Comment on Notice of Submission:
MON 87429 corn genetically engineered for tolerance to dicamba, 2,4-D / quizalofop and glufosinate, and to have male sterility inducible by glyphosate

Submitted by the Canadian Biotechnology Action Network and Prevent Cancer Now
August 18, 2019

To the Biotechnology Notices of Submission, Canadian Food Inspection Agency

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The Canadian Biotechnology Action Network and Prevent Cancer Now are writing to object to the approval of corn MON 87429, which is genetically engineered (GE, commonly referred to as genetically modified or GM) to tolerate the herbicides dicamba, 2,4-D / quizalofop, and glufosinate, and to have male sterility inducible by glyphosate.[1]

MON 87429 would be the first genetically engineered plant with tolerance to both dicamba and 2,4-D. As such, it is a clear demonstration of the failure of herbicide-tolerant (HT) cropping systems and glyphosate-tolerant crops in particular.

The following information and analysis is provided in response to an invitation for comment on MON 87429 from the Canadian Food Inspection Agency (CFIA) via the Biotechnology Notices of Submission,[1] a process about which we have previously raised concerns.[2] This invitation to comment provides no substantive information on the product MON 87429, and the CFIA directs the public to contact the company (named as Monsanto, though now owned by Bayer) for further information. For example there is no information provided on the "2,4-D / quizalofop" herbicide tolerance and there is no 2,4-D / quizalofop combination herbicide registered in the Canadian Pest Management Regulatory Agency (PMRA) label search tool.[3]

Our objection to the approval of MON 87429 is based on evidence of the environmental, health and economic impacts of the use of HT crops, genetically engineered to withstand application of particular chemical pesticides. These impacts would be exacerbated by the use of MON 87429 and by the continued use of herbicide-tolerant cropping systems.

Summary

Our objection to the approval of MON 87429 is related to:

- the serious short- and long-term environmental, health and economic impacts of HT crops; and
- the lack of assessment of potential changes in pesticide use and related impacts.

The promise of HT technology was to decrease herbicide use.[1] Instead, HT crops have increased the use of herbicides, glyphosate in particular. This in turn has driven the wide-spread development of glyphosate-resistant weeds, increasing the quantity and variety of herbicides needed to control them.

This increased use of pesticides in food production has serious negative environmental consequences. The same pesticides are also implicated in serious health issues including cancers, chronic diseases and impairment of child development.

The GE HT technology model is breaking down. Rather than assess this failure and work to find solutions to protect the environment, our health, farmers' livelihoods and food supplies, the CFIA is permitting companies to replace failing HT crops with new HT crops that are tolerant to multiple and older herbicides, as is the case with MON 87429. The approval of such HT crops is a short-term fix that will further increase herbicide use and exacerbate the resultant economic, environmental and health risks.

Monsanto's application for approval to commercialize MON 87429 is a clear demonstration of the unsustainability of HT cropping systems.

We request a systematic review of the environmental, health, agronomic and economic impacts of the use of herbicide tolerant crops in Canada, and the development of an appropriate response to the failure of HT cropping systems. This process should include consultation with farmers and weed scientists, and experts in human and environmental health, and lead to the development of a national pesticide-reduction strategy, bringing us closer to building resilient, sustainable agriculture in the face of climate change.

Increased Use of Herbicide Tolerant Crops

The first GE crops approved in Canada (1995) were herbicide tolerant (to one of glyphosate, glufosinate, or imidazolinone). In 2012, the CFIA approved the first dicamba-tolerant and 2,4-D-tolerant crops, just now reaching the market.[2] In 2012, civil society groups Équiterre, Nature Québec, the Canadian Association of Physicians for the Environment, Prevent

[1] Monsanto's promise was that, "with the Roundup-resistant crops farmers will be able to target application more precisely and thus may use less herbicide overall." (Monsanto. Undated (prior to 1997) *Common Ground: Agriculture for a Sustainable Future*.)

[2] In 2017, Monsanto launched Roundup Ready™ Xtend™ dicamba-tolerant GE soy, which is also tolerant to glyphosate. The GE corn Enlist™ that is tolerant to 2,4-D plus glyphosate was sold by DowDupont for the first time in Canada in 2018.

Cancer Now, the Canadian Biotechnology Action Network, and Vigilance OGM raised concerns that the approval of 2,4-D-tolerant crops would lead to further increases in herbicide use, with more toxic pesticides in the environment and our food.[4]

Five GE crops are grown in Canada: corn, canola, soy, white sugar beet, and a small amount of GE alfalfa. Almost 100% of these GE crops are HT; the only exception is a few GE sweet corn varieties that are only insect-resistant. Without engaging in an overall assessment of the potential impacts of HT cropping systems, the CFIA's incremental product-by-product approval of genetically engineered HT crops over the past twenty years has led to a predominance of HT cropping systems in corn, canola, soy and sugarbeet production in Canada. These systems are reliant on patented GE HT seeds and the accompanying brand-name herbicides.

Until 2016, the global market for GE crops was dominated by six companies – Monsanto, Dupont, Syngenta, Dow, Bayer and BASF – that, together, controlled around 75% of the global pesticide market and 62% of the commercial seed market. After a series of mergers, these markets are now controlled by just four companies: Bayer bought Monsanto, Dow and Dupont merged (and created Corteva), ChemChina bought Syngenta, and some of Bayer's and Monsanto's business was sold to BASF. Pesticide and GE seed sales are closely integrated for these companies, and investments in the HT cropping model prioritize the continued or increased sale of both herbicides and GE seeds.

In order to manage the spread of glyphosate resistant weeds, and in the absence of new herbicide products with new modes of action, seed and pesticide companies have genetically engineered HT crops that are tolerant to multiple herbicides. The CFIA lists 76 stacked-trait plants: most are corn and soy, and all have at least one trait for herbicide-tolerance. **MON 87429 is the first HT crop that is genetically engineered to tolerate both 2,4-D and dicamba, both of which mimic plant growth hormone (auxin).**

"Although HR-trait stacking offers growers increased flexibility to manage HR [herbicide resistant] weeds, the consensus of weed science academics is that this solution is not sustainable in the long-term with current practices and will inevitably lead to increased incidence of multiple-HR populations." – Beckie et al., 2019[5]

Increased Use of Herbicides

Herbicide-tolerant crops were introduced with the promise of creating a more efficient system for herbicide application, and hence reducing total herbicide use. While this was true for many farmers in the first few years of growing GE crops, this trend quickly reversed.[6]

Herbicide sales (kilograms [kg] active ingredients) in Canada have increased by 199% during the first two decades of genetically engineered herbicide-tolerant crops (1994-2016).[7] The use of the flagship herbicide for GE crops, glyphosate, tripled in Canada between 2005 and 2011.[8] As of 2016 (the most recent Health Canada sales report),[9] glyphosate is the top herbicide ingredient sold in Canada (>25 million kg), followed by glufosinate-ammonium and 2,4-D (>1,000,000 kg each), dicamba (>100,000 kg) and quizalofop (>50,000 kg).

In 2012, the Environmental Commissioner of Ontario noted that the adoption of GE crops has resulted in "a huge increase in the application of glyphosate to agricultural soils" [10] and expressed concern over the impacts of herbicide-tolerant weeds, and the long-term sustainability of the partnership of genetically engineered crops and glyphosate-based herbicides. In regards to the requests to commercialize 2,4-D-tolerant crops, the Commissioner stated, "If these new GM plants are approved in Canada, Ontario may see a lot more 2,4-D applied to agricultural fields in years to come."[11]

Spread of herbicide-resistant weeds

The widespread and frequent use of certain herbicides has led to the spread of weeds that are resistant to those herbicides. Six glyphosate resistant weed biotypes now exist in Canada, and one or more of these is growing in five Canadian provinces.

Introducing 2,4-D- and dicamba-tolerant crops will lead to more weeds becoming resistant to herbicides with these modes of action. According to Canadian scientists Hugh Beckie and Linda Hall, "Cultivars with stacked-HR [HT] traits (e.g., glyphosate, glufosinate, dicamba or 2,4-D) will provide a short-term respite from HR weeds, but will perpetuate the chemical treadmill and selection of multiple-HR weeds."[12] Twenty-three weeds around the world are already resistant to 2,4-D, including two in Canada,[13] and 2,4-D-resistant waterhemp has now been reported in the US.

In summaries of past decisions, the CFIA has identified their evaluation of "herbicide tolerance stewardship plans" from Monsanto as the means to address the issues of increased selection pressure for herbicide resistant weed populations and the appearance of HT volunteers. These plans have not succeeded, as evidenced by the prevalence of glyphosate resistant weeds and Bayer's request to approve MON 87429 that is tolerant to multiple non-glyphosate pesticides. Corporate stewardship plans were not adequate to prevent the spread and development of glyphosate resistant weeds and will not be an adequate strategy to manage the risks associated with the use of crops that are tolerant to dicamba and 2,4-D (and 2-4,D / quizalofop).

Economic impacts

Farmers are facing increasing costs of managing herbicide resistant weeds and volunteer HT crop plants. The economic impacts were made clear when, in 2010, Monsanto began offering rebates to farmers when Monsanto's glyphosate formulation failed to kill weeds.

DowDupont is now warning that weeds with resistance to multiple herbicides may prevent some farmers from growing certain crops altogether.[14] As discussed by Beckie et al., "An increasing number of growers are now facing the prospect of changing crops or crop rotations to manage their HR weeds with remaining effective herbicides." [15] Additionally, for example, volunteer glyphosate-resistant canola is a limiting factor on soybean expansion in Saskatchewan.[16]

The use of dicamba on GE dicamba-tolerant soybean varieties in the US has led to widespread crop damage from herbicide drift. The US experience with dicamba-tolerant soy

should be closely examined in relation to management strategies in Canadian corn producing areas that may mitigate or duplicate such issues. Damage to crops in neighbouring GE soybean fields has reportedly led some US farmers to buy GE dicamba-tolerant seeds as a strategy to protect their crops.[17]

Environmental and health impacts

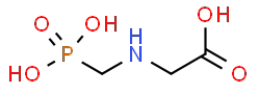
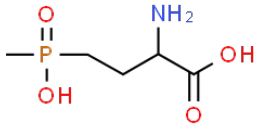
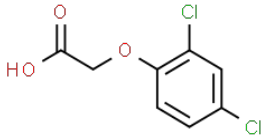
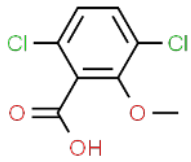
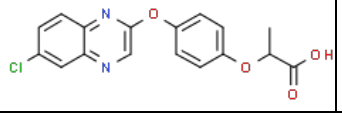
Toxicity considerations are limited to the toxicity and allergenicity of the expressed genetic components in the resulting food. The toxicity of increased pesticide use, and potential synergism among multiple herbicides (in the case of MON 87429, the four or five pesticide active ingredients) are not considered.

The use of tank mixes of multiple herbicides to control resistant weeds also poses risks. For example, dicamba volatility is greatly increased at lower (acid) pH; glyphosate formulations may be fairly acidic and increase volatilization.[18] As well, pesticide assessments cover single chemicals, but not additive or synergistic effects of tank mixes, including adjuvants.

The extent to which the environmental impacts of potential changes in herbicide use are assessed by the CFIA in GE product evaluations is unknown, but appears to be limited. The Notice of Submission information on MON 87429 states that, "To allow the CFIA to assess the environmental impact, Monsanto submitted information (confidential business information) describing: Examination for potential weediness; Examination of seed yield; Examination of phenotypic characteristics; Examination of seed dormancy and germination; Examination of the response to biotic and abiotic stressors; Examination of plant pest potential." These criteria do not include explicit assessment of changes in pesticide use and their impacts. The extent of consideration of pesticide impacts is unknown because the regulatory decision-making process is confidential and is based on confidential business information submitted by the company. While consideration of volunteer herbicide-resistant weeds and the development of herbicide resistance is mentioned in CFIA summaries of past decisions to approve HT crops (Decision Documents), no in-depth analysis or long-term, systematic evaluation appears to have been undertaken.

Chemistry and brief scientific comments on some health and environmental issues relating to the use of the relevant herbicides are summarized in Table 1. Numerous bio-effects occur beyond killing target plants. One aspect that is not captured in federal government pesticide assessment is effects on the endocrine system – blocking or mimicking hormone actions. These mechanisms result in many adverse outcomes, including early developmental harms, metabolic disorders, chronic diseases and cancers. Dicamba, 2,4-D and quizalofop are chlorinated pesticides with aromatic ring structures (both features flag potential toxicity), and are older than the phosphorus-containing glyphosate and glufosinate. Research has shown 2,4-D to be an endocrine disruptor, and that 2,4-D can be persuasively linked to cancers, neurological impairment and reproductive problems, and may affect the immune system.[19]

Table 1. Herbicide chemistry and effects

Herbicide	**Chemical Group** (from omafra.gov.on.ca)	**Mode of Action** (from omafra.gov.on.ca)	**Chemical Structure** (from chemspider.com)	**Comments**
Glyphosate	phosphonic / phosphinic acids	Aromatic amino acid Synthesis Inhibitor (Group 9)		Enzyme pathway also inhibited in bacteria, leading to gut dysbiosis. Soil microbial communities also changed. Glyphosate is linked with cancer, inflammatory bowel disease, and shortened pregnancy / premature birth. Endocrine effects* include: thyroid, aromatase (sex hormones and ovarian function), and retinoic acid signaling (birth defects).
Glufosinate		Cell Membrane Disrupter (Contact Herbicide, Group 10) Glutamine amino acid synthesis inhibitor		Causes acute damage to skin, airways, etc. Glyphosate and glufosinate metabolites can provide phosphate for plant growth and algal blooms.
2,4-D 2,4-dichlorophenoxy-acetic acid	phenoxy acid ester	Auxinic Herbicide (Growth Regulator, Group 4) Mimics plant growth hormone “auxin” so plant grows very quickly and exhausts resources.		2,4-D is plausibly linked with cancer, neurological impairment and reproductive problems. Chlorinated dioxins (endocrine disrupting persistent toxicants) are formed during industrial production.
Dicamba	benzoic acid derivative			Endocrine disruption*: human hypothyroidism; murine developmental toxicity; alters mRNA expression in minnow at environmentally relevant levels.
Quizalofop	aryloxyphenoxyl	Lipid Synthesis (ACCase) Inhibitor (Class 1) Specific to grasses.		Limited endocrine related research*. Estrogenic activity in zebrafish.
Surfactant blend	Adjuvant mixture to improve spreading and penetration of active ingredient. May also have some contact herbicide activity.		Common adjuvants include both surfactant and petroleum distillates. These irritate respiratory tract, and may include carcinogenic compounds such as benzene or naphthalene. Adjuvants are synergistic with pesticidal ingredients both to kill plants and for harmful bio-effects.	

* The Endocrine Exchange (www.TEDX.org), initiated by Dr. Theo Colborne, has reviewed and compiled peer-reviewed scientific research indicating endocrine effects of a large number of chemicals. The search function leads directly to relevant chemical-specific literature.

Other

In addition to the herbicide tolerant traits, MON 87429 has a "glyphosate inducible male sterility" trait that incorporates glyphosate use into hybrid seed production. The Notice of Submission contains no details about the mechanisms for creating this inducible male sterility; however, a paper by Monsanto (Yang et al., 2018) describes a "second-generation Roundup Hybridization System" (RHS2) that uses glyphosate to induce male sterility.[20] The trait (RHS1) whereby the male reproductive tissues are not tolerant to glyphosate and the application of glyphosate during the tassel development stages thereby produces a male sterile phenotype – was approved by the CFIA in MON 87247, in 2013. It is used to reduce or eliminate the need for detasseling during the production of hybrid corn seed. This is one more reliance on pesticide applications that should be avoided in an effort to decrease pesticide use.

Conclusion

"The vision for the future of HR weed management globally should center on reduced herbicide dependency, especially glyphosate."[21] – Beckie et al., 2019

The request to approve MON 87429 is a clear demonstration of the failure of the herbicide-tolerant cropping system introduced twenty years ago by Monsanto, Bayer and other companies. The introduction of new GE herbicide-tolerant crops will repeat and deepen the cycle of increasing herbicide use and the evolution of resistant weeds in a "pesticide treadmill". This treadmill needs to be addressed rather than further fuelled by the approval of more (stacked) HT crops.

The Canadian Biotechnology Action Network and Prevent Cancer Now therefore request a systematic review of the environmental, health and agronomic/economic impacts of the use of herbicide-tolerant crops in Canada, and the development of an appropriate response to the failure of HT cropping systems. This process should include consultation with farmers and weed scientists, and experts in human and environmental health, and lead to development of a national pesticide-reduction strategy, bringing us closer to building resilient, sustainable agriculture in the face of climate change.

We ask the federal government to:

- Initiate a broad a systematic assessment of the uses and impacts of herbicide-tolerant crops and associated pesticides in Canada;
- Reform GE plant/animal assessments to include long-term, systematic environmental impacts and related human health impacts, and economic impacts;
- Establish a system to monitor which GE crops and animals are on the market, including through the mandatory labelling of all GE foods;
- Mandate the Pest Management Regulatory Agency to track and publish annually, pesticide use nationally, on a regional scale;
- Mandate Statistics Canada to track plantings of all GE crops and production of GE animals, including where and how much of each GE crop/trait is planted;
- Develop a national strategy for pesticide reduction;

- Work with farmers and their organisations as well as with civil society organisations to develop a strategy for a just transition to sustainable agriculture (agroecology).

Contacts

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The Canadian Biotechnology Action Network (CBAN) brings together 16 groups to research, monitor and raise awareness about issues relating to genetic engineering in food and farming. CBAN members include farmer associations, environmental and social justice organizations, and regional coalitions of grassroots groups. CBAN is a project on the shared platform of Tides Canada. www.cban.ca

Prevent Cancer Now is a civil society organization including scientists and medical and health practitioners, that aims to stop cancer before it starts, by eliminating preventable exposures to contributors to cancer. www.preventcancernow.ca

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