Genetically Engineered Crops, Monsanto's Glyphosate and the Deterioration Of Health In America

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Abstract

A huge increase in the incidence and prevalence of chronic diseases has been reported in the United States (US) over the last 20 years. Similar increases have been seen globally. The herbicide glyphosate was introduced in 1974 and its use is accelerating with the advent of herbicide-tolerant genetically engineered (GE) crops. Evidence is mounting that glyphosate interferes with many metabolic processes in plants and animals and glyphosate residues have been detected in both. Glyphosate disrupts the endocrine system and the balance of gut bacteria, it damages DNA and is a driver of mutations that lead to cancer.

In the present study, US government databases were searched for GE crop data, glyphosate application data and disease epidemiological data. Correlation analyses were then performed on a total of 22 diseases in these time-series data sets. The Pearson correlation coefficients are highly significant (< 10-5) between glyphosate applications and hypertension (R = 0.923), stroke (R = 0.925), diabetes prevalence (R = 0.971), diabetes incidence (R = 0.935), obesity (R = 0.962), lipoprotein metabolism disorder (R = 0.973), Alzheimer's (R = 0.917), senile dementia (R = 0.994), Parkinson's (R = 0.875), multiple sclerosis (R = 0.828), autism (R = 0.989), inflammatory bowel disease (R = 0.938), intestinal infections (R = 0.974), end stage renal disease (R = 0.975), acute kidney failure (R = 0.978), cancers of the thyroid (R = 0.988), liver (R = 0.960), bladder (R = 0.981), pancreas (R = 0.918), kidney (R = 0.973) and myeloid leukaemia (R = 0.878).

The Pearson correlation coefficients are highly significant (< 10-4) between the percentage of GE corn and soy planted in the US and hypertension (R = 0.961), stroke (R = 0.983), diabetes prevalence (R = 0.983), diabetes incidence (R = 0.955), obesity (R = 0.962), lipoprotein metabolism disorder (R = 0.955), Alzheimer's (R = 0.937), Parkinson's (R = 0.952), multiple sclerosis (R = 0.876), hepatitis C (R = 0.946), end stage renal disease (R = 0.958), acute kidney failure (R = 0.967), cancers of the thyroid (R = 0.938), liver (R = 0.911), bladder (R = 0.945), pancreas (R = 0.841), kidney (R = 0.940) and myeloid leukaemia (R = 0.889). The significance and strength of the correlations show that the effects of glyphosate and GE crops on human health should be further investigated.

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Excerpts from the Introduction

Within the last 20 years there has been an alarming increase in serious illnesses in the US, along with a marked decrease in life expectancy (Bezruchka, 2012). The Centers for Disease Control and Prevention (CDC) estimates that the cost of diabetes and diabetes-related treatment was approximately $116 billion dollars in 2007. Estimated costs related to obesity were $147 billion in 2008 and cardiovascular diseases and stroke were $475.3 billion in 2009. Health care expenditures in the US totaled 2.2 trillion dollars in 2007 (CDC, 2013a). The onset of serious illness is appearing in increasingly younger cohorts. The US leads the world in the increase in deaths due to neurological diseases between 1979-81 and 2004-06 for the 55-65 age group (Pritchard et al., 2013). These mental disorder deaths are more typical of the over 65 age group. There have been similar findings for obesity, asthma, behavior and learning problems, and chronic disease in children and young adults (Van Cleave et al., 2010). Type II diabetes in youth is being called an epidemic (Rosenbloom et al., 1999). The rate of chronic disease in the entire US population has been dramatically increasing with an estimated 25% of the US population suffering from multiple chronic diseases (Autoimmunity Research Foundation, 2012). These findings suggest environmental triggers rather than genetic or age-related causes.

During this same time period, there has been an exponential increase in the amount of glyphosate applied to food crops and in the percentage of GE food crops planted (Benbrook, 2012). We undertook a study to see if correlations existed between the rise of GE crops, the associated glyphosate use and the rise in chronic disease in the US.

Genetic engineering

To genetically modify a plant for herbicide tolerance, genes are identified which convey tolerance of the active chemical in the herbicide to the organism. In the case of glyphosate, glyphosate-tolerant genes were isolated from a strain of Agrobacterium. These were inserted into the genome of the plant via a multi-step process resulting in a plant that can withstand the direct application of the herbicide. Genetic modification is also utilised for developing insect resistant plants by using insecticidal proteins from Bacillus thuringiensis, or Bt toxin. The promoter used to drive the expression of the foreign genes is generally the 35S promoter from the Cauliflower Mosaic Virus (CaMV). Not only are the virus and bacteria genes themselves potentially harmful (Ho, 2013; Ewen & Pusztai, 1999), but the plants are sprayed directly with herbicides. The herbicide-tolerant plants absorb the poisons and humans and domestic animals eat them.

The GMO industry claims that genetic engineering is no different than plant hybridisation, which has been practiced for centuries (FDA, 1992). It is the reason they gave, which the US Food and Drug Administration (FDA) accepted, for not having to submit GE food to rigorous safety testing to obtain FDA approval. This distortion of the facts needs to be corrected. One critical issue is that multiple genes are being transferred across taxonomical kingdoms in ways that do not occur by natural breeding methods (Bohn et al., 2014).

All living things are classified according to a ranking system that starts with species and sub species. Closely related species are grouped together under a rank that is called a genus. Closely related genera are grouped together under the rank of family. There are seven ranks. Starting with the highest they are: kingdom, phylum or division, class, order, family, genus, species.

Plants, animals, fungi, viruses and bacteria belong to separate kingdoms. Natural inter-breeding can take place between some species that belong to the same genus and very occasionally between species of different genera. However, species that belong to different families do not inter-breed and definitely species that belong to different kingdoms such as plants, animals, fungi, bacteria and viruses do not inter-breed in nature. Plants, for example, do not inter-breed with animals, bacteria or viruses. Genetic engineering allows for the transfer of genes between kingdoms in a way that does not occur naturally.

The other great misconception is that only one gene with the desired trait is inserted. At this stage, science is not sophisticated enough to insert a single gene and get it to work. To overcome this problem, scientists have to combine the gene with the desired trait (such as herbicide tolerance or pesticide production) with other genes that will make it work, such as promoter genes and marker genes. The result is a complex construction of transgenes that can come from bacterial, viral, fish, plant and other sources. This is completely different from natural hybridisation.

The stance taken by Monsanto, Dow, Bayer and the other purveyors of both chemicals and genetically engineered seeds is that GE food is "substantially equivalent" to non-GE products. According to the US FDA, "the substances expected to become components of food as a result of genetic modification of a plant will be the same as or substantially similar to substances commonly found in food, such as proteins, fats and oils, and carbohydrates" (FDA, 1992, Section I). The FDA maintains that it is up to the biotech companies that manufacture GE seeds to research and determine the safety of their products.

But Bohn et al. (2014) were able to discriminate between organic, conventional and GE soybeans without exception, based on vitamin, fat and protein content. Furthermore, they were able to distinguish GE soybeans from both conventional and organic by their glyphosate and AMPA (glyphosate degradation product) residues, as well as substantial non-equivalence in numerous compositional characteristics of soybeans. The researchers stated, "Using 35 different nutritional and elemental variables to characterise each soy sample, we were able to discriminate GM, conventional and organic soybeans without exception, demonstrating 'substantial non-equivalence' in compositional characteristics for 'ready-to-market' soybeans" (p. 207).

Exponentially increasing use of glyphosate world-wide

Since glyphosate was introduced in 1974 as the active ingredient in Roundup® it has become the most widely used herbicide for urban, industrial, forest and farm use (Monsanto, 2010). Pre-harvest application of glyphosate to wheat and barley as a desiccant was suggested as early as 1980, and its use as a drying or ripening agent 7-10 days before harvest has since become routine. It is now used on grain crops, rice, seeds, dried beans and peas, sugar cane and sweet potatoes (Monsanto, 2010; Orgeron, 2012; Orson & Davies, 2007). According to the Canadian Pulse Growers Association (PGA pamphlet, 2012), "Desiccants are used worldwide by growers who are producing crops that require 'drying down' to create uniformity of plant material at harvest. These products may also assist in pre- harvest weed control. In Canada, products such as diquat (Reglone) and glyphosate (Roundup) have been used as desiccants in pulse crops in the past, and there are new products on the way." In 2012, 98% of spring wheat, 99% of durum wheat and 61% of winter wheat were treated with glyphosate or glyphosate salts in the US (USDA:NASS, 2013c). The glyphosate plots in this study include all formulations of glyphosate.

Monsanto, the manufacturer of Roundup®, states, “Since its discovery in the early 1970’s the unique herbicidal active ingredient glyphosate has become the world’s most widely used herbicide because it is efficacious, economical and environmentally benign. These properties have enabled a plethora of uses which continue to expand to this day providing excellent weed control both in agricultural and non-crop uses to benefit mankind and the environment. Glyphosate has an excellent safety profile to operators, the public and the environment. … It is approved for weed control in amenity, industrial, forestry and aquatic areas. Roundup Pro Biactive and ProBiactive 450 can be used at any time of the year as long as weeds are green and actively growing” (Monsanto, 2010, p.1).

The Monsanto document outlines use areas including vegetation control on agricultural land, on GE Roundup Ready Crops and on non-agricultural land. By 2006, glyphosate became used routinely for both agricultural and non-agricultural weed control and pre-harvest treatment. Since 1995, glyphosate use has rapidly increased with the planting of GE glyphosate-tolerant crops. Glyphosate and its degradation product, aminomethylphosphonic acid (AMPA) have been detected in air (Majewski et al., 2014, Chang et al., 2011), rain (Scribner et al., 2007, Majewski, 2014), groundwater (Scribner, 2007), surface water (Chang, 2011; Scribner, 2007; Coupe et al., 2012), soil (Scribner, 2007) and sea water (Mercurio et al., 2014). These studies show that glyphosate and AMPA persist in the soil and water, and the amounts detected are increasing over time with increasing agricultural use. Chang et al. (2011) reported that glyphosate was frequently detected in water, rain and air in the Mississippi River basin with concentrations as high as 2.5 µg/L in agricultural areas in Mississippi and Iowa.

Because glyphosate is in air, water and food, humans are likely to be accumulating it in low doses over time. Glyphosate residues of up to 4.4 parts per million (ppm) have been detected in stems, leaves and beans of glyphosate-resistant soy, indicating uptake of the herbicide into plant tissue (Arregui et al., 2004). Reports from Germany of glyphosate in the urine of dairy cows (Kruger et al., 2013b), rabbits and humans (Kruger et al., 2014) ranged from 10-35 ppm. According to the study (Kruger, 2014, p. 212), “Chronically ill humans had significantly higher glyphosate residues in urine than healthy humans.” Furthermore, the cows were dissected and glyphosate residues in the tissues of the kidney, liver, lung, spleen, muscles and intestines were comparable to that found in the urine. This means that the glyphosate is not being passed through the urine without affecting the organism and that meat and dairy are an additional source of dietary glyphosate for humans.

Industry and lobbyists claim that GE crops reduce the amount of pesticides used on crops, resulting in a more sustainable agriculture. This has proved not to be the case. Since the introduction of GE seeds in 1996 the amount of glyphosate used on crops in the US has increased from 27 million pounds in 1996 to 250 million pounds in 2009 (US Geological Survey pesticide use maps, 2013). Charles Benbrook (2012) showed that there was a 527 million pound (239 million kilogram) increase in herbicide use in the United States between 1996 and 2011. Furthermore, Benbrook states that the spread of glyphosate-resistant weeds has brought about substantial increases in the number and volume of herbicides applied. This has led to genetically engineered forms of corn and soybeans tolerant of 2,4-D, which he predicts will drive herbicide usage up by approximately 50% more.

In the US, glyphosate residues allowed in food are some of the highest in the world. In July of 2013 the Environmental Protection Agency (EPA, 2013) raised the maximum allowable residues of glyphosate. An abbreviated list is provided in Table 1 and Table 2.

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