

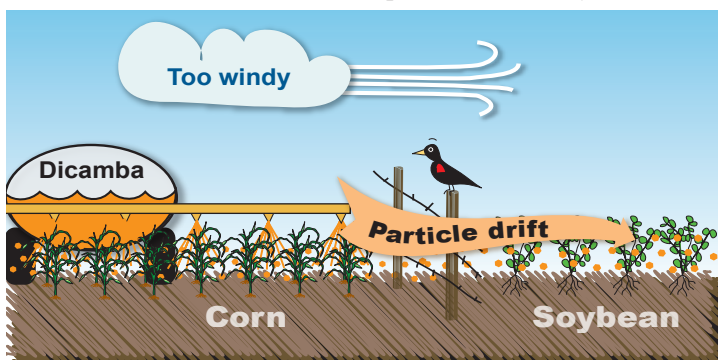
# Dicamba injury to soybeans

Every year a small percentage of Wisconsin's soybean fields show injury symptoms generally described as "leaf puckering." Many factors can cause leaf puckering. Some causes are soybean aphids, plant viruses, and injury from growth regulator herbicides like dicamba. A number of commonly used corn herbicides contain dicamba including Banvel, Celebrity Plus, Clarity, Distinct, Marksman, NorthStar, Sterling, and Yukon. Three common ways that dicamba can reach a soybean field are as spray particle drift, vapor movement, or by a contaminated sprayer.

Investigations of soybean leaf puckering have often found the injury was caused by dicamba. Clearly, dicamba is not a soybean herbicide. However, it is found in many herbicides applied to corn fields, which may be near soybean fields.

## Spray Drift

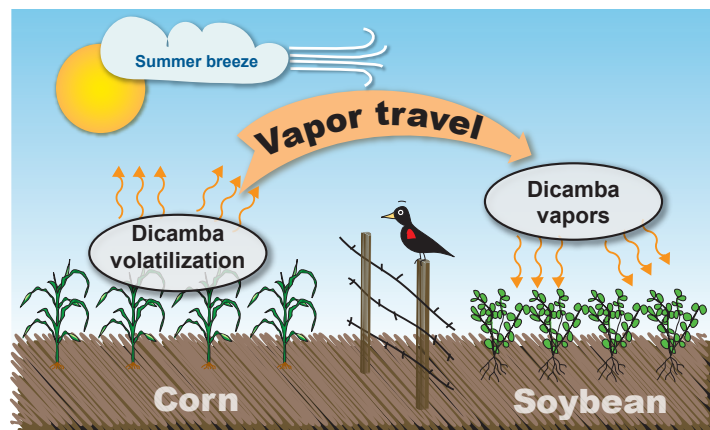
An important source of dicamba movement to soybean is spray particle drift. Droplet size plays a major role in particle drift. Small droplets take longer to reach the ground, increasing their susceptibility to drift. For example, a droplet from a fine spray (100 microns) takes 10 seconds to fall 10 feet whereas a droplet from a coarse spray (400 microns) takes only 2 seconds. Add a 3 mph wind, and the fine droplet will drift 44 feet while the coarse droplet will drift only 9 feet.



The Spray Drift Task Force reported that drift from 8004 flat fan nozzles at a 20 inch height with 40 psi and an 8 mph wind was about 0.5% at 25 ft, 0.2% at 100 ft, and 0.125% at 200 ft. This level of drift may not be noticeable with many herbicides, but dicamba drift at any of these levels can cause soybean injury. In the studies, drift was greatly increased with higher boom heights or smaller droplet sizes. It is impossible to eliminate tiny drift-prone droplets, but they can be minimized with proper application techniques for correct boom height, spray pressure and nozzle selection.

## Dicamba Vapors

A second source of dicamba movement from corn fields is when dicamba volatilizes to a vapor. All dicamba formulations volatilize, but some volatilize more than others. For example, in a study where field corn was sprayed to test



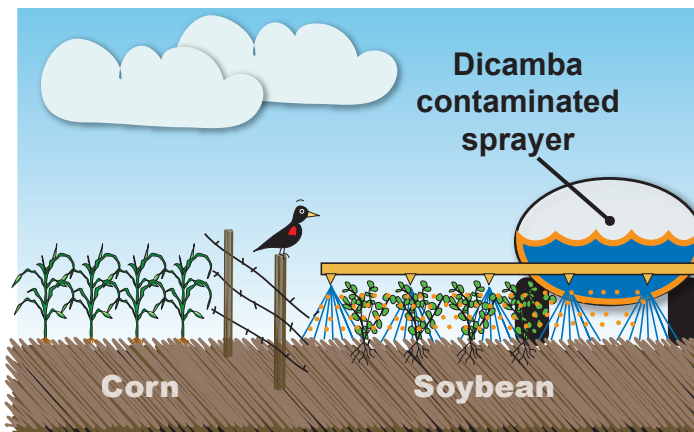
dicamba volatility, the dimethylamine salt of dicamba (formulation used in Banvel) injured adjacent soybeans about twice as much as when the sodium salt of dicamba (formulation used in NorthStar).

Weather conditions play an important role in increasing or decreasing volatilization. For example, volatilization and the potential for vapor movement increases at high temperatures and low relative humidity. However, as little as 0.04 inch of rainfall can dramatically decrease volatilization by washing dicamba off corn and weed leaves and onto the soil where it is less likely to volatilize. Overall, the potential for dicamba vapor movement is greatest under hot, dry conditions during and after the application.

## Contaminated Spray

The third source of dicamba movement to soybeans is contaminated spray. This may occur from a contaminated spray tank, make-up water or nurse tank, transfer hoses, measuring containers, screens with residues, or re-used jugs. It has been reported that as little as 0.01% contamination with dicamba can cause minor leaf puckering on soybean. To illustrate how small this amount is, consider a 500 gallon spray tank that applied Clarity at 1 pt/a. If 6.4 oz (3/4 cup) of this spray

*(continued on back page)*



# Dicamba injury Symptoms

Dicamba symptoms appear on the soybean leaves that grow after the exposure occurs. As a result, symptoms are often not noticed for 7 to 14 days. Fully developed leaves on the plant typically do not exhibit symptoms. Usually, the next four leaves that develop after exposure are injured the most. Then, most of the final leaves grow to near full size.

On Fig. 1, trifoliolate leaves 1-2 had grown before being exposed and are not injured. Trifoliolate leaves 3-6 grew after the exposure and are injured. Leaves developing after the 6th trifoliolate should be close to normal size and shape (7).

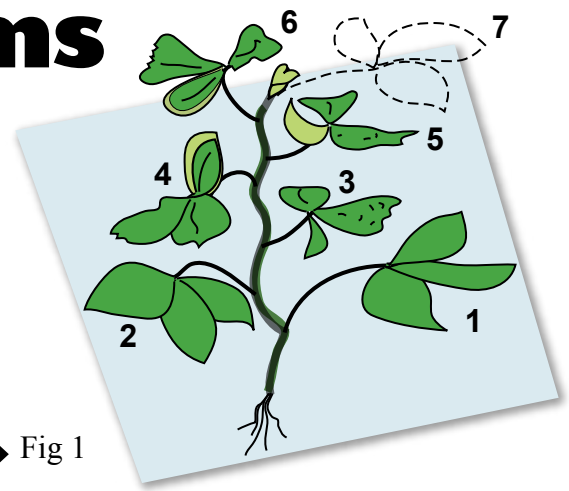


Fig 1



Fig 2: You may see a slight crinkle of leaf tips at low doses.



Fig 3: Leaves can cup up or down.



Fig 4: You may see severely puckerred leaves with blunt leaf tips. Leaf tips may appear light colored due to dense covering of hairs and unexpanded cells.



Fig 5: Upper leaves may appear strap-shaped.



Fig 6: The stem can twist, swell, and split at high doses. Axillary branches often grow to compensate for the damage, but will have puckerred leaves.



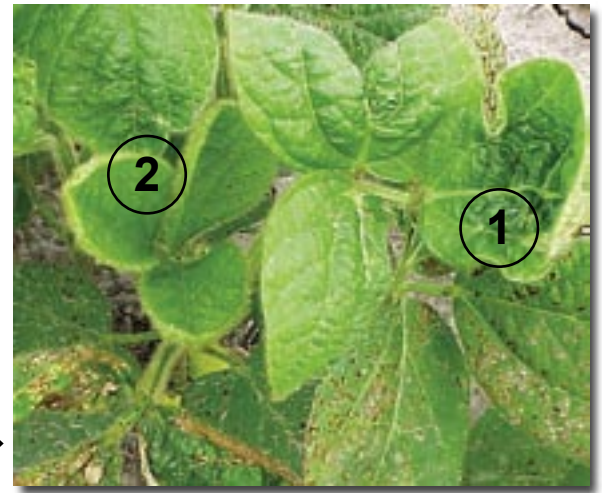
Fig 7: Damaged pods when plants were exposed during pod set.

# Dicamba injury Mimics

Other growth regulating herbicides such as 2,4-D and clopyralid can cup, pucker or strap soybean leaves.

Other mimics do not cause the same pattern on the plant (four or five puckered leaves followed by recovery) or leaf symptoms (injury concentrated toward the leaf tip) as dicamba.

Contact soybean herbicides like Cobra or Flexstar can cause the first leaf (1) that expands after spraying to crinkle. However, the next leaf to grow (2) is not injured. Dicamba does not cause leaf burn. See Fig. 8, to the right. →



← Fig 9: Leaf cupping was caused by carryover of clopyralid, an ingredient in Hornet.



← Fig 10: Herbicides like Dual II Magnum, Outlook, or Intro with cold, wet soil can cause a drawstring appearance, where the leaf tip is pulled in. New growth is normal. →



← Fig 11: Heavy soybean aphid feeding can cause leaf cupping.



← Fig 12: Bean pod mottle, soybean mosaic, and tobacco streak viruses can cause downward cupped soybean leaves. →



← Fig 13: Bean pod mottle and soybean mosaic viruses can cause a bumpy appearance on leaves. Some viruses also cause a yellow blotchy appearance.



← Fig 14: These upward cupped leaves are similar to soybean dwarf virus symptoms. →

solution remained in the tank, sump, or lines, this amount would be sufficient to contaminate the next 500 gallon load at the 0.01% level.

It's important to note that even spray tanks cleaned using common procedures (rather than according to more thorough label directions) can leave measurable concentrations of dicamba. Weed researchers at UW tested a sprayer for residues after spraying dicamba. The tank was drained, washed with an ammonia-water solution which was also flushed through the booms, and re-filled with water. The water from the spray tank and water sprayed out of the boom was sampled and analyzed for dicamba (Table 1). The dicamba concentration in the spray tank's water was extremely low, but the concentration may have been sufficient to cause minor injury symptoms. The water from the spray boom contained a higher concentration of dicamba which might cause moderate soybean injury. This concentration suggests the boom was not adequately cleaned.

Table 1. Dicamba residues detected in water after a sprayer was drained, washed and flushed with an ammonia-water solution, and re-filled with water.

Water source	Dicamba (ppb)	Percent of use rate*
Spray tank	945	0.02%
Spray boom	24,800	0.63%

\*based on 1 pt/a Banvel or Clarity applied in 15 GPA water.

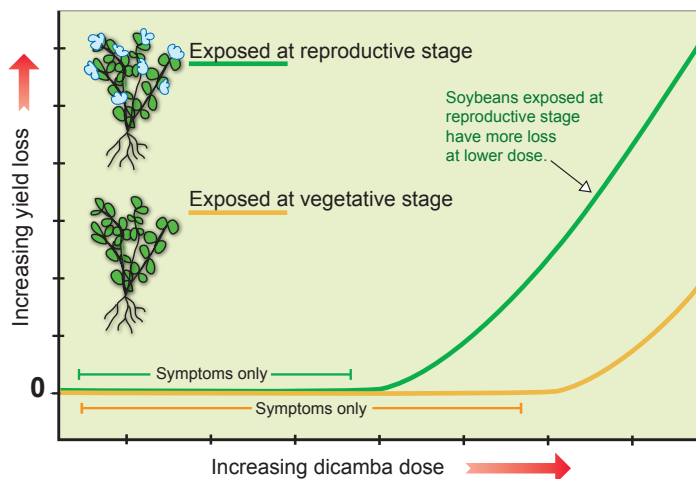
Similarly, small amounts of dicamba from the improper use of an old jug to shuttle glyphosate or adjuvants can contaminate spray solutions. The reuse of old herbicide containers in this manner is illegal. Only 0.05 oz of Banvel or Clarity would contaminate a 500-gallon load (calibrated to spray 15 GPA) at the 0.01% level. A non-rinsed jug could certainly retain this small amount of dicamba.

### Dicamba Injury and Soybean Yield Loss

Without a doubt, extremely low dicamba concentrations can cause soybean injury symptoms. Minor symptoms, while often causing concern, do not result in yield loss. As concentrations increase, injury symptoms and the potential for soybean yield loss also increase. The level of yield loss depends on the amount of dicamba that reached the soybean and the plant's growth stage. It's impossible to state the exact dicamba concentration that causes yield loss due to soybean's ability to recover from injury, differences among varieties, and variation in growing conditions among years. Yield is most often lost when severe injury symptoms persist through the growing season.

In general, experiments have shown that soybeans recover from minor to moderate dicamba injury in the veg-

etative stage without suffering yield loss. However, yield loss is more likely to occur when soybeans are exposed to dicamba after they begin to bloom. Fortunately, soybeans are more frequently exposed to dicamba in the vegetative stage than in the reproductive stage.



Growers and agronomists should investigate any soybean injury and determine its cause. However, if dicamba or dicamba-containing products caused the injury, use caution in trying to predict the yield effect. Due to the sensitive nature of soybeans to dicamba, injury symptoms are not reliable indicators of yield loss.

### Ways to Reduce the Risk of Dicamba Injury

Soybean injury from dicamba usually results from mistakes during mixing, tank cleaning, or application. Spending a little extra time during these activities may prevent or reduce the risk of dicamba injury. These simple recommendations can reduce the potential for soybean injury from dicamba.

1. Clean spray tanks according to label directions.
2. Do not re-use old herbicide containers to shuttle herbicides or adjuvants.
3. Thoroughly rinse measuring containers after measuring dicamba.
4. Do not spray in windy conditions, especially if the wind is blowing towards a soybean field.
5. If possible, avoid dicamba applications during hot, dry weather to reduce volatilization.
6. Adjust boom height and spray pressure and select nozzles to minimize spray drift.

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