Best Management Practices for Farmers Using Seeds Treated With Neonicotinoid Insecticides

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Neonicotinoids are a group of insecticides that have a mode of action similar to that of nicotine and are often used as seed treatments because they can travel from the seed into the plant and control insects feeding on plants as well as on the seed. Honey bees, native bees such as bumble bees and mason bees, and many other native pollinators are critically important to Connecticut's agricultural community. While the primary concern is acute exposure to neonicotinoid insecticides, particularly from airborne dust associated with planting of treated seed, there is growing concern regarding the chronic exposure to foraging bees from nectar, pollen, and plant guttation which supplies water bees transport back to the hive.

Four neonicotinoid insecticides that are highly toxic to honey bees and native bees such as bumble bees are regulated by Connecticut Public Act 16-17 (An Act Concerning Pollinator Health): clothianidin, dinotefuran, imidacloprid, and thiamethoxam.

Some common trade names for insecticides used as seed treatments with these active ingredients are (1):

Clothianidin: Poncho, NipsItInside, Poncho/VOTiVO

Thiamethoxam: Cruiser

Imidacloprid: Gaucho

Although neonicotinoid seed treatments are used on a wide range of crop plants, including soybean, cotton, canola, wheat, sunflower, potato, and many vegetables (1,2), reported honey bee kills from neonicotinoids have most often been associated with dust from corn seed released by vacuum planters at planting time (3,4,5,6). In addition to affecting honey bees and native bees, neonicotinoids applied as seed treatments may also affect other beneficial insects (7,8) and contaminate groundwater, streams and wetlands (9,10,11). Treated seeds are also attractive to birds, and the amount of neonicotinoid on one treated corn kernel is enough to kill a songbird (12). Thus, there are many reasons to be careful in using neonicotinoid-treated seeds.

General Principles for Best Management Practices:

1. Do not use seed treated with neonicotinoids unless there is a specific pest problem that can be effectively managed with a neonicotinoid seed treatment.
2. When the use of neonicotinoids is not warranted, purchase seed that is not treated with this group of chemicals (seeds may be treated with fungicides or other pesticides). If seed selection is limited, contact your seed company's field representative to request increased selection and availability of seed that is not treated with neonicotinoids.

3. Before planting with seeds treated with neonicotinoids, notify any nearby beekeepers, so that they can protect their bees. Also remove flowering plants from the field and field edges by mowing or tillage.
4. Read and follow all instructions on the seed tag including personal protective equipment to be used in handling seed and required buffer zones.
5. Keep the treatment on the seed during storage and handling. Avoid storing seed under extreme temperatures and excessive humidity that may increase the breakdown of the seed treatment.
6. Reduce insecticide dust produced at planting, keeping the treatment on the seed as much as possible. Load treated seed into planter boxes in a manner that will minimize the dust from becoming airborne. Minimize any drift of dust outside the field. Most problems with neonicotinoid-contaminated dust drifting in the air have been with treated corn planted using vacuum planters. There is currently no single solution to this problem. Options, including using deflectors or filters on the planting equipment and changing the lubricant mixed with the seed, are discussed below.
7. Avoid planting on windy days when any dust will blow into the environment, particularly if wind is blowing toward bee hives, flowering trees or standing water sources used by bees.
8. Dispose of any leftover treated seed properly, following directions on the seed tag. Generally it is best to plant it or bury it in an appropriate place away from water bodies.
9. Dispose of any dust left over in seed bags and filters properly, following any instructions on the seed bag or using the hazardous waste collection process in your municipality. (Because this is farm waste rather than household waste, there may be a fee.)

Specific Information:

Seed treatment with neonicotinoids has advantages when compared to application of pesticides by other methods, particularly when used to control insect pests that feed on seeds or seedlings early in the season. Neonicotinoids have a combination of high toxicity to insects and low toxicity to mammals that make them safer than many of the older insecticides, and application to the seed allows the amount applied per area to be greatly reduced compared to soil or foliar applications (6, 13). However, several studies have found that neonicotinoid seed treatments are being widely used in crops and regions where there is little or no economic benefit (14, 15), and in some cases even reducing yield by killing off the natural enemies of pests (8). The Integrated Pest Management (IPM) approach would call for using a preemptive pesticide treatment only when there is a high probability of a target pest causing economic damage or when rescue treatments cannot keep the target pest under the economic injury level (15, 17). This approach would greatly decrease the use of seed treatments (15, 16) and the associated unintended consequences of overuse of pesticides including evolution of insecticide resistance, outbreaks of non-target pests, resurgence of target pests, and negative effects on the environment (14 ,16).

For some crops, neonicotinoid seed treatments have been overused in part because seed producers sold these as part of a “package” along with fungicide treatment or genetic modifications for resistance to insects not controlled by neonicotinoids (14, 16). According to Canadian authorities, most seed companies can accommodate orders for non-insecticide treated seed (16).

As with any application of an insecticide highly toxic to bees, drift of insecticide dust onto bee hives and onto flowering plants being used by bees should be avoided. Although research has shown that honey bees are mostly using flowering trees such as maple, willow, apple, cherry, and hawthorn at the time of spring planting (17), other spring flowering weeds and wildflowers like clovers, dandelions and mustards are also used by honey bees (17) and mustards and clovers are very important to bumble bees and other native pollinators (18, 19).

Although seeds of many different crops have been treated with neonicotinoids, bee kills at planting have generally been associated with treated corn (3, 4, 5, 6, 21). A few studies of treated seeds of other crops have found much less insecticide dust in batches of sugar beet and oil seed rape seeds than in corn (6), although another detailed study found that wheat may have as much risk of dust drift as corn (22).

The most important factors affecting the amount of dust released into the air when planting neonicotinoid treated corn seeds are the quality of the seed treatment, the equipment used for planting, and the weather conditions at the time of planting (6, 17, 21). The quality of the seed treatment depends on how well the seed has been cleaned before treatment; the formulation of the treatment, including the active ingredient (insecticide), polymers used to stick the active ingredient to the seed; and film coatings added to the outside (6,17). The quality of the seed treatment has been shown to be variable across corn varieties and among batches in various studies (17, 21), and this has been correlated with bee kills (21) or with high levels of dust released at planting (17).

The equipment used for planting has also been found to be important. Most farmers growing corn use pneumatic precision seed planters, also called vacuum planters (5, 6, 17, 21). A few studies have compared vacuum planters to planters using a mechanical method or compressed air to place the seed, and have found that the planters without a vacuum produce much less dust (16, 21) and less hazard to bees (21) than vacuum planters. In vacuum planters, corn seeds are precisely spaced in the row by using a vacuum, generated by a central fan, to aspirate the seeds onto a perforated disk, and to keep each seed sticking to a single hole in the disk until the seed drops into the furrow (5, 21). The fan draws air in through an air intake, and then exhausts it through an outlet that is typically 4 to 6 feet above the ground (5, 21). A lubricant, such as talc or graphite, may be used to keep the seeds from sticking together, but also abrades the seed and creates insecticide dust, which mixes with the lubricant (23). This mixture of lubricant and insecticide dust travels in different directions: some travels into the furrow and is planted with the seed, some is exhausted into the air, and some remains behind in the planting equipment (23). Xue et al. (5) have also shown that field dust is sucked in through the air intake, abrades the seed, and then is exhausted into the air. Because neonicotinoid insecticides break down slowly and are so heavily used, the field dust already has residues of a neonicotinoid (clothianidin) before it goes into the planter, but the carry-over pesticide accounts for only 5% of the insecticide residue in the aerial dust; 95% of the neonicotinoid residues are from seed dust (5).

The combination of defective seed treatment and the vacuum planter system can create the problem of dust highly toxic to bees traveling into the air and potentially coming into contact with bees or plants used by bees (5, 6, 17, 21, 23). Various modifications have been tried with some degree of success. After a large bee kill in Germany associated with poor quality seed treatment of corn and vacuum planters (21), Bayer (the pesticide manufacturer) instituted standardization of seed treatment, training of workers, and testing of seeds to make sure that dust was minimized, and also worked with European equipment manufacturers to create kits to modify the vacuum planters to release the exhaust air, and thus the dust, at a lower air speed close to the ground, ideally into the furrows (6, 21). These deflectors were required in some European countries, but they generated such a large amount of dust close to the ground that many farmers refused to use them (6).

The province of Ontario requires farmers to use a new lubricant, Bayer Fluency Agent (ethane, a homopolymer), rather than talc or graphite, when planting neonicotinoid-treated seed of corn or soybeans (20). However, a direct comparison of this lubricant compared to the lubricants chosen by farmers (talc, graphite or a mixture of the two) showed no significant difference in dust released (17). A change in lubricant may not be effective in reducing insecticide dust if field dust is also entering the system and abrading the seed (5).

There are many points at which farmers could modify the planting system: using no-till planting to avoid generating field dust (5), filtering the air intake to limit field dust coming into the planter (5), using a new seed lubricant to reduce abrasion of the seed (20), diverting the dust into the seed furrow during planting (6, 21) or filtering the air exhaust (5, 6, 21). In my discussions with scientists researching these options, none is currently considered the single best option (Reed Johnson, Ohio State University; Art Schaafsma, Guelph University; personal communication).

Once the planting is finished, it is important to collect any spilled seed and dispose of spilled and leftover seed properly. Seeds left on the soil surface are particularly a hazard to birds. According to a study by the American Bird Conservancy, a single corn kernel treated with any of the commonly used neonicotinoids can kill a songbird, and 1/10 of a treated corn kernel is enough to reduce reproduction in a songbird (12). Seed disposal instructions should be on the seed tag. Generally it is recommended to plant leftover seed in the headland or in double rows in the field or to bury it away from water bodies.

At the end of planting, the farmer may be left with seed bags contaminated with insecticide dust, or if filters have been used on the air exhaust of the planter, these filters will have collected the insecticide dust. Dust may also be left behind in the planting equipment, and should be vacuumed out using a vacuum with a filter. This then leaves the farmer with the problem of disposing of bags and filters with insecticidal dust. If there are instructions on the seed tag or label about how to dispose of the dust, those should be followed. Otherwise, seal the material securely and dispose of it using the local hazardous waste process. Because this is farm waste and not household waste, there may be a fee.

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Appendix

Best Management Practices for Treated Seeds from other sources:

American Seed Trade Association

www.seed-treatment-guide.com

For Farmers

http://seed-treatment-guide.com/wp-content/uploads/2014/12/ASTA-Seed-Guide-Farmers.pdf

Health Canada

Pollinator Protection and Responsible Use of Insecticide Treated Seed.
http://fieldcropnews.com/wp-content/uploads/2014/01/pollinator-protecton-Jan-9final.pdf

Corn Dust Research Consortium Report, July 2015:

http://www.pollinator.org/PDFs/July2015CDRCFINAL.pdf

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