Dr. Arthur Schaafsma and Planter Modifications Resources and Summary

Summary of:

Schaafsma, Dr. A. (n.d.). Planter Modification Can Fix Neonic Problem, says University of Guelph Researcher. (B. Tobin, Interviewer)

"Planter Modification Can Fix Neonic Problem, says University of Guelph Researcher".

Real Agriculture post on YouTube.com:

https://youtu.be/AhnBlR9Oyew

An interview of University of Guelph professor Dr. Arthur Schaafsma conducted by Bernard Tobin with Real Agriculture.com at the Ontario Seed Growers Meeting that was posted to YouTube on July 15, 2016. Dr. Schaafsma postulates that dust-off is primarily a "machinery problem" with dust being exhausted from the back of the vacuum style seed planter being the main culprit in the problem of neonicotinoid fugitive dust. Initially researchers had thought that the practice of using talc as a seed lubricant was the major contributor to dust-off. Now it is believed to be the field dust sucked into the planter that is the source of most fugitive dust.

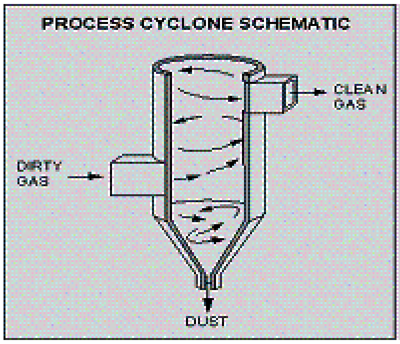
As the vacuum system pulls air through its intake it also pulls in field dust which acts as an abrasive blasting off portions of the seed treatment as the air moves the seed onto the plate for planting then exhausting the air and dust out the rear of the planter. Specifically problematic are those planters with a high negative pressure. This leaves the industry with two ways to mitigate liberated dust coming from the planters. First, air could be cleaned as it is sucked into the machine. Second it could be cleaned as it is exhausted from the machine. Or a combination of these two processes could be applied. Dr. Schaafsma feels that these solutions could eliminate over 95% of the fugitive dust noting that once in the ground seed treatments are shown to stay relatively close to the site it is planted in. Fugitive dust that settles on the soil surface however is subject to being redistributed via natural forces such as water, wind, or soil erosion.

Dr. Schaafsma has conducted experiments comparing traditional seed lubricants with Bayer Crop Science's Fluency agent and has demonstrated this product added greater than 95% efficiency in the lab yet only a 60% efficiency in the field. The disparity he believes is due to the use of vacuum seeders. In speaking about retrofit options he comments he is not a supporter of the deflector units applied in Europe. He feels these units do slow down air intake and do not release the fugitive dust into the air, but they deposit it back onto the soil surface which leaves it subject to redistribution by natural forces.

Some ideas put forth by Dr. Schaafsma for consideration by the seed and equipment manufacturers include:

- Making seed coatings more abrasive resistant.

- Adding an additional coating to make applied coatings more abrasive resistant.
- Using filters on intake and exhaust air of vacuum planters.
- Use cyclone machines to clean exhaust air prior to release into the atmosphere. (Google search "cyclone air filter") What is a cyclone machine?



https://www.lenntech.com/air-purification/dust-purification-techniques/cyclones.htm)

- Applying dust off with use of a coulter planter (Google Search "what is a coulter planter") What is a planter coulter?

Yetter Farm Equipment's planter-mount coulters are designed to integrate seamlessly with planter openers and floating row cleaners. They lightly till soil, which helps extend the life of the seed opener. (https://www.yetterco.com/products/15-plantermount-coulters#:~:text=Yetter%20Farm%20Equipment's%20planter%2Dmount,life%20of%20the%20seed%20opener)

Summary of:

Field Crop News "Neonicotinoid Contaminated Dust and Pollinator Exposure during Planting; Results from 2013"

A study that was conducted by the Corn Dust Research Consortium (CDRC) conducted from April of 2013 to late June of 2013 purposes of determining "available flowering resources around corn during planting" and to evaluate the efficacy of Bayer Fluency Agent in "reducing neonicotinoid contaminated dust from vacuum planter manifolds." There was also a cooperative investigation to determine other potential routes for exposures for pollinators.

Nine paired fields were planted one with seed coated with their conventional lubricant (talc, graphite, or a combination of the two) and one planted using a Bayer product called Fluency. Prior to the start of the study monitoring began in nine bee yards within a range of 2-3 km of the study fields. Monitoring in these bee yards continued weekly from planting through week 6 collecting pollen and dead bees for identification and residue analysis. To evaluate pollen available researchers did weekly scouting around the field sites and at the beehives.

Scouting determined that the foraging resources available to pollinators consisted of willows, maples, and members of the Rosaceae family (hawthorn, apples etc) with dandelions being only a small portion collected by the study. These pollen findings reflect those of researchers at both Ohio State University and Iowa State University and represent one of the five key findings of the study. Second, neonicotinoid dust is emitted from negative vacuum planters through their exhaust manifolds and was captured by the researchers both directly at the manifold and at dust towers located 2 metres above ground downwind of the corn planting "…suggesting that dust leaves the field via wind drift, landing on flowering resources off-site." Third, in comparing traditional lubricants and Bayer's Fluency product researchers found a 28% reduction in neonicotinoid ingredient in the planter exhaust when using the Bayer Fluency. Fourth, a correlation was established between neonicotinoid dust escaping from the planter and downwind levels on dandelions suggesting that "planters have a direct effect on what is found in/on the flowering resources downwind." Finally noted was that there may be other routes of neonicotinoid residue exposure such as "standing water, in the soil at field surface (top 5 cm), in the dry soil dust layer stirred up by the movement of planter equipment through the field and in virgin corn pollen at tasseling." All these alternate routes of exposure captured neonicotinoid residues yet all at "several orders of magnitude lower than those found escaping the planter manifolds…"

In conclusion researchers suggest all efforts be made to reduce the amount of dust that is emitted by vacuum planters from leaving fields, that the use of the Bayer Fluency lubricant may be beneficial to that end in combination with other best practice measures such as the planting of fungicide only seeds in fields that are low risk, using deflectors on manifold covers to deflect dust down to the ground to reduce contamination of off-target flowering resources. Researchers also pointed to PMRA/OMAF and MRA's Best Management Practices for Pollinator Protection and Responsible Use of Insecticide Seed Treatment.

Summary of:

Field Crop News "What Growers Can Do to Mitigate Dust Drift at Planting"

1. Use fluency agent to reduce dust (not graphite or talc)
2. Adapt equipment to direct exhaust air from the planter fan downward to the ground.
3. Alert beekeepers in your area prior to planting to allow them time to relocate hives.
4. Adapt conservation tillage practices to limit loss of soils which can contain neonicotinoid residues.
5. Follow IPM, using treated seed only when indicated.
6. Control blooming weeds prior to planting with treated seed to reduce pollinator's attraction to the fields.

Future additional steps may include use of polymers to place a final seed coat and filtering air taken in by seed planters to eliminate abrasive dust from entering in to prevent treatments from being abraded and creating fugitive dust.

Summary of:

<u>Environmental Science & Technology "Quantifying Neonicotinoid Insecticide Residues Escaping during Maize Planting with Vacuum Planters"</u>

The wide use of pneumatic planters, the near universal use of neonicotinoid treated maize seed (>99% of the entire 2013 Canadian crop) and concerns about acute bee mortality prompted these scientists to consider the role use of pneumatic planters has in neonicotinoid contaminated exhaust emitted during the planting process. As the team introduced its research the following items were noted for consideration:

- Studies in Germany have reported that: "the abrasion potential of seed coatings is strongly related to the potential dust content of maize seed lots…Average emissions from pneumatic planters with imidacloprid-treated seeds were around 4% of the applied dose in Germany, equivalent to an emission rate of 3-4 g of active ingredient(a.i.)/ha."…"0.02-0.41 g/ha neonicotinoid residue 1-5 m from the field edge and 0.026-0.685 g/ha on vertical gauze netting placed 3 m from the planter."
- Studies in Italy reported ranges of 0.43-1.53 g/ha or 0.52-1.85% of the seed treatment applied to maize.

In North America talc and graphite are added to seeds prior to planting to aid movement through the equipment. Talc acts as an abrasive when in contact with treated seed liberating some of the treatment applied. Possible routes of release include the seed planting process and the routine cleaning of equipment. When planting conditions are dry and windy spread of fugitive dust may be "enhanced". A decrease of the planter's fan airflow of "30% may reduce dust emission by more than 80%."

Materials/Methods:

- 2013 nine Ontario co-operators each enrolled two commercial maize fields (minimum of 20 ha to >40 hectares). In 2014 efforts were made to keep as many of the original co-operators in the study as possible while enrolling some new participants due to mandated crop rotation resulting in 10 maize fields enrolled.
- day of planting pre-planting soil samples from top 5 cm of soil surface, obtained randomly over a walked zig-zag pattern gathering 10 subsamples from each field. Either by a gloved hand if field was tilled or if no-till by means of a petri dish on undisturbed surface soil.
- soil dust samples collected prior to Planting by running a utility vehicle with a modified planter unit in tow through each field at planting speed of 8-9 km/h and moving 500 m upwind.

- For maize planter exhaust dust virgin vacuum cleaner filter bags were sealed over the outlet of the planter's exhaust manifold and the planter made two complete passes with distance record and results standardized to 100 m distance for a single planter row. 18 fields were sampled (with data from 2 fields removed due to "unexpected complications, which may have affected dust collection") in 2013 and 10 fields were sampled in 2014.
- Dust sticky trap towers placed on three 2 m high poles at 0 m in downwind direction from the planter oriented into the wind. Three towers were placed in each field. Time was standardized to a width of 150 m of planting perpendicular to the direction of the wind.
- Samples were analysed for clothianidin, thiamethoxam and atrazine.

Results/Discussion:

"Our results clearly confirm the presence of neonicotinoid residues in dust generated by planting maize with pneumatic planters." Exhaust dust during planting was measured to be an average of 0.0593 g/ha with 95.8% being comprised of seed treatment residues and 4.2% from soil disturbance which are approximately 0.21% of the treatment rate. This study recovered 0.437% of seed applied neonicotinoids in 2014 via the exhaust filter bag while a previous study by Schnier et al. reported recovering 10-fold more through a commercial car air filter. This was proposed to be perhaps due to variables such as " seed and seed treatment characteristics, planter design and scale, planter operational characteristics" but that the "planters, seed treatments, and lubricants used in the commercial fields used in this study were "typical" of "mainstream maize production in the Great Lakes Region of the North American maize belt." The assumption made was that the 0.1104 g/ha of neonicotinoid residue collected by the trap towers represents mainly larger particles and the bulk of the remaining 0.0029 g/ha fugitive dust had potential for "long distance movement". Concentrations of "total neonicotinoid residues in the dust plume during planting averages approximately 0.1 $\mu g/m^3$, which is greater than previously reported in exhaust measured 5 m from the outlet of the planter fan (4.2-28.4 ng/m^3)." Research determined 95% of the neonicotinoid residues released during planting with pneumatic planters came directly from the seeds themselves while the remainder from the disturbed field soils. Pointed to the need to mitigate release of neonicotinoid fugitive dust from:

- Soil dust containing neonicotinoid residues from previous applications (felt to be a minor contributor to the emitted dust) entering the intake of the vacuum planter.
- Dry dust itself entering the intake causing abrasion of the seed-coating.
- Added talc causing abrasion of the seed-coating.

Researchers recommend reducing …"the amount of neonicotinoid contaminated dust generated in a maize planting system…" by the following steps; "(1)Develop seed coatings to improve adherence of active ingredient to treated seed, (2) reducing abrasion from talc or from surface dust entering the vacuum air stream, (3) removing active ingredient from planter exhaust, and (4) adopting conservation tillage practices to reduce surface soil disturbance before, during, and after planting…results unequivocally show that well over 95% of the exposure to non-target organisms for neonicotinoid insecticide seed treatment use originates from the exhaust during planting…"

Summary of:

The role of field dust in pesticide drift when pesticide-treated maize seeds are planted with vacuum-type planters.

Introduction:

During testing of a seed lubricant for Bayer Crop Science Dr. Schaafsma observed in the field levels of fugitive contaminated dust were greater than that of those in laboratory testing. This led to the hypothesis that field dust enters the air intakes of vacuum-style seed planters abrades the pesticide treatments and releases them via their exhaust.

Previous research:

- Nuyttens et al. generated proposed pathways for mitigation; among these: use of deflectors to reduce wind speed and redirect exhaust emissions from the planters to the soil. Studies have demonstrated this method may reduce off-site drift by 30-70% yet pesticide residues deposited on the soil surface may be subject to redistribution still leading to potential pollinator exposure.
- Manzone et al. employed the use of a cyclone apparatus to remove the pesticide residues from the exhaust prior to discharge, applying them into a soil furrow raising levels of reduction to nearly 100% recapture. Drawback: "cyclones are capital intensive".
- Biocca et al. conducted similar work, with a "less capital intensive" option: use of a filtering recirculating system. This achieved a near 85% efficacy in reducing fugitive dust emission. Drawbacks cited were need for "…filter replacement and potential disposal restrictions of spent cartridges."

Earlier research focused on treatment dust emanating from seed-to-seed contact. Dr. Schaafsma's belief is that abrasion of seed is "enhanced" with exposure to field dust entering planters or the use of traditional seed lubricants such as talc.

"The objectives of this study were: (1) to characterize the role of field dust in the escape of pesticide-contaminated exhaust from vacuum planters, (2) to quantify the amount of dust involved in this contamination, (3) to determine what extent the dust could be practically mitigated and (4) to determine whether the addition of surrogate dust to the ESA Heubach protocol could increase the resolution of testing anti-abrasive properties of seed coatings."

Materials and Methods:

Field study

- An eight-row pull-type planter was used (3500 Twin-Line; Kinze Manufacturing of Williamsburg, Iowa, USA) Row spacing of 0.76 m.
- A pneumatic seed metering system (7100-456 EdgeVac, Kinze Manufacturing) calibrated to 76 200 seeds ha^{-1} at 17.3 cm spacing between plants within rows at a travel speed of 8 km h^{-1} . Exhaust redirected to vacuum cleaner bags with care taken not to alter planting performance while allowing for collection of the escaping dust.
- 2014 seven fields selected (loam, sandy loam, and clay loam soils). Various tillage methods (conservation, no-till and conventional).
- 2015 and 2016 one extra conventional clay loam field used for each year.
- "The same seed lot was planted at all locations" Maizex 4030 (1000 seed weight of 200g)

  Treatments applied to all seed as follows:
    - 0.25 mg/kernel clothianidin (Poncho 250 ®)
    - 0.007 mg/kernel mefenoxam (Maxim XL®)
    - 0.002 mg/kernel azoxystrobin (Dynasty®)
    - Seed finishing polymer/binder

Lab study

- Selected the maximum measured amount of dust (0.5 g dust per 100 g of seeds at a rate of 75000 seed ha^{-1} measured during the field portions of the study as the amount of dust surrogate used (diatomaceous earth).
- Utilized a stationary Kinze single unit standing planter.
- Employed the use of two variable speed motors. One to drive the seed metering device and the other to drive a cone-seeding device adapted to deliver the dust into the airstream at prescribed rate.

Heubach Dust Meter

- Utilized to evaluate the role of field dust on clothianidin quantities and concentrations.
- Two seed lots sourced tested and treated separately one feed corn and one seed corn.
- Used the same treatment protocol as above.
- Seed lots then divided into equal batches and then treated with additional polymer ingredients:
    - Batch one, BASF Flo Rite 1197
    - Batch two, BASF product X
    - Batch three, used BASF product X both in the initial treatment slurry with the insecticides and fungicides and a second overcoat when initial treatment nearly dry.

Dust Mitigation Field Experiment Collaborative Study

- Pre-dust mitigated portion of the study was part of a larger study on pollinator exposure to neonicotinoid seed treatments on maize through use of vacuum-style planters.
- 10 co-operators = 24 fields total planted in 2014-2015 with neonicotinoid treated seed.
- During dust mitigated portion:
    - Planters had vacuum bags installed on all vents in the metering units, on hopper box lids, and tubing was sealed.
    - Air drawn into planter via a special pipe drawing “relatively” clean air from ~ 4 m above the equipment through an added filter.
    - Seeds used were dressed in the additional polymer coating and Bayer Fluency® product was used at label recommended rate.

Air Sample Collection

- 2014-2016 agricultural fields were sampled for exiting particulate matter with active air samplers facing directly into the wind, results adjusted to ng/m^3.

Results

- “Field dust entering the vacuum System had a positive effect on the total amount of clothianidin captured in the filter bags.” (Mean amount of dust collected was 46 g/ha^{-1}, mean amount of clothianidin collected was 0.77 g/ha^{-1}) Displayed a linear relationship.
- In the laboratory dust experiments, ~80% of the dust added was recovered by the exhaust filter with the total amount of clothianidin recovered increasing linearly as the amount of dust introduced increased.
- Heubach dust meter experiments in the laboratory on the Flo Rite 1197 treated seed showed a “strong positive and linear relationship between the amounts of fine dust (diatomaceous earth) added with the seeds and the amounts recovered in the filters.”
    - Comparing seed lots and treatments in this experiment found no “main or interactive effects attributable to seed lot. When seed lots and polymer treatments were compared using dust recovered as the parameter, for the treatments where no dust was added, the Heubach protocol showed no effect attributable to seed lot…polymer used…or their interaction.”
    - There was “an interaction between polymer treatment and dust added” when product X was double applied “slightly less dust was recovered”.
    - Where dust was added into the Heubach protocol “amount of clothianidin recovered increased with the amount of dust added into the system, but reached a maximum before it started to drop off as more dust was added. This response varied with treatment group and with seed lot. The maximum amount of clothianidin recovered ranged from 0.13 to 0.25 g per 100 seeds…Regardless

of the seed lot used, product X applied twice resulted in the least amount of clothianidin lost. Product X applied alone resulted in less clothianidin lost than polymer 1197 applied alone.”

- Dust mitigation field experiments 2016 data, compared with and without various mitigation strategies deployed, found when several mitigation strategies are utilized: *“The mean reduction in fugitive clothianidin achieved was approximately 98%.”*

Discussion & Conclusion

- Field dust entering the vacuum planters is abrasive to seed treatments and increases the amount of the treatment lost via exhaust = ~12.6% of the active ingredient lost in the worst-case scenario and ~2.6% as an average
- Previous work by Xue et al. had recovered 0.004-0.671% difference is likely attributable to the following differences:
    - John Deere planters used in the first study utilize lower negative pressures, less air volume, lower air speed and do not lend themselves as readily to the tight seals when filter bags were applied. The Kinze planters higher power system may have promoted more seed abrasion as well as lent itself better for a tight seal with the vacuum bags employed for filtration; with rates of dust recovered greater than in the John Deere planters.
- “Residues bound on soil from applications from previous years also contribute a portion (4.2%) to the exhaust.”
- “There were three cases of residue escapes exceeding 3g ha^{-1} and one exceeding 4 g ha^{-1}, suggesting that the amount of active ingredient escaping the vacuum planters is greater than originally believed, that it is proportional to the field dust entering the system, and that certain characteristics such as the type (e.g. soil texture) and availability (e.g. tillage and soil moisture) of dust may result in worse situations.”
- “Similar results were obtained in the laboratory using a single stationary planting unit of similar design to that used in the field. The amount of dust recovered was 80% of that applied, with a good correlation between the two. It was observed that as the amount of dust entering the vacuum system increased, the concentration of clothianidin decreased, suggesting that a point of saturation might be reached in the system where adding more dust would make no difference to the result. This phenomenon was observed in the field, where the concentration of clothianidin declined logarithmically with the amount of dust recovered in the planter exhaust.”
- The Heubach dust meter is “accurate and precise under the conditions it was designed to operate, and for the measurements it was designed to take.” But the system”…underestimates the risk of contaminated dust drift…Vacuum system on the Heubach unit operates at a much lower negative pressure than what the seeds experience during planting in the hoppers and in the metering devices. What the

Heubach also fails to account for is the abrasiveness of the air laden with field dust as it passes by the seed metering device."

- Adding dust to the Heubach protocol, differences between seed lots and polymer treatments were highly discriminable, whereas when the same treatments and seed lots were tested without dust, differences where much less discernible. A smaller proportion of dust was recovered relative to what was added using the Heubach method compared with the standard planting unit, and the Heubach system seemed more easily saturated with excess dust. Furthermore, the ratio of clothianidin recovered to dust added was also about half of that observed for the planting equipment experiments, suggesting that some efficiency improvements can be explored with the Heubach system."
- "…in addition to the Heubach protocol which sets seed quality standards before seed is planted, adding a step with dust to set anti-abrasive seed quality standards during planting, to move the development of non-abrasive seed treatment polymers and treatment technology forward to address the problem of particulate pesticide drift during planting."
- "…the goal of mitigating pesticide drift during planting with vacuum planters by >95% is realistic and achievable. Our study was not designed to differentiate between the relative contributions of each of the mitigation strategies, but it is our opinion that filtering the exhaust air in this study was the main contributing factor to the 98% reduction in fugitive clothianidin achieved. Without the other factors deployed, the filter system, which served as the system backstop, would likely have been saturated. We believe a combination of mitigation strategies must be deployed in tandem to achieve the goal of curtailing the pesticide drift during plant(*sic*) with modern corn planters. These include: the use of better seed treatment polymers with some changes in how they are applied; sourcing clean air to operate the vacuum metering systems, and the scrubbing of vacuum exhaust through filtration or other mechanical means, ensuring that the residues are not left on the soil surface where they can be redistributed."

References

Baute, T. (2014, January 20). *Neonicotinoid Contaminated Dust and Pollinator Exposure during Planting; Results from 2013*. Retrieved from https://fieldcropnews.com/: https://fieldcropnews.com/2014/01/neonicotinoid-contaminated-dust-and-pollinator-exposure-during-planting-results-from-2013/

Baute, T. (2016, April 26). *What Growers Can Do to Mitigate Dust Drift at Planting*. Retrieved from Field Crop News: https://fieldcropnews.com/2016/04/what-growers-can-do-to-mitigate-dust-drift-at-planting/

Pollinator Protection and Responsible Use of Treated Seed - Best Management Practices. (2015, March 9). Retrieved from Government of Canada: https://www.canada.ca/en/health-canada/services/consumer-product-safety/reports-publications/pesticides-pest-management/fact-sheets-other-resources/pollinator-treated-seed/best-management-practices.html

Schaafsma, A. L.-R. (2017). The role of field dust in pesticide drift when pesticide-treated maize seeds are planted with vacuum-type planters. *Pest Management Science 74*, 323-331.

Schaafsma, D. A. (n.d.). Planter Modification Can Fix Neonic Problem, says University of Guelph Researcher. (B. Tobin, Interviewer)

Yingen Xue, V. L.-R. (2015, 49). Quantifying Neonicotinoid Insecticide Residues Escaping during Maize Planting with Vacuum Planters. *Environmental Science & Technology*, 13003-13011.