PESTICIDE ACTION NETWORK UK

GM FREEZE the campaign on GM food, crops and patents

# GM Herbicide Tolerant Crops – Less Equals More

*Herbicides needed to support glyphosate and combat resistant weeds: Dicamba*

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The rapid increase in the number of, and area affected by, weeds with resistance to glyphosate (sold as Monsanto's Roundup) in the US and South America has lead to recommendations that farmers should use other herbicides to control weeds in GM crops tolerant to the herbicide (known as or Roundup Ready, or RR, crops).

One such chemical is Dicamba.

Monsanto and BASF are seeking US approval for GM soybeans with tolerance of two herbicides (glyphosate plus dicamba). This has proved necessary because of widespread and escalating weed resistance to glyphosate, which has been used for a number of years on RR GM maize, cotton and soya. To slow the development of further resistance in weeds, glyphosate and dicamba will either be sprayed as a mixture so that weeds not killed by glyphosate will be killed by dicamba, or the two herbicides will be used in rotation on alternate crops.

This increased use of all chemical weedkillers should put the final nail in the coffin of Monsanto's claim that RR crops would lead to cheaper, easier and safer weed control and demonstrate that on the contrary RR crops are now another proven staging post in the pesticides "arms race" that began in the 1940s.

## What is dicamba?

Dicamba is a benzoic acid used as a systemic broadleaf weedkiller that mimics auxins (a class of plant hormones) in a way that is similar to the more well-known herbicide 2,4-D (see companion briefing from GM Freeze for more on 2,4-D).

## Dicamba and glyphosate mixtures

The use of dicamba and glyphosate on GM herbicide tolerant crops is not the first time the two herbicides have been used in combination. The chemical combination was previously marketed in the US in Monsanto's Fallow Master, a post emergence herbicide used in zero tillage systems.[i]

## Current uses for dicamba

Dicamba is used for broadleaf weed control in lawns and as a brushwood killer, often in combination with 2,4-D and MCPA (both hormone weed killers). A common brand name in the US for products containing dicamba or its dimethylamine salt is Tremec (manufactured by PBI/Gordon Corporation).

Dicamba is also used on arable crops including maize and cotton. In 2010 nearly 410,000kg of dicamba herbicides were used on maize crops and 76,000kg on cotton.[ii] In contrast over 29,000,000kg of glyphosate-based products were used on maize and 6,800,000kg on upland cotton. Most dicamba was applied to pastureland (nearly 45% or 1,520,000kg) to kill broadleaved plants.

In the UK dicamba is used on cereals and grassland, although its use has declined since the 1980s.[iii]

## Dicamba resistance

Weed resistance to dicamba is already developing in the US and New Zealand.[iv and v] The most

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recent occurrence of dicamba resistance was reported in 2010 in Nebraska in *Kochia scoparia* in maize. The next year *Kochia* weeds resistant to glyphosate were reported in maize and soya in the same State.[vi] From these two incidents it would seem that *Kochia* weeds with resistance to both dicamba and glyphostate will appear before too long. One study of *Kochia* weed after harvest found each plant produced over 4,000 seeds[vii] in a single month, demonstrating its massive capacity to spread herbicide-resistant individuals throughout the weed population.

## Contaminants of dicamba

The manufacturing process for dicamba results in the final product being contaminated with the dioxin 2,7-dichlorodibenzo-p-dioxin (dioxins are breakdown and by-products from synthetic chemicals production and are recognised as some of the most toxic compounds in the world). Although not as toxic as its chemical cousin 2,3,7,8-TCDD, this dioxin has been found to cause leukaemia, lymphoma and liver cancer in male mice although not in female mice or rats.[viii]

## Health concerns about dicamba

Dicamba is linked to a variety of health problems. Table 1 summarises human health concerns related to dicamba hazards.

**Table 1 Human health concerns for dicamba**

| General human health issues | Occupational exposure issues |
|---|---|
| Harmful if swallowed.<br>Possible liver toxicant.<br>Possible carcinogen.<br>Possible reproductive or development effects. | Irritant to skin and eyes. |

*Source: Compiled from the Pesticide Properties Database (known as FOOTPRINT) maintained by University of Hertfordshire as a readily accessible summary source of data for users in the EU.*

*Mutagenicity*

There is evidence that dicamba can cause mutations in rat livers, human blood cell cultures, bacteria, plants and Chinese hamster ovaries.[ix] It can cause cellular and DNA damage.[x]

*Carcinogenicity*

Dicamba has not been classified as to its carcinogenicity, but some studies have linked it to Non-Hodgkins Lymphoma.[xi]

## Environmental concerns

Table 2 summarises ecotoxicological rankings of moderate or high concern related to dicamba hazards to wildlife.

**Table 2 Ecotoxicological concerns for dicamba**

| Mammalian hazard rankings | Other wildlife hazard rankings |
|---|---|
| Moderate for short-term dietary intake. | Bees (oral): Moderate<br>Earthworms: Moderate<br>Aquatic invertebrates: Moderate<br>Fish: Moderate<br>Birds: Moderate |

*Source: compiled from Pesticide Properties Database.*

*Dicamba in water*

Dicamba is very soluble in water compared to glyphosate (250,000mg/l compared to 10,500mg/l). Therefore dicamba is highly mobile in soil water and is regularly found as a contaminant of surface and groundwater. Contamination of water can also occur because of aerial movement due to spray drift or evaporation after being sprayed. In a survey published in 2001 dicamba was present in 28% of samples taken from 14 catchments across the USA with concentrations up to 3.77µg/l.[xii]

In Canada 2% of groundwater samples were contaminated with up to 517µg/l of dicamba in 1993.[xiii] Groundwater in the northern plains of Canada also had dicamba present in 2007.[xiv]

Rainfall or irrigation soon after spraying can accelerate the movement of dicamba into groundwater.

*Fungal Diseases in Crops*
There is evidence that dicamba used with another hormone weedkiller, MCPA, can increase the incidence of "take-all", a fungal disease of cereals crops, reducing shoot growth by up to 28%.[xv] Dicamba has also been linked to an increase in leaf spot (*Bipolaris sorokiniana)*, another disease of cereals.[xvi]

*Non-target plants and pollinators*
Dicamba can drift during spraying or re-evaporate from leaves, damaging neighbouring crops and non-target plants growing in margins of field or nature reserves. Reduction of flowering plant abundance and diversity in farmland areas through herbicide spraying or drift can negatively affect honeybees and other pollinators that rely on a variety of flowers for pollen and nectar sources.[xvii]

## Conclusion

Reliance on dicamba for weed control in GM herbicide tolerant crops will only serve to escalate the exposure of workers, people and the environment. It will add to the complexity and costs of weed control for farmers and will eventually lead to more resistance in weed populations. This model of arable crops production is flawed and is now failing.

Integrated Weed Management can greatly reduce dependency on chemical weed control without using GM crops and can provide an important transitional step to agroecological methods of weed management based on crop rotations, break crops, grazing, mechanical weed control and mulches. Such approaches provide safer alternatives and deal with all types of weed – herbicide resistant or not.

## Notes

[i] See product label (pdf available here)
[ii] USDA National Agricultural Statistics Survey. National Agricultural Statistics Service
[iii] Defra. FERA Pesticide Usage Survey Reports
[iv] Heap, I, 30 April 2012. The International Survey of Herbicide Resistant Weeds
[v] Rahman A, James TK and Trolove MR, 2008. "Chemical control options for the Dicamba resistant biotype of fathen (chenopodium album)". *New Zealand Plant Protection* 61: 287-291
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[xiv] Donald DB, Cessna AJ, Sverko E, and Glozier NE, 2007. "Pesticides in surface drinking-water supplies of the northern Great Plains". *Environmental Health Perspectives* 115:1183-91

[xv] Rovira AD, Neate SM and Warren RA, 1993. "The effect of MCPA and dicamba on take-all disease and the growth of wheat seedlings". *Farming - From Paddock to Plate*. Edited by GK McDonald and WD Bellotti. Proceedings of the 7th Australian Agronomy Conference, 19-24 September 1993, The University of Adelaide, Adelaide, South Australia

[xvi] Hodges, CF, 1992. "Vegetative growth and sporulation of *Bipolaris sorokiniana* on infected leaves of *Poa pratensis* exposed to postemergence herbicides". *Canadian Journal of Botany* 70:568-570

[xvii] Spivak M, Mader E, Vaughan M and Eulis NH, 2011. "The Plight of the Bees". *Environmental Science & Technology* 45 34-38.