Minnesota Department of Agriculture

Neonicotinoids Special Registration Review

August 2016

Minnesota Department of Agriculture

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Process Leading to Review Initiation

- MDA previously reviewed neonicotinoid concerns as part of its emerald ash borer insecticide review (including concerns about pollinator exposure);
- November 5, 2013 – Commissioner of Agriculture directed staff to initiate the Special Registration Review;
- PMU staff developed a scoping document in collaboration with U of M, MPCA, DNR and BWSR outlining into six broad criteria;
- Draft scoping document made available to the public for comments on March 1-May 2, 2014;
- Received 444 comments, Unique comments responded individually and incorporated into the scoping document when appropriate;
- Revised scoping document posted online October 2014;
- ≈2 years to complete the SRR.

Scope of Review

Goal: Present relevant information and identify Minnesota-specific concerns that might be addressed by specific regulatory or non-regulatory activities.

- Summary of the various issues, lines of evidence, and activities related to neonicotinoid impacts on insect pollinators;
- Provide more information about Minnesota-specific pesticide products and issues and federal registration concerns;
- Provide a variety of opportunities for action;
- Not intended to be redundant of analyses and decisions reached by USEPA during federal registration;
- Does not include every citation but attempted to be fair in choosing genuinely important ones.

Six Broad Criteria of Neonicotinoid Review:

1. Neonicotinoid background, chemistry, and mode of action;
2. Federal, state and other neonicotinoid registration policies and initiatives;
3. Neonicotinoid use and sales;
4. Neonicotinoid applications and movement in the environment;
5. Risks of neonicotinoid use;
6. Benefits of neonicotinoid use.

Review Focus

The review focused on six neonicotinoid active ingredients:

Active ingredient	Common Product names
• Acetamiprid	(Assail, Chipco, Tristar)
• Clothianidin	(Belay, Clutch, Poncho)
• Dinotefuran	(Safari, Scorpion, Venom)
• Imidacloprid	(Admire Pro, Bayer Advanced 12 Month Tree & Shrub Insect Control, Gaucho)
• Thiacloprid	(Calypso)

(registration cancelled voluntarily by the registrants in Aug 2014)

• Thiamethoxam	(Actara, Cruiser, Platinum)

(breaks down to clothianidin)

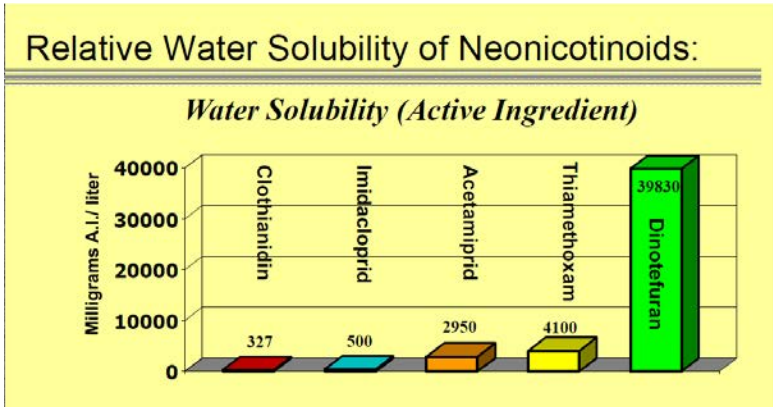
Neonicotinoid background, chemistry, and mode of action

- A relatively new class of insecticides registered for use on ≈140 crops and many other residential uses;
- Show similar broad spectrum activity to insects specifically to sucking insects (aphids) and chewing insects (beetles);
- Used as seed treatment, foliar, and soil applications;
- Also used for some invasive pests (emerald ash borer) and some hard to control pests (potato Colorado beetle);
- Move systemically within the plant tissues;

Neonicotinoid background, chemistry, and mode of action

- Half life
- UV stability
- Water solubility
- Rate of uptake by plants
- Mobilization within plants
- Degradates
- Host range of susceptible insects

Neonicotinoid	Half-life (USEPA)	Half-life (Literature)
Acetamiprid	<1-8.2	<1-450
Clothianidin	148-1,155	148-6,931
Dinotefuran	81.5-138.4	75-138.4
Imidacloprid	>120-660	28->2,000
Thiacloprid	1.5-13.5	1.5->1,000
Thiamethoxam	13-353	7-3,001



Federal, state and other neonicotinoid registration policies and initiatives

- Three tiered risk evaluation framework using honey bees as surrogate species.
- EPA in collaboration with Health Canada and the California Department of Pesticide Regulation developed new risk assessment framework for bees in 2012.
- The new framework takes into account multiple lines of evidence including registrant-submitted data, open literature, and ecological incident data.

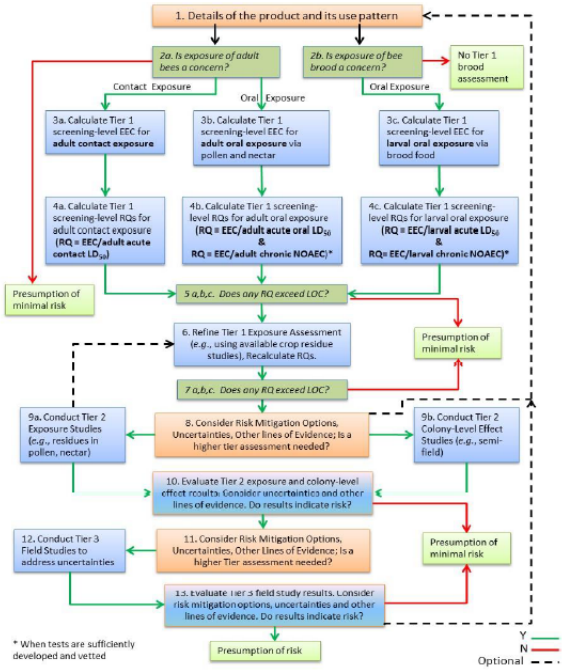


Figure 1. Tiered Approach for Assessing Risk to Honey Bees from Foliar Spray Applications: EEC=Estimated Environmental Concentration; RQ=Risk Quotient; LOC=Level of Concern; and NOAEC=No Observable Adverse Effect Concentration (USEPA, 2014b).

Federal, state and other neonicotinoid registration policies and initiatives

Test Title	Tier	Test Objective
Honey bee adult acute contact toxicity	I	Laboratory test that identifies the dose that is lethal to half of the test population (LD_{50}) by dermal contact.
Honey bee adult acute oral toxicity	I	Laboratory test that identifies the oral dose that is lethal to half of the test population (LD_{50}) by oral ingestion.
Honey bee larvae acute oral toxicity	I	Laboratory test that identifies the dose that is lethal to half of the larval test population (LD_{50}).
Honey bee adult chronic oral toxicity	I	Laboratory test that identifies effects following repeat exposures (*e.g.*, 10-day) to the test compound.
Honey bee larvae chronic oral toxicity	I	Laboratory test that identifies effects on larvae following repeat exposure to the test compound.
Honey bee toxicity of residues on foliage	I	Provides information on the amount of time during which contact exposure to weathered residues of the test compound remains toxic to >25% of the adult bees.
Semi-field testing for pollinators	II	Field-level test, where exposure to bee colonies is conducted within enclosures; study provides information on exposure as well as effects on a whole colony.
Field feeding study	II	Field-level test where bee colonies are located in an open field setting, but exposure is delivered at predetermined concentrations in either sucrose solution or a pollen supplement. Field feeding studies can provide information on long-term effects.
Measure of residues in pollen and nectar	II	Provides exposure information (from the pollen and nectar) following application of the product at label rates.
Field testing for pollinators	III	Field-level test that typically looks at long-term effects under environmentally realistic exposure conditions.

Federal, state and other neonicotinoid registration policies and initiatives

Table 4. Summary of toxicity studies required by USEPA on honey bees as surrogate species for neonicotinoids and other Group 4A systemic insecticides based on Environmental Fate and Effects Division (EFED) documents submitted at the time of registration and registration review plan.

Insecticide	Year of registration	Tier 1- Toxicity test results based on					Tier II- Semi-field test results based on whole colony level effects (also include new guidelines) [a,d]	Tier III- Field test results based on whole colony level effects (also include new guidelines) [a,e]	Conclusions
		Adult contact toxicity[a]	Adult oral toxicity[a]	Larval contact toxicity (New guidelines) [b]	Larval oral toxicity (New guidelines) [b]	Residual contact toxicity effects[a,c]			
Acetamiprid	2002	Moderate	Low	Not yet submitted (requested for review)	Not yet submitted (requested for review)	Under review (not conducted in 2002)	Registrant may be requested to submit studies	Registrant may be requested to submit studies	Uncertainties identified
Clothianidin	2003	High	High	Not yet submitted	Not yet submitted	Under review (not conducted in 2003)	Under review (Not conducted or considered supplemental)	Under review (Not conducted or considered supplemental)	Uncertainties identified
Dinotefuran	2004	High	High	Not yet submitted	Not yet submitted	48 hr	Registrant may be requested to submit studies	Registrant may be requested to submit studies	Uncertainties identified
Imidacloprid	1992	High	High	Not yet submitted	Not yet submitted	Under review (not conducted in 1992)	Registrant requested to submit studies	Registrant requested to submit studies	Uncertainties identified
Thiacloprid	2003	Low	Low	Not yet submitted	Not yet submitted	< 2hr	Not conducted or considered supplemental	Not conducted or considered supplemental	Active ingredient cancelled
Thiamethoxam	1999	High	High	(Requested for review)	(Requested for review)	(Requested for review)	Registrant may be requested to submit studies	Registrant may be requested to submit studies	Uncertainties identified
Sulfoxaflor (Neonicotinoid-like)	2014	High	High	High	High	< 24hr	Potential risks identified	Likely no long-term effects	Likely no long-term effects
Flupyradifurone (Neonicotinoid-like)	2015	Non toxic	High	Non-toxic	High	<3 hr	Potential risks identified	Likely no long-term effects	Likely no long-term effects

Federal, state and other neonicotinoid registration policies and initiatives

- EPA amended labels to add bee icon to outdoor foliar uses of neonicotinoid products in 2013;

- EPA is in process of conducting a cyclical 15 year registration review of all neonicotinoids;
- Preliminary imidacloprid, pollinator specific review for agricultural and horticultural crops released in January 2016 (relevant information incorporated in MDA's review);
- Preliminary pollinator specific risk assessment for clothianidin and thiamethoxam issued for public comment in January 2017.

Preliminary pollinator assessment to support the registration review of imidacloprid

Risks quantified for honey bee and characterized qualitatively for other bee taxa.

Summarized preliminary risk findings on a crop group-based approach.

Low potential for on field risk

Crop Group (Available Residue Data)	Appl. Method	Individual Bee (Tier I) Risk?			Colony (Tier II) Risk?		Risk Conclusions (Basis and Other Considerations)
		On Field (Screening Level)	Off Field (Screening Level)	On Field (Refined)	Nectar	Pollen[3]	
Crop Groups/Use Patterns that Present Low On-Field Risk							
Root/Tuber Vegetables[4]	Foliar	N	Y	No further analysis conducted			Low On-Field Risk (all uses, lack of exposure)[1]; Off-Field Risk (Tier I, foliar uses only)
	Soil	N					
	Seed	N					
Bulb Vegetables	Soil	N					Low On-Field Risk (all uses, lack of exposure)[1]; Off-Field Risk (Tier I, foliar uses only)
	Seed	N					
Leafy Greens Vegetables	Foliar	N	Y				Low On-Field Risk (all uses, lack of exposure)[1]; Off-Field Risk (Tier I, foliar uses only)
	Soil	N					
Brassica Vegetables	Foliar	N	Y				Low On-Field Risk (all uses, lack of exposure)[1]; Off-Field Risk (Tier I, foliar uses only)
	Soil	N					
	Seed	N					
Fruiting Vegetables (Tomatoes)	Foliar	Y	Y	Y	No data[2]	N	Low On-Field Risk (Tier II, pollen; nectar not produced, lack of exposure) Off-Field Risk (Tier I, foliar uses only) (Determinations apply to all members except okra due to unattractiveness of group to honey bees, *Bombus* used for pollination services in greenhouse)
	Soil	Y					
Berries/Small Fruits (Blueberry)	Soil	Y		Y	N	N	Low On and Off-Field Risk (Tier II, nectar and pollen)
Cereal Grains (Corn)	Seed	Y		Y	No data[2]	N	Low On and Off-Field Risk (pollen; nectar not produced) (Other members such as wheat, barley, oats, millet and rye are either not attractive to bees)
Tobacco, globe artichoke	Foliar	N	Y	No further analysis conducted			Low On-Field Risk (all uses, lack of exposure)[1]; Off-Field Risk (Tier I, foliar uses only)
	Soil	N					

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Imidacloprid crop groups/Use patterns with uncertainty in colony (Tier II assessment)

Crop Group (Available Residue Data)	Appl. Method	Individual Bee (Tier I) Risk?			Colony (Tier II) Risk?		Risk Conclusions (Basis and Other Considerations)
		On Field (Screening Level)	Off Field (Screening Level)	On Field (Refined)	Nectar	Pollen[3]	
Cucurbit Vegetables (Melons)	Soil	Y		Y	Uncertain (Potential bridging)	Uncertain (Potential bridging)	On-Field Risk (Tier I); Tier II Risk uncertain (Long [6 weeks +] bloom duration; uncertainty of lower than maximum annual rate used and one sampling interval, no residues in coarse soils, unknown as to whether application closer to bloom would yield higher residues; Tier III full field study [pumpkins] expected for 2016 assessment)
Citrus Fruits (Oranges/ grapefruits)	Soil	Y		Y	Uncertain (Potential bridging)	No data (Potential bridging)	On-Field Risk (Tier I); Tier II Risk uncertain (6 week + bloom duration; uncertainty of no residues in coarse soils and residues do not reflect worst case scenario as current labels permit pre and during bloom applications where these applications were made post-bloom)
Pome Fruits	Foliar	Y	Y	Y	No data	No data	On-Field Risk (Tier I); Off-Field Risk (Tier I, foliar uses only) (Residue data expected in 2016)
	Soil	Y		Y	No data	No data	
Stone Fruits (Cherries)	Foliar	Y	Y	Y	N	Possible	Low On-Field Risk (Tier II, Nectar;), Tier II Risk possible (Pollen); Off-Field Risk (Tier I) (Stone fruits associated with short bloom duration [2-3 weeks] relative to exposure duration in open literature pollen feeding study [12 weeks] which likely mitigates the potential for colony level from pollen route of exposure)
Stone Fruits	Soil	Y		Y	No data (potential bridging)	No data (potential bridging)	On-Field Risk (Tier I); Tier II Risk unknown
Berries/small fruits	Foliar	Y	Y	Y	No data (potential bridging)	No data (potential bridging)	On-Field Risk (Tier I); Tier II Risk unknown Off-Field Risk (Tier I)
Berries and small fruits (Strawberries)	Soil	Y		Y	No data	Possible	On-Field Risk (Tier I); Tier II Risk possible (pollen) (Long [6 weeks +] bloom duration; uncertainty of one sampling interval, no residues in coarse soils, unknown timing of application relative to bloom
Legumes	Foliar	Y	Y	No data	No data	No data	On Field Risk (Tier I, all uses); Tier II Risk unknown Off Field Risk (Tier I, foliar uses only) (Honey bee attractive; no bloom restrictions; seed treatment of soybean = highest usage of all registered crops (400,000 lbs a.i/year).
	Soil	Y		No data	No data	No data	
	Seed	Y		No data (Potential bridging)	No data (Potential bridging)	No data (Potential bridging)	

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Imidacloprid crop groups/Use patterns with colony risk indicated (Tier II assessment)

9	Cucurbit Vegetables	Yes	Foliar	Cucumber	Yes	Yes	Yes- Nectar Yes- Bee Bread	**On-field risk likely** Refined RQs are above LOCs. Tier II assessment indicates that concentrations of residues in nectar and bee bread exceed levels where colony effects have been observed in the registrant-submitted CFS.
10	Citrus Fruits	Yes	Soil	Oranges	Yes	Yes	No- Nectar Yes- Bee Bread	**On-field risk likely** Refined RQs are above LOCs. Tier II assessment indicates that concentrations in nectar are below colony-level NOEC. Concentrations in bee bread are above levels where colony effects have been observed in registrant-submitted CFS. A bee kill incident involving an application of thiamethoxam to lemons was reported in CA

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Clothianidin/Thiamethoxam crop groups/Use patterns with colony risk indicated (Tier II assessment)

Group #	Crop Group	Produces Honey Bee Attractive Nectar and/or Pollen?[1]	Appl. Method	Residue data available	Individual Bee (Tier I) Risk concerns?		Honey Bee Colony (Tier II) Risk concerns?	Overall On-Field Risk Conclusions[4]
					On Field (Screening Level)	On Field (Refined)		
12	Stone Fruits	Yes	Foliar	Peaches, plums, cherries	Yes	Yes	No-Nectar Yes-Bee Bread	**On-field risk likely** Refined RQs are above LOCs. Tier II assessment indicates that concentrations in nectar are below colony-level NOEC. Concentrations in bee bread are above levels where colony effects have been observed in registrant-submitted CFS. Bee kill incidents involving applications of thiamethoxam to cherries and unspecified orchard crops were reported in WA.
13	Berry and Small Fruit	Yes	Foliar	Cranberry	Yes	Yes	Yes-Nectar Yes-Bee Bread	**On-field risk likely** Refined RQs are above LOCs. Tier II assessment indicates that concentrations of residues in nectar and bee bread exceed levels where colony effects have been observed in the registrant-submitted CFS.
20	Oilseed	Yes	Foliar (cotton only)	Cotton	Yes	Yes	Yes-Nectar	**On-field risk likely** Refined RQs are above LOCs. Comparison of residues in nectar exceed levels where colony effects have been observed in the registrant-submitted CFS (honey bees are not expected to consume cotton pollen).
9	Cucurbit Vegetables	Yes	Foliar	Cucumber	Yes	Yes	Yes-Nectar Yes-Bee Bread	**On-field risk likely** Refined RQs are above LOCs. Tier II assessment indicates that concentrations of residues in nectar and bee bread exceed levels where colony effects have been observed in the registrant-submitted CFS.
10	Citrus Fruits	Yes	Soil	Oranges	Yes	Yes	No-Nectar Yes-Bee Bread	**On-field risk likely** Refined RQs are above LOCs. Tier II assessment indicates that concentrations in nectar are below colony-level NOEC. Concentrations in bee bread are above levels where colony effects have been observed in registrant-submitted CFS. A bee kill incident involving an application of thiamethoxam to lemons was reported in CA

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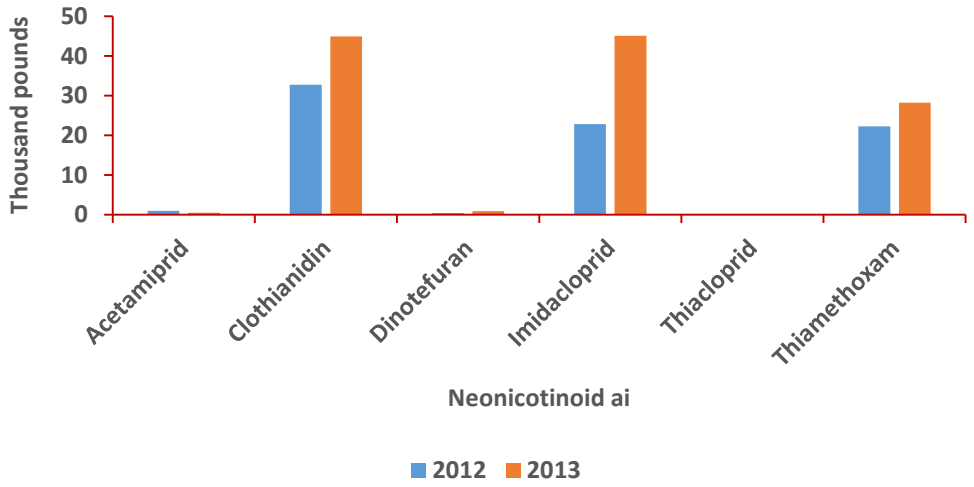
Federal, state and other neonicotinoid registration policies and initiatives

- About 12 Minnesota cities, townships, school districts including Minneapolis and Saint Paul made ordinance limiting use of neonicotinoid insecticides on the land they own;
- Some city ordinances include exceptions for using neonicotinoids for invasive pests such as emerald ash borer;
- Canada's providence of Ontario implemented new laws that requires farmers to use treated seed only when pest problem exists;
- EU enacted a moratorium (December 2013–December 2015) on use of imidacloprid, clothianidin, and thiamethoxam to certain bee-attractive crops;
- Updated risk evaluations of impacts of EU moratorium are proposed to be completed by November 2017;

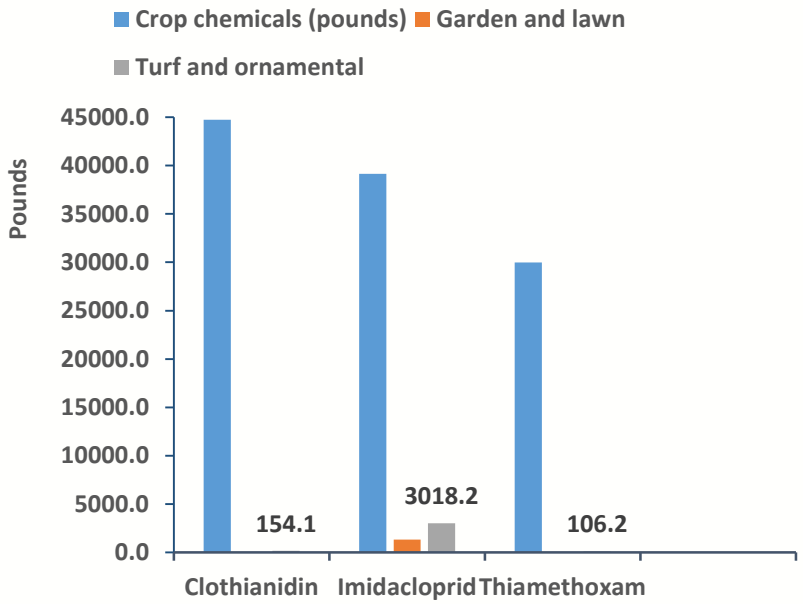
Neonicotinoid use and sales in Minnesota

- 510 registered neonicotinoid products in 2015;
- 127,970 pounds (all neonicotinoid active ingredients) sold in MN as compared to 791,948 pounds of chlorpyrifos (6.1 times higher) in 2011;
- Bulk (>99%) of sales comprised of clothianidin, thiamethoxam and imidacloprid.



Neonicotinoid use and sales in Minnesota

- Bulk (>99%) of neonicotinoid sales in agricultural crops (not necessarily in soybeans and corn);
- Neonicotinoids accounted for 0.26% of all crop chemicals in 2013;
- The MDA collected $332,480 from neonicotinoid registration fees;



Neonicotinoid use and sales in Minnesota

- State does not have the authority to track or regulate the sale and use of pesticide treated seeds;
- Treated seeds are considered to be “Treated Articles” and are exempt from all provisions of FIFRA;
- Based on estimates about 90% of corn and about 40% of soybean acreage in Minnesota is planted with neonicotinoid treated seeds;
- About 8,200,000 acres of corn and about 581,600 acres of soybean planted with neonicotinoid seeds treated in Minnesota are not tracked by the MDA.

Neonicotinoid applications and movement in the environment

- Half-life varies with soil type, climate, soil pH, moisture, temperature, light intensity, fertilizer use, and presence or absence of ground cover etc;
- Range: few days to years;
- Maximum half- life for the most commonly used neonicotinoids; clothianidin, imidacloprid, thiamethoxam: >1 year;
- MDA regularly monitors groundwater and surface water for presence of neonicotinoids in Minnesota.

Neonicotinoid detections in Minnesota groundwater

Table 10. Neonicotinoid concentrations detected in Minnesota groundwater in 2014.

Insecticide	Samples analyzed	Number of detections	Percent detections statewide (%)	Maximum concentration (ppb)	PMRs with detections[2]	MDH drinking water guidance and screening values (ppb)[3]
Acetamiprid	274	ND[1]	ND	ND	ND	100
Clothianidin	274	31	11	0.511	4,5,7,9	200
Dinotefuran	274	ND	ND	ND	ND	5
Imidacloprid	274	26	9	1.520	1,4	90
Thiacloprid	274	ND	ND	ND	ND	28 (HHBP)[4]
Thiamethoxam	274	14	5	1.350	4	20

- Highest concentration of any neonicotinoid compound (thiamethoxam) detected was 15 times below the MDH guidance values for human health;
- Detection frequencies for neonicotinoid pesticides ranged from 3% to 13% from 2010-2014;
- Detections occur most frequently in the Central Sands Region;
- No detections in urban areas and private drinking water wells.

Neonicotinoid detections in Minnesota surface water

Table 11. Maximum neonicotinoid concentrations and number of detections in Minnesota surface waters, in 2014, compared to USEPA aquatic life benchmarks.

Active ingredient	Maximum detection (ppb)	Number of detections	Samples analyzed	% detected	USEPA, aquatic life benchmarks (ppb)				
					Acute			Chronic	
					Fish	Invertebrates	Plant*	Fish	Invertebrates
Acetamiprid	ND**	0	214	0	>50,000	10.5	>1,000	19,200	2.1
Clothianidin	0.260	25	214	12	>50,750	11	64,000	9,700	1.1
Dinotefuran	ND	0	214	0	>49,550	>484,150	>97,600	>6,360	> 95,300
Imidacloprid	0.467	7	214	3	>41,500	34.5	>10,000	1,200	1.05
Thiacloprid	ND	0	214	0	12,600	18.9	45,000	918	0.97
Thiamethoxam	0.223	26	214	12	>50,000	17.5	>90,000	20,000	-

* Values represent the most conservative endpoint for either nonvascular or vascular freshwater plants.

- Detections both in urban and agricultural areas;
- Detection frequencies ranged from 1% to 15% from the year 2010 to 2014;
- Max. detection for clothianidin and imidacloprid about 22% and 45% of chronic aquatic life benchmarks, respectively;
- No detections in lake samples from the year 2010 to 2014.

Neonicotinoid Risks

General risks

Prophylactic use in absence of specific identified pest problems may lead to:

- Insecticide resistance,
- Replacement by secondary pests,
- Adverse impacts on pollinators and natural enemies,
- Soil and water contamination
- Increased costs.

Neonicotinoid risks to pollinators

- Move systemically within plant tissues and can stay in plant parts for days to months as parent or metabolites.
- Highly toxic to bees both through contact and ingestion.
- Based on acute LD_{50} : Four of the six neonicotinoids (clothianidin, dinotefuran, imidacloprid, thiamethoxam) are classified as highly toxic to pollinators.
- Clothianidin LD_{50} - 0.0039 µg/bee (39 ppb).

Neonicotinoid risks to pollinators

- Pollinators exposed to neonicotinoid through:
  - abraded dust from planting treated seed
  - plant pollen,
  - nectar,
  - guttation fluid (plant excreted water droplets)
  - nesting material or resins collected by pollinators.
  - contaminated water
- Acute, chronic and sub-lethal risks;
- No standardized techniques to evaluate sub-lethal impacts on pollinators.

Neonicotinoid risks to pollinators

- 161 pesticides found in honey bee hives at different concentrations.
- Lethal Dose (LD_{50}) for clothianidin, imidacloprid, and thiamethoxam is about 0.004 µg/bee. LD_{50} is the concentration that can kill 50% of test bee populations.
- Neonicotinoid concentrations in treated seed abraded dust :
    - Up to 12,400 ppb (thousands of times higher than what is needed to kill an individual).
- Neonicotinoid concentrations in pollen:
    - 127 ppb in pumpkin (2.5 times a honey bees oral LD_{50}).
    - 85 ppb in wild flower (2.0 times a honey bees oral LD_{50})
- Neonicotinoid concentrations in nectar:
    - 319 ppb (8.6 times of a honey bees oral LD_{50})

Neonicotinoid risks to pollinators

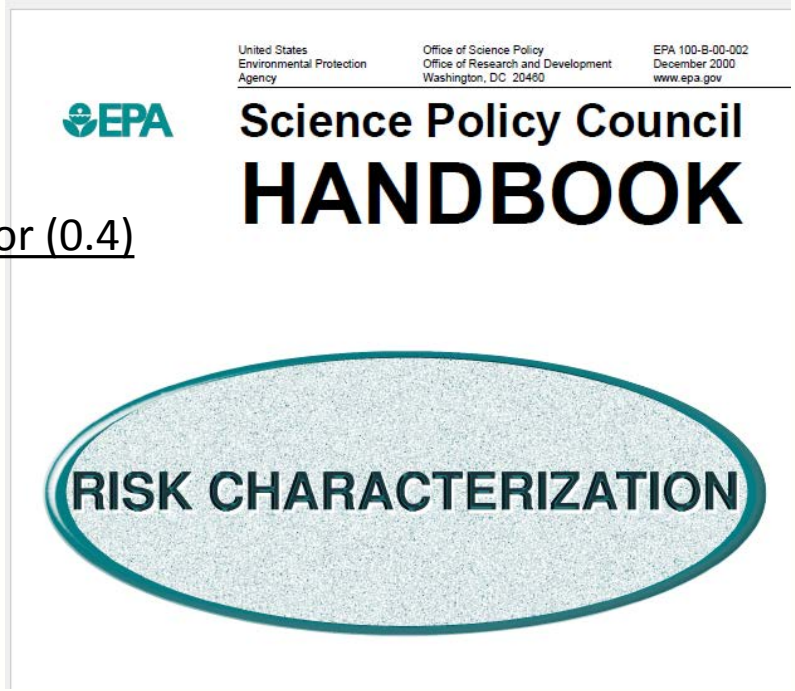
- Higher neonicotinoid residues from foliar applications than from seed treatment.
- Higher residues in pollen and nectar if neonicotinoids were applied closer to flowering;
- Higher neonicotinoid residue accumulation in pollen as compared to nectar;
- Detectable residues found in flowers and leaves 540 days after soil application.

Neonicotinoid risks to pollinators

Risk characterization

Risk Quotient= $\frac{LD_{50} \text{ of chemical X uncertainty factor (0.4)}}{\text{detected residues}}$

Concern is identified if risk ≥ 1.0



Neonicotinoid risks to pollinators : Lethal impacts

Table 13. Neonicotinoid lethal effect values for some wild bees and other insects

Insect scientific name (Common name, and role)	Lethal dose to 50% of a population (LD_{50}) (ppb)			LD_{50} (contact or oral)	Reference
	Clothianidin	Imidacloprid	Thiamethoxam		
Bombus terrestris (Bumble bee, Pollinator)	-	59	63.1	oral	(Mommaerts et al., 2010)
Bombus impatiens (Bumble bee, Pollinator)	3,900	32,200	-	contact	(Scott-Dupree et al.,2009)
Osmia lignaria (Mason bee, Pollinator)	1,000	700	-	contact	(Scott-Dupree et al.,2009)
Megachille rotundata (Leaf cutter bee, Pollinator)	800	1,700	-	contact	(Scott-Dupree et al.,2009)
Eretmocerus eremicus (Wasp, Parasitic)	-	1.9	1.0	contact	(Pisa et al., 2014)
Sasajiscymnus tsugae (Beetle, Predator)	-	1,821	-	contact	(Eisenback et al., 2010)
Coleomegilla maculata (Beetle, Predator)	-	98.7	-	contact	(Eisenback et al., 2010; Lucas et al., 2004)
Hyaliodes vitripennis (True bug, Predator)	-	-	500	contact	(Pisa et al., 2014)
Orius laevigatus (True bug, Predator)	-	-	300	contact	(Pisa et al., 2014)
Danaus plexippus *[3rd instar larvae]* (Monarch butterfly, Pollinator)	15.6	-	-	contact	(Pecenka and Lundgren, 2015)

Neonicotinoid risks to pollinators

Sub-lethal effects on pollinators:

- Impacts orientation, learning, memory, feeding, movement, reproduction, and development time;
- Results in lower colony weight, reduced worker populations and stored nectar;
- Large amount of variation in procedures used for determining sub-lethal effects.

Neonicotinoid risks to pollinators : sub-lethal impacts

- Significant decrease in ability of honey bee foragers to navigate back to their nest when exposed to thiamethoxam at 13.4 ppb.
- Contact exposure of thiamethoxam at 10 ppb reduced learning ability honey bee .
- Chronic exposure of bumble bees to 16 ppb imidacloprid resulted in 47% less movement.
- Bumble bee workers laid 42% less eggs when orally exposed to 1.3 ppb imidacloprid.
- Bumble bee exposure to imidacloprid at ≤ 14 ppb in laboratory and semi-field studies reduced colony weight.
- Honey bee colonies exposed up to 20 ppb imidacloprid over 39 days did not reduce colony weight or population size.

Neonicotinoid risks to other organisms

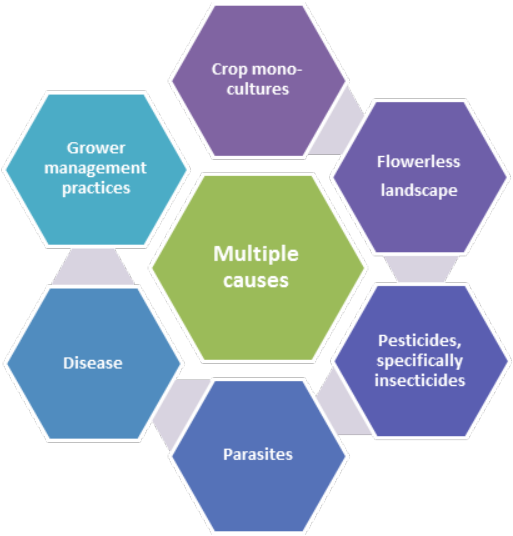
- Toxicity to mammals: Low to moderate.
- Toxicity to birds: Low to moderate.
- Toxicity to fish: Practically nontoxic to moderately toxic.
- Aquatic invertebrates: highly toxic.

Benefits of neonicotinoid use

- Registered as “reduced risk” pesticides by the USEPA.
- Relatively safe to applicators and farm workers.
- Provide very effective control of piercing and sucking insect pests and some difficult-to-control pests such as emerald ash borer.
- Seed treatments provide efficient and prolonged control of insect pests at low dosages when plants are small and most vulnerable to pests.
- Limited resistance in insect populations.
- Seed treatments limit direct exposure to non-target organisms.
- Additional mode of action provides choice for resistance management.
- Suppress secondary spread of insect-transmitted plant diseases.
- Alternatives pesticides may be more toxic to bees, mammals, birds and aquatic organisms than neonicotinoids.

Other stressors

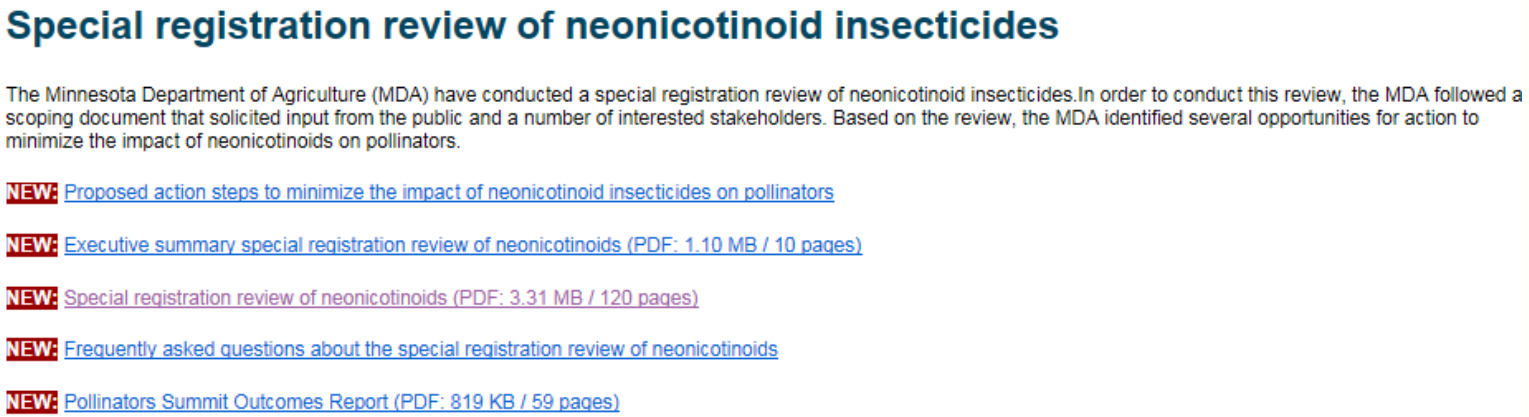
- Loss of habitat
- Diseases (viruses, bacteria)
- Parasites, predators, and pests
- Beekeeper practices
- Climate change



MDA website

Full review available at the MDA website:

http://www.mda.state.mn.us/neonicsreview



Special registration review of neonicotinoid insecticides

The Minnesota Department of Agriculture (MDA) have conducted a special registration review of neonicotinoid insecticides.In order to conduct this review, the MDA followed a scoping document that solicited input from the public and a number of interested stakeholders. Based on the review, the MDA identified several opportunities for action to minimize the impact of neonicotinoids on pollinators.

NEW: Proposed action steps to minimize the impact of neonicotinoid insecticides on pollinators

NEW: Executive summary special registration review of neonicotinoids (PDF: 1.10 MB / 10 pages)

NEW: Special registration review of neonicotinoids (PDF: 3.31 MB / 120 pages)

NEW: Frequently asked questions about the special registration review of neonicotinoids

NEW: Pollinators Summit Outcomes Report (PDF: 819 KB / 59 pages)