Detection Patterns of Neonicotinoid Insecticides in Minnesota Rivers and Streams

2018 – 2022

DEPARTMENT OF AGRICULTURE

CLEAN WATER LAND & LEGACY AMENDMENT

Neonicotinoid insecticides are used as a seed treatment for many agricultural crops and applied as a broad-spectrum insecticide in both agricultural and urban areas. In agricultural regions, neonicotinoid use occurs during two application periods, when treated seeds are planted in May and June and when foliar spraying occurs in mid-July through August. The total amount of neonicotinoids used as a seed treatment is expected to be far greater than other application methods. Planting of treated seed is common in all agricultural regions of Minnesota. Neonicotinoids are relatively persistent in agricultural soils, soluble in water, and highly mobile in the environment.

The Minnesota Department of Agriculture (MDA) has an extensive water quality monitoring program and analyzes for over 180 pesticide compounds, including neonicotinoid insecticides. Neonicotinoids have been detected in rivers and streams, agricultural subsurface drainage tiles, urban storm water ponds, rain, and groundwater. There are three neonicotinoids, clothianidin, imidacloprid, and thiamethoxam, that are detected annually in rivers and streams. This summary evaluates annual detection patterns in rivers and streams and draws possible connections to neonicotinoid application methods (seed treatment vs. foliar spray).

Regional Detection Summary – Rivers and Streams

- The likelihood of detecting a neonicotinoid in a river was highest in May, June, and July during and following the agricultural crop planting season (Figure 1).
- The likelihood of detecting a neonicotinoid in a river fell in August (Figure 1). Foliar applications normally occur from mid-July through August in Minnesota.
- The EPA has developed chronic aquatic life benchmarks (ALBs) for clothianidin (50 ng/L), imidacloprid (10 ng/L), and thiamethoxam (740 ng/L) based on toxicity to aquatic invertebrates. Each ALB is based on a 21-day exposure duration.
- Detections of clothianidin and imidacloprid above their numeric EPA ALBs are most common in May through July and decrease in August. Exceeding the ALB requires the concentration to be above the ALB concentration for 21 days. Many detections of clothianidin and imidacloprid above the numeric ALB are not sustained for 21 days; however, the MDA has calculated instances where the ALB has been exceeded (duration and concentration). Thiamethoxam has not been detected over the ALB.
- Clothianidin, imidacloprid and thiamethoxam were detected in agricultural regions in southern and western Minnesota. Imidacloprid was also detected in urban streams (Figure 2).
- The infrequent detections in central and east central Minnesota rivers and streams, where there is significant corn and soybean production, may suggest that the coarse textured soils and a less prominent network of subsurface tile drainage limit neonicotinoid movement to surface waters and allow transport into groundwater. Supporting this theory, the neonicotinoid detection frequency and concentrations tend to be highest in central Minnesota in MDA's groundwater monitoring network.

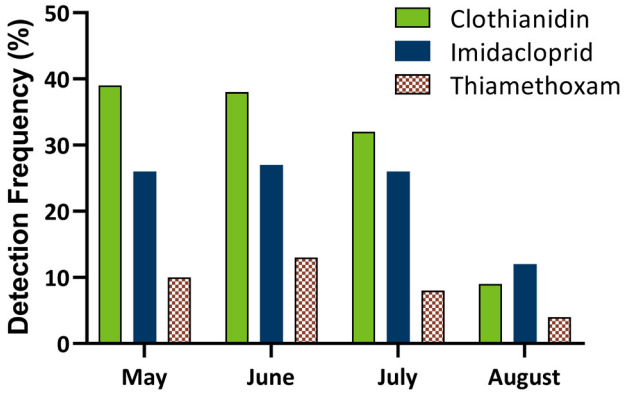


Figure 1. Monthly neonicotinoid detection frequency in rivers in agricultural regions from 2018 to 2022.

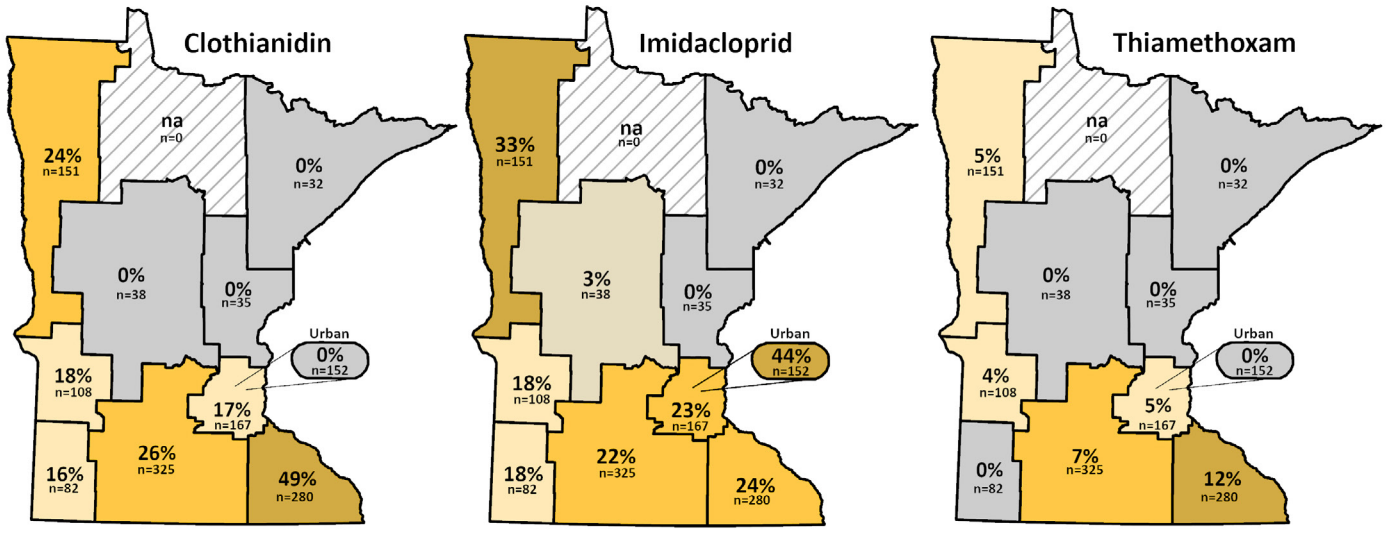


Figure 2. Regional neonicotinoid river and stream detection frequency from 2019 to 2022.

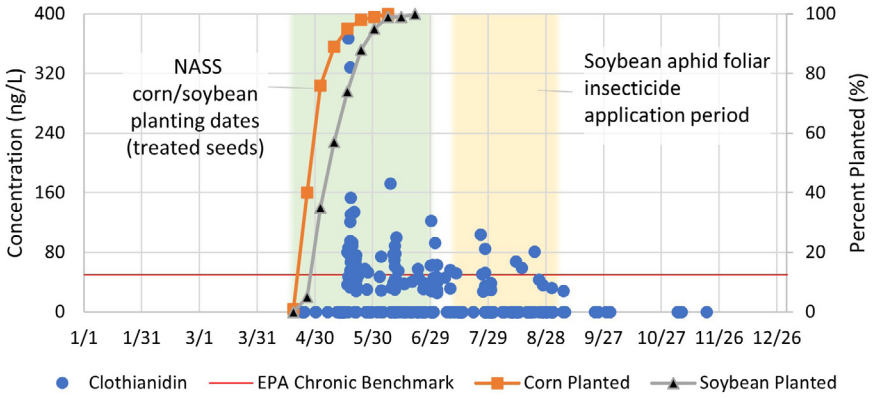
Neonicotinoid Annual Detections and Use Evaluation

Annual crop planting progress and the typical soybean aphid foliar insecticide application periods were plotted with the water quality data to evaluate the potential source (seed treatment vs. foliar) based on the seasonal timing of detections in Minnesota rivers and streams. The 2020 summary is presented as an example (Figure 3). The EPA ALB is plotted for reference; however, the 21-day duration must be considered with each detection to determine if the ALB has been exceeded.

Annual detection patterns from 2018 through 2022 display a strong seasonal increase beginning in May in Minnesota. The neonicotinoid concentrations indicate an annual increase that aligns well with the start of corn and soybean planting each year, and concentrations appear to peak during or near the end of the corn and soybean planting period. Some late season detections may be related to foliar applications and/or an increase in runoff or subsurface drainage tile flow following heavy late-season rainfall.

The MDA water quality and planting progress data seems to indicate the planting of treated seeds is the primary source of neonicotinoids in Minnesota rivers and streams in agricultural regions (excluding central and east central Minnesota). In these regions, 84% of the clothianidin, 85% of the imidacloprid and 92% of the thiamethoxam detections occurred when water levels were elevated from runoff conditions. This

2020 MDA River Clothianidin Detections in Agricultural Watersheds and Clothianidin Application Periods



2020 MDA River Imidacloprid Detections in Agricultural Watersheds and Imidacloprid Application Periods

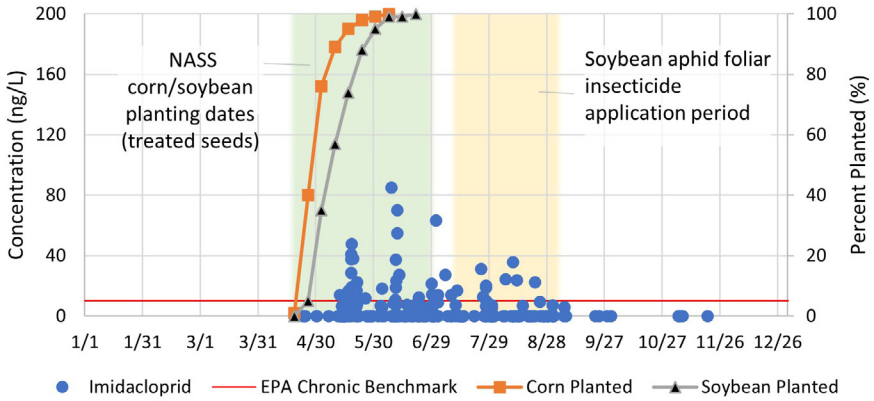


Figure 3. Clothianidin (top) and imidacloprid (bottom) concentrations detected in Minnesota rivers and streams in 2020 plotted with crop planting dates and the typical foliar spraying window for soybean aphid control.

suggests that the overland flow and/or subsurface drainage tile may be the primary transport mechanisms to surface waters.

The lack of neonicotinoid seed treatment use information (active ingredient, amount, crop type, regional use patterns, etc.) limits the interpretation of the water quality data. Without specific use information, it can be difficult to determine if changes in the water quality data are related to changes in use patterns.

Neonicotinoid Annual Detections in Urban Streams

- Clothianidin and thiamethoxam use in urban settings is very limited and neither were detected in urban streams.
- May through August detection frequency ranged from 33% to 48% (Figure 4).
- Imidacloprid was detected over the numeric EPA chronic ALB in 18% of the samples collected, and the MDA has calculated a 21-day average imidacloprid concentration over the ALB at each urban stream location.
- One notable difference between the imidacloprid detection pattern in urban streams compared to rivers and streams in agricultural regions is the absence of a surge in detections in May and June when corn and soybeans are planted in agricultural regions.
- In urban streams, imidacloprid detections occurred in both runoff (storm) flow conditions (48% of detections) and during low (base) flow conditions (52% of detections).

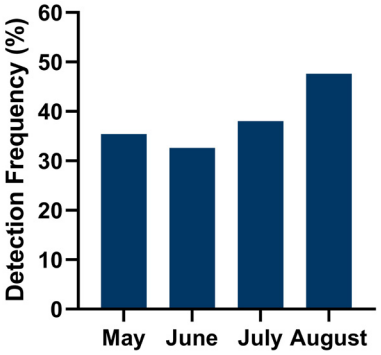


Figure 4. Monthly imidacloprid detections frequency in urban streams from 2018 to 2022.

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