Risk mitigation measures for seed treatments using neonicotinoids

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Abstract

Background: In 2008 the poisoning of about 12000 bee colonies was reported in Germany. These poisonings were caused by the drift of dust particles containing the insecticidal substance clothianidin following the seeding of maize, treated with the insecticide Poncho Pro. Dust abrasion from coated seeds occurred because of inadequate seed dressing quality, resulting in high quantities of dust emitted into the environment. In order to cover this specific risk, Regulation (EC) No. 1107/2009 provides for special arrangements for the placing on the market of treated seeds. In addition, the Commission Directive 2010/21/EU lays down specific provisions relating to certain neonicotinoids and fipronil for seed coating and seeding.

Results: According to these provisions the German authorities applied risk mitigation measures in the form of specific labels for certain products and seed bags of treated seeds.

Conclusions: Dust within seed bags and drift from seeding actions is a common phenomenon for a number of crops. However, the quantity within the seed bags and the emission of dust can be reduced significantly by technical means (e.g. treatment recipe, facility equipment, deflector technique) and by additional mitigation measures (e.g. max. wind speed). These can be established within the authorization procedure by the Member States.

Keywords: honeybee, poisoning, seed treatment, dust, guttation, risk mitigation

1. Introduction

Over the last decade, honeybee poisonings were reported with a close correlation of spring mortality of bees and the sowing of maize seeds dressed with neonicotinoids, e.g. from Austria, Germany, Italy, Slovenia. In 2008 severe poisonings occurred in Germany, with approx. 12000 colonies being affected. These were attributable to high quantities of contaminated dusts from maize seeds, emitted onto flowering plants (e.g. OSR, fruits, weeds) esp. by vacuum-pneumatic seeders.[1,2,3,4,5] The findings of the Julius Kühn-Institut (JKI) (Heimbach U and Stähler M, 2011, unpublished) indicated that seed bags of different crops may contain significant total quantities of contaminated dust. These data indicate that total quantities of dust within the seed bags as well as the emission of dusts need to be regulated. Regulation (EC) No. 1107/2009 of the European Parliament and of the Council concerning the placing of plant protection products on the market provides special regulations for the placing on the market of treated seeds in Article 49:

4. Member States shall not prohibit placing on the market and use of seeds treated with plant protection products authorised (…) in at least one member state.
5. Where there are substantial concerns that treated seeds (…) are likely to constitute a serious risk to human or animal health or to the environment and that such risk cannot be contained satisfactorily by means of measures taken by the Member State(s) concerned, measures to restrict or prohibit the use and/or sale of such treated seeds shall be taken immediately (…).
6. (…).
7. (…) the label and documents accompanying the treated seeds shall include the name of the plant protection product with which the seeds were treated, the name(s) of the active substance(s) in that product, standard phrases for safety precautions as provided for in Directive 1999/45/EC and risk mitigation measures set out in the authorisation for that PPP (…)[6].

In 2008 authorizations of neonicotinoids for treatment auf maize seeds were suspended by the German Federal Office of Consumer Protection and Food Safety[7], the suspensions still being in force.

To meet the political requirement of a free market for treated seeds within the EU, a harmonized approach for risk assessment and risk reduction measures is a condition precedent. Due to the honeybee poisonings attributable to the sowing of neonicotinoid treated maize seeds reported over the last decade, the Commission Directive 2010/21/EU laid down the following general recommendations for mitigating risk arising from the emission of dusts:

8. 1 The seed coating shall only be performed in professional seed treatment facilities. Those facilities must apply the best available techniques in order to ensure that the release of dust (…) can be minimised.
9. 2 Adequate seed drilling equipment shall be used to ensure a high degree of incorporation in soil, minimisation of spillage and minimisation of dust emission.
10. 3 The label of the treated seed includes the indication that the seeds were treated with the specific active and sets out the risk mitigation measures provided for in the authorisation.
11. 4 The conditions of the authorisation, (…), include, where appropriate, risk mitigation measures to protect honeybees. [8]

2. Results

According to the provisions established by the European Commission the German authorities decided to apply the following risk mitigation measures (RMM) via labelling of neonicotinoid products (PPP) or seed bags of treated seeds:

2.1 RMM on the PPP for the application in professional facilities

The following labelling is issued as part of the authorization procedure:

- The seed treatment shall only be performed in professional seed treatment facilities, which are registered in the index of "Seed Treatment Facilities with Quality Assurance Systems to Minimise Dust" of the Julius Kühn-Institut (visit the homepage of the Julius Kühn-Institut <http://www.jki.bund.de)/>).

This restriction currently applies for all uses as seed treatments of neonicotinoids and will be extended to all crops and other substances toxic to honeybees and other non-target organisms if found necessary based on a risk assessment on a case by case basis. This is because the findings of the JKI indicated that seed bags of different crops may contain significant total quantities of contaminated dust (Heimbach U, 2011, Heimbach U et al., 2011).[9,10] Cereals contained more dust than maize, OSR or sugar-beet, if normalized for a field size of one hectare. The quantity of fine-grained dust in barley seed bags showed more than 300 times higher amounts than fine-grained dust in sugar-beet seed bags, if normalized for one hectare (Table 1).

Tab. 1 Amount of free dust from seed bags of several crops (Heimbach U and Stähler M, 2011, unpublished)

CROP/Year of treatment	Target drilling rate of seeds [a] (kg or No. ha^{-1})	Fine-grained dust [b]< 0.5 mm (g ha^{-1})	Coarse-grained dust [b]> 0.5 mm (g ha^{-1})	N
Cereals 2009				
- Barley	180	11.3 (31)	46.0 (116)	30
- Wheat	250	9.5 (28)	6.7 (19.2)	31
- Rye	150	5.1 (24)	6.6 (32.9)	23
Maize	100000			
- 2008		4.5 (25.6)	6.1 (47.3)	82
- 2009		1.99 (5.8)	3.5 (12.1)	45
OSR	700000			
- 2007		0.81 (4.72)	-	22
- 2008		0.27 (0.88)	-	24
Sugar-beet	100000	0.035 (0.125)	-	22
- 2008				

[a] Cereals given in kg seed rate ha^{-1}; [b] Amounts given in mean (max) g normalized for one ha

Furthermore, the findings of the JKI (Heimbach U et al., 2011, unpublished) showed that concentrations of the active substances may vary between treatment facilities, supposedly depending on the individual treatment procedures, recipes (esp. additives, stickers) and the implementation of effective dedusting equipment.

According to the JKI the resistance of treated seeds to abrasion can be considerably improved by implementing a quality assurance system (Heimbach U et al., 2011, unpublished) (Table 2).

Tab. 2 Resistance of treated maize seeds to abrasion using the Heubach-Dustmeter (Heimbach, U. et al., 2011, unpublished)

CROP/Year of treatment	Target drilling rate of seeds (No. ha^{-1})	Heubach-value[a] (g ha^{-1})	N
Maize			
2008	100000	1.11 (4.15)	53
2009		0.42 (0.91)	81
2010		0.33 (0.66)	43
2011		0.18 (0.4)	34

[a] Amounts given in mean (max) g ha^{-1} normalized for target drilling rates of 1 ha

In preparation for a quality improvement initiative of the German professional treatment facilities for maize, the resistance of the treated seeds to abrasion was significantly improved. While the seeds treated in the year 2008 showed mean normalized Heubach-values of 1.11 g ha^{-1}, the resistance to abrasion was improved to 0.18 g ha^{-1} in 2011. This optimization is also reflected in the maximum normalized Heubach-values for maize seeds that were reduced by about 90 % from 4.15 g ha^{-1} in 2008 to 0.4 g ha^{-1} in 2011.

Further investigations of the JKI using the Heubach-Dustmeter revealed that the resistance of treated seeds to abrasion can be regarded as a key factor for the amount of dust potentially being contained in the seed packages. Sugar-beet turned out to show the best resistance to abrasion, followed by OSR, maize and cereals. For maize seeds it was demonstrated that the overall emission of contaminated dusts can be reduced by about 90 % by improving the seed coating quality of seeds in terms of resistance to abrasion.[3] Therefore, in order to guarantee for a high technical standard of resistance of the seeds to abrasion and low amounts of dust in the seed bags, the use of neonicotinoids for seed treatment has been restricted to those facilities, which have adopted a quality control system (QS). This QS includes e.g. the training of staff members, the improvement of treatment recipes and procedures, the compliance with maximum permissible values for dust (e.g. Heubach-values: OSR < 0.5 g ha^{-1}; sugar beet < 0.25 g ha^{-1}), a technical check and where applicable a reconstruction of the technical equipment (incl. dedusting techniques, packaging, storage of pesticides and treated seeds, disposal of waste). Finally the compliance with the QS is inspected, verified and certified by an independent service. Only those facilities that have received recognition by the independent service are listed by the JKI. However, because a QS has not yet been established for the treatment of maize seeds, the suspension of neonicotinoid PPP as well as the prohibition of the sowing of maize seeds treated with neonicotinoids is still in force in Germany.

2.2 RMM on the seed package for the use of pneumatic seeding machines

The following label must be printed on the seed package:

- Treated seeds may only be sown by using a pneumatic seeding machine which operate with negative pressure, if this machine is registered in the "List of drift reducing sowing equipment" of the Julius Kühn-Institut (this can be seen on the Julius Kühn-Institut's website at <http://www.jki.bund.de/geraete)/>).

In order to reduce dust emission, the use of vacuum-pneumatic seeders for sowing of seeds treated with neonicotinoids is allowed only, if the emission of dust is reduced by a tested reconstruction of the vents, in order to guarantee for a high technical standard of reduction of dust drift. It has been

established for pneumatic (vacuum) maize seeding machines, that the emission of contaminated dusts can be reduced by about 90 % by reconstructing the vents (Rautmann D, 2011, unpublished) (Figure 1).

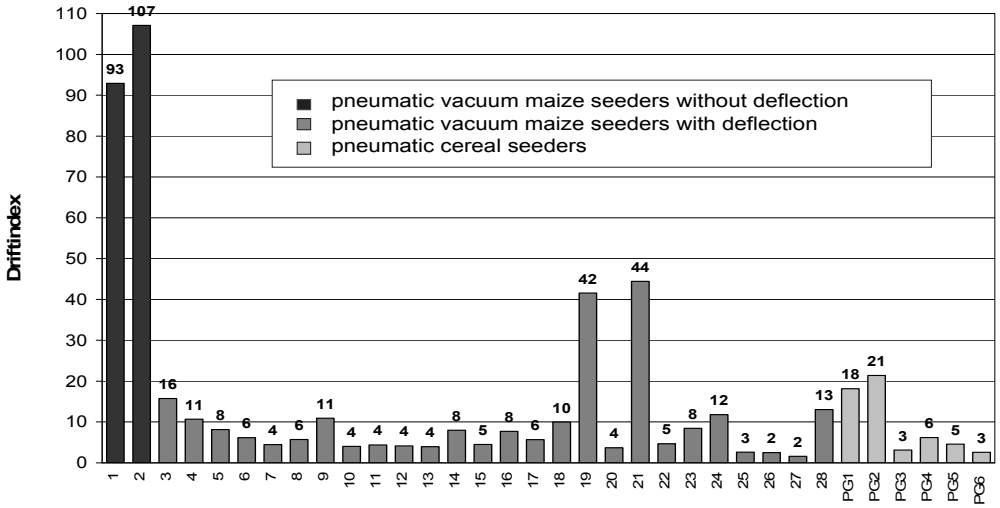

Fig. 1 The relative emission of dust by vacuum-pneumatic seeders for maize without (1, 2) and with deflection technique (3 to 28) and pneumatic cereal seeders (PG1-PG6) (Rautmann D, 2011, unpublished).

Only those seeders or deflector techniques that fulfill the requirements of 90 % reduction of emission compared to without deflector have received recognition by the JKI and are allowed to be used for seeding operations of seeds treated with certain insecticides.

2.3 RMM on the seed package to avoid dispersion of dusts and the spillage of treated seeds

To avoid the dispersion of dusts the following label must be printed on the seed package:

- Do not sow treated seeds at wind speeds of more than 5 m s^{-1}.

In order to minimise drift of dust particles, the sowing of seeds treated with neonicotinoids is allowed only, if the maximum wind speed does not exceed 5 m/s. This regulation is based on the findings of a literature study prepared at the University of Essen (Höke S and Burghardt W, 1997, unpublished). Obviously drift of soilborne particles of different nature into adjacent areas increased, if wind speed exceeded approx. 5 m s^{-1}. Furthermore the size and shape of particles affect the potential of drift with respect to distance and duration of sedimentation. However, further research and development activities should be initiated. Currently there is a lack of knowledge about the particular size distribution of dust particles from treated seeds and especially the transportation of particles smaller than approx. 70 microns. This fraction is subject to the mid and long distance transport and may contain particles of high pesticide concentration (Heimbach et al., 2011, unpublished).

To avoid the spillage of treated seeds the following label must be printed on the seed package:

- The treated seeds, including any dust they contain, or dust which is produced during the sowing process, has to be incorporated completely into the soil.

The spillage of treated seeds has been regularly reported in Germany and drift of dust from seeding actions is considered a common phenomenon for a number of crops. As honeybees collect water from different sources, e.g. puddles on or beside fields, they are likely to be exposed to contaminated water, creating a very high potential of risk, at least if neonicotinoids are concerned. In order to

reduce this risk, treated seeds and dust must be incorporated completely into the soil, when sowing seeds treated with neonicotinoids.

2.4 RMM on the seed package to protect honeybees

In order to make sure, that colonies are not located under unfavourable conditions, for instance directly adjacent to fields that were planted with treated seeds, beekeepers must be informed prior to the sowing of seeds treated with neonicotinoids.

The following label must be printed on the seed package:

- The farm manager is obligated to notify the area designated for the sowing of the treated seeds to beekeepers, whose bee hives are located within a radius of 60 m to the sowing area, at least 48 hours prior to sowing.

Bees usually find and collect water close to their colonies. Further to that, honeybees do not seem to prefer guttation water of treated plants but seem to use any other available water source near to their colony. However, current studies clearly showed that under certain conditions honeybees may forage on guttation drops of plants (Pistorius J et al., 2011, unpublished) near-by to their colony. Because concentrations of neonicotinoids in guttation drops of field crops may be very high for up to about 8 to 9 weeks (showing highest concentrations in maize of approx. 100 µl l^{-1}), these drops create a high potential of risk. Under certain situations it seems therefore advisable for beekeepers to place their colonies in a safe distance to the field or to provide appropriate water sources. In addition, the direct exposure of honeybee colonies to dusts from sowing can be omitted in order to further reduce the risk for honeybees.

3. Discussion and conclusions

In general, from the data available, it can be concluded that contaminated dust within the bags of treated seeds is commonly occurring and highly dependant on the type of crop and the treatment procedure. Usually, bags of cereals and maize contain higher quantities of dust compared to OSR and sugar beet. Dust particles once emitted by seeders deposit on soil and on plant surfaces. The drift of dust particles highly depends on the size and shape of particles, the type of seeder and surrounding conditions (e.g. wind speed, soil humidity). In fact the findings indicate that for seeding operations of some crops (e.g. cereals, maize and OSR), treated with compounds highly toxic for honeybees, best seed treatment techniques (i.e. reducing free dust within the seed bags as well as the abrasion of dusts) together with the best seeding techniques (i.e. reducing the dust emission e.g. by effective deflectors for vacuum-pneumatic seeders) need to be mandatory. For example, the total emission of dust occurring at maize seeding could be reduced by about 99 % compared to 2008 levels, if the treatment of seeds and the outlet air pipe of the seeders are improved.

So, in principle, the serious risks posed by some insecticides to honeybees may be contained satisfactorily by risk mitigation measures, as required in Article 49 of Regulation (EC) No. 1107/2009. However, in order to implement these legal conditions, Member States will need harmonized quality criteria for seed treatment and seeding technique, a harmonized approach to Risk Assessment as well as an agreed and open data base of relevant data for Risk Assessment and Risk Management. The appropriate risk mitigation measures as well as appropriate label phrases still need to be agreed. All aspects should be covered by the relevant Guidance Document which is currently being prepared lead-managed by the Netherlands.

Finally, further research and development activities should be considered, e.g. covering the occurrence, dispersal and toxicity of different fractions of dust from treated seeds.

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