Welcome to the 15th Annual

Pesticides and the Chesapeake Bay Watershed Project Conference

Session 1
Glyphosate Resistant Weeds and the Pesticide Treadmill: From Jog to Sprint

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Glyphosate Resistant Weeds and the Pesticide Treadmill:

From a Jog to a Sprint

Nathan Donley, Ph.D.
Center for Biological Diversity
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Glyphosate – From Wonderchild to What!?

- Initially developed in the 1970’s, glyphosate quickly became Monsanto’s flagship product: Roundup.
- But it wasn’t until the mid-1990s that it became the most widely-used pesticide in the USA.
- This coincided with the development of genetically engineered corn, cotton and soy that were resistant to Roundup.
- Adoption was quick and allowed for glyphosate to be used regularly throughout the year.
- In 2015, the WHO’s cancer research arm found glyphosate to be a probable carcinogen.
- Bayer is drowning in tort litigation and recently decided to phase out glyphosate use in the residential sector by 2023.

USGS Pesticide National Synthesis Project
Glyphosate Resistance in a Nutshell

- Glyphosate’s downfall is not just due to cancer – decades of irresponsible overuse has led to loss of effectiveness against many weeds

- Resistance is just evolution in action

- Glyphosate resistant weeds are thought to be present on well over 100 million acres of farmland
This Ain’t your Daddy’s Pesticide Treadmill: Version 2.0

• The term “pesticide treadmill” was coined in the 1970’s and was historically used to describe the phenomenon of replacing a pesticide with another one when it doesn’t work anymore. Common with insecticides targeting one species or a few similar species, like mosquitos

• But most herbicides don’t target just one species, they are killing many species of weeds. i.e. glyphosate still has utility

• So now the pesticide treadmill has evolved from replacing pesticides to combining pesticides – this is now the recommended approach to combat resistance

• This is being driven in large part through the same mechanism that led to glyphosate’s rise – genetic engineering

• “The only corn worse than candy corn” MON 87429 corn - glyphosate, dicamba, 2,4-D, quizalofop, and glufosinate resistant currently under consideration

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<thead>
<tr>
<th>Crop</th>
<th>Glyphosate</th>
<th>Glufosinate</th>
<th>Dicamba</th>
<th>2,4-D</th>
<th>Acetolactate Inhibitor</th>
<th>Acetohydroxyacid Inhibitor</th>
<th>Phosphoenolpyruvate Carboxylase Inhibitor</th>
<th>Phosphoenolpyruvate (PEPC)</th>
<th>Choline Oxidase (CCOX)</th>
<th>Bromoxynil</th>
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*Approval Pending
By Individual herbicide or (class)

Donley, N. 2017
Here’s What’s Happening Now

Not only are alternatives to glyphosate increasing now, but many did not decrease while glyphosate was increasing - this was the selling point of Roundup Ready

- Glyphosate
- Acetochlor
- 2,4-D
- Dicamba
- Mesotrione
- Paraqua
- Metolachlor-S
- Fomesafen
- Atrazin

USGS Pesticide National Synthesis Project
Maryland-Specific Data are Hard to Come by, National Trends are Not Good

- To the extent that MD follows these national trends, total herbicide load in the environment is on the rise

Rise/run = 7 million lbs per year
Rise/run = 5 million lbs per year
Rise/run = 700,000 lbs per year

Data from Hygeia Analytics Pesticide Use Database – Compilation of USDA survey data
I’d Rather be Lost…

- We had a figurative fork in the road in the early 2010s. The pesticide industry dangled an apple and we followed.

- For better or for worse, this is the path we’re on – short-term fix followed by short-term fix until we run out of short-term fixes.

- Two Trends Are Starting to Emerge on Our Path
  - Easier path that leads to a whole lot of suffering
  - Tougher path that leads to a new horizon

YOU CHOSE...
POORLY

Older herbicides are being repurposed and rebranded
New herbicides are being approved
Meet the New Brand, Same as the Old Brand

Atrazine/Simazine –
• Good news = probably won’t increase in Ag, many non-Ag uses cancelled
• Bad news = probably won’t decrease in Ag, re-registration was inconsequential
• Shiny new thing = Acuron

2,4-D –
• Good News = Choline less likely to contaminate water than ester
• Bad news = very toxic to aquatic organisms and presence will likely increase in Bay
• Shiny new thing = Enlist Duo

Dicamba –
• Good news = nope
• Bad news = Use increasing dramatically, vast terrestrial harm expected
• Shiny new thing = Xtendimax

Paraquat –
• Good news = nope
• Bad news = Use increasing dramatically on soy, re-registration was inconsequential
• Shiny new thing = nope, not enough window dressing in the world
We’re Fluorinating Everything Else, Why Not Pesticides?

• Fluorinated pesticides (some of which are considered PFAS) accounted for only 9% of pesticide active ingredients in the year 2000

• Now they account for 70% of pesticides approved since 2015 (Alexandrino et al., 2021)

• These new pesticides range from slightly to very persistent. The ones that metabolize relatively quickly will break down into other fluorinated molecules that can last indefinitely

• Whatever is put into our environment today will persist in one form or another for decades or longer

New Herbicides Containing Carbon-Fluorine Bonds

Bicyclopyrone (C-F=3)
Halauxifen-methyl (C-F=1)
Pyroxasulfone (C-F=5)
Saflufenacil (C-F=4)
Tiafenacil (C-F=3)
Trifludimoxazin (C-F=3)

• Good news is that these tend to be lipophilic (less likely to contaminate water) and less toxic than older herbicides, but a lot of unknowns still
How Will This Affect the Chesapeake Bay Watershed?

• Herbicide use is increasing – just how much we don’t know. Things are in a major state of flux right now and it’s unclear where the ceiling is.

• The name of the game is mixtures (as it has been for some time). Unfortunately this introduces many unknowns and that uncertainty cannot be overcome. Regulatory scrutiny of mixtures is non-existent (albeit very difficult).

• As herbicides stop working, expect more tilling and sediment loading.

“There will be weeds that can’t be killed by any chemical herbicides in our lifetime – we can start transitioning now and make it easier or do it the hard way.” – Bob Hartzler, weed scientist at Iowa State University

“Now we’re going downhill, and that’s why we’re in such a big moment of change. In not very many things in our lives do we go backward. In weed management, we are going backward. And that’s very hard to accept.” – Bob Hartzler, weed scientist at Iowa State University