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The December/January 2010 issue of The Organic & Non-GMO Report featured an interview with Robert Kremer, an adjunct professor in the Division of Plant Sciences at the University of Missouri, whose research showed negative environmental impacts caused by glyphosate, the main ingredient in Monsanto's Roundup herbicide, which is used extensively with Roundup Ready genetically modified crops.

The following interview is with another scientist, Don Huber, who recently retired from Purdue University, who has also documented negative environmental impacts from glyphosate.

The widespread use of glyphosate is causing negative impacts on soil and plants as well as possibly animal and human health. These are key findings of Don Huber, emeritus professor of plant pathology, Purdue University.

Compromise agricultural sustainability, animal and human health

In a paper published in the *European Journal of Agronomy* in October 2009, Huber and co-author G.S. Johal, from Purdue's department of botany and plant pathology, state that the widespread use of glyphosate that we see today in agriculture in the United States can 'significantly increase the severity of various plant diseases, impair plant defense to pathogens and diseases, and immobilize soil and plant nutrients rendering them unavailable for plant use.' Further, the authors state that glyphosate stimulates the growth of fungi and enhances the virulence of pathogens such as *Fusarium* and 'can have serious consequences for sustainable production of a wide range of susceptible crops.' The authors warn '*ignoring potential non-target detrimental side effects of any chemical, especially used as heavily as glyphosate, may have dire consequences for agriculture such as rendering soils infertile, crops non-productive, and plants less nutritious. To do otherwise might well compromise not only agricultural sustainability, but also the health and well-being of animals and humans.*'

Please tell me about your research with glyphosate.

Don Huber: I have been doing research on glyphosate for 20 years. I began noticing problems when I saw a consistent increase in 'take-all' (a fungal disease that impacts wheat) where glyphosate had been applied in a previous year for weed control. I tried to understand why there was an increase in disease with glyphosate.

I found that glyphosate has an effect on reducing manganese in plants, which is essential to many plant defense reactions that protect plants from disease and environmental stress. Glyphosate can immobilize plant nutrients such as manganese, copper, potassium, iron, magnesium, calcium, and zinc so they are no longer nutritionally functional.

Glyphosate kills weeds by tying up essential nutrients needed to keep plant defenses active. Glyphosate doesn't kill weeds directly but shuts down their defense mechanisms so pathogens in the soil can mobilize and kill the weeds. Glyphosate completely weakens the plant, making it susceptible to soil borne fungal pathogens.

That is one reason why we see an increase in plant diseases. Glyphosate causes plants to be more susceptible and greatly stimulates the virulence of pathogens that kill plants.

How many plant diseases are linked to glyphosate?

DH: There has been a general increase in the number of plant diseases in the last 15 to 18 years.

There are four primary soil fungi 'Fusarium, Phythium, Rhizoctonia, and Phytophthora' that become more active with the use of glyphosate.

There has been an increase in take-all, Fusarium diseases, such as head scab, Gibberella (Fusarium) in corn, Pythium, Corynespora or root rot in soybeans, crown rot in sugar beets, and bacterial and fungal diseases. Fusarium head blight (which affects cereal crops) is a disease that produces a mycotoxin that could enter the food chain.

There are more than 40 diseases reported with use of glyphosate, and that number keeps growing as people recognize the association (between glyphosate and disease).

Has research confirmed the link between glyphosate and Fusarium?

DH: There is plenty of data to show that, and it raises concerns about toxins in food.

Can you give an example of a specific crop that has been negatively impacted by glyphosate?

DH: Last summer I visited farms that had typical glyphosate damage. I received a call from a potato seed farmer in Minnesota who grows 1000 acres of seed potatoes. There was so much glyphosate in the potato tubers from a previous crop of Roundup Ready soybeans that the potatoes can't be used as seed and could not be certified.

Proponents of glyphosate say it is environmentally benign. Would you agree with that assessment?

DH: Absolutely not. That's an outright mistaken notion. Glyphosate is the single most important agronomic factor predisposing some plants to both disease and toxins. These toxins can produce a serious impact on the health of animals and humans.

Toxins produced can infect the roots and head of the plant and be transferred to the rest of the plant. The toxin levels in straw can be high enough to make cattle and pigs infertile.

In your paper you say that 'the introduction of such an intense mineral chelator as glyphosate into the food chain through accumulation in feed, forage, and food, and root exudation into ground water, could pose significant health concerns for animals and humans and needs further evaluation.' Could you elaborate on this?

DH: Micronutrients such as manganese, copper, potassium, iron, magnesium, calcium, and zinc are essential to human health. All of them can be reduced in availability by glyphosate; mineral nutrients are less in glyphosate treated plants. We are seeing a reduction in nutrient quality (in food crops).

There are also reports of allergic reactions, such as stomach lesions, produced by the Roundup Ready (genetically modified) gene.

These reactions need to be studied; there needs to be a lot more information that we don't have. This type of research has been prevented by a lack of access to information.

What other impacts do you see caused by the Roundup Ready gene?

DH: The gene will reduce micronutrient efficiency up to 50% for zinc and manganese. It's very significant unless the plant is supplemented with micronutrients. This could also account for the yield drag (reported with Roundup Ready crops).

Unfortunately, most researchers are forbidden to do work in the area. They don't have access to isogenic lines (conventional and Roundup Ready plant lines that are otherwise genetically identical); the materials are denied to researchers.

In your paper you recommend using as small a dose of glyphosate as possible. Why is this?

DH: To my knowledge we've never had this much reliance on one herbicide. It's hard to find an acre in the US that hasn't had glyphosate applied on it in the last three years.

We need to have judicious use of glyphosate and remediate the damage that it does. If we continue to abuse the use of glyphosate, it's just a matter of time before we see more serious negative ramifications. We will have increasing toxin levels (in crops), reduced nutrient values, and the direct presence of glyphosate in crops.

There are a lot of serious questions about the impacts of glyphosate that we need answers for in order to continue using this technology. I don't believe we can ignore these questions any more if we want to ensure a safe, sustainable food supply and abundant crop production.

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