on glyphosate's biological impacts is required to resolve these difficulties.

The goal of this study was to use a variety of methodologies to investigate the toxicity of glyphosate to bacteria and its mutagenesis activity in the *E. coli* model. Glyphosate's effect on bacterial biofilm development was studied, allowing researchers to assess biomass, physiological activity and the number of living cells in the biofilm in the presence of this herbicide.

A battery of luminous whole-cell bacterial lux-biosensors was utilized to evaluate the glyphosate toxic effects and the spectrum of damage to cellular components. The rifampicin mutant approach was employed to examine the mutagenesis effect and this method allowed researchers to determine the extent of bacterial genome destabilization caused by this insecticide.

Environmental implication

Glyphosate (N-(phosphonomethyl) glycine) is a non-selective broad-spectrum herbicide that is widely used for weed management around the world. Farmers used enough pesticide in 2014 to cover all arable land on the planet with around 0.5 kg/ha. At the same time, the safety of glyphosate use has not been established.

CONCLUSION

The suppression of mutagenesis at high glyphosate concentrations is related, in our opinion, not with the drug's stabilizing effect on the bacterial genome, but with the general inhibition of cellular metabolism, as established in the current work. When bacterial cell metabolism is inhibited, DNA replication mechanisms, including trans lesion repair, are also inhibited.