Possible implications of the EU moratorium on neo-nicotinoids and change in use for phenylpyrazole products in cocoa

Roy Bateman, June 2013

A growing controversy on the causes of bee decline (sometimes referred-to as 'colony collapse disorder') over recent years has now resulted in an EU moratorium on the neonicotinoids (NNI): clothianidin, imidacloprid and thiamethoxam[1]. This forms an "Ongoing review of active substances" by the EU and a possible re-evaluation of fipronil (on the same page) is also of interest to cocoa producers. In this discussion document, I attempt to: (i) illustrate the consequences of the EUs move from hazard to risk-based decision making; (ii) examine possible medium-long term consequences to cocoa producers; (iii) discuss the immediate risk of high NNI levels in cocoa beans and (iv) suggest new recommendations.

The restriction on clothianidin, imidacloprid and thiamethoxam followed risk assessments by the European Food Safety Authority (EFSA)[2], which "concluded the following for all three substances:

1. Exposure from pollen and nectar. Only uses on crops not attractive to honey bees were considered acceptable.
2. Exposure from dust. A risk to honey bees was indicated or could not be excluded, with some exceptions, such as use on sugar beet and crops planted in glasshouses, and for the use of some granules.
3. Exposure from guttation. The only risk assessment that could be completed was for maize treated with thiamethoxam. In this case, field studies show an acute effect on honey bees exposed to the substance through guttation fluid.

EFSA's conclusions contain tables listing all authorised uses for seed treatment and as granules of the three substances in the EU ...". Subsequently, a restriction of use of the 3 NNI was adopted by the Commission. The move followed votes on 15 March 2013 to Member States' experts meeting at a Standing Committee on the Food Chain and Animal Health and on 29 April 2013 at an Appeal Committee where EU Member States did not reach a qualified majority – either in favour or against the Commission's proposal. The UK was one of the states voting against, influenced by a DEFRA evaluation of studies[3] purporting to link the 3 NNI to bee harm: this provides a useful literature search and found that much of the evidence was based on laboratory work and would not normally occur in field scenarios. Prof. J Beddington suggested the EU was in danger of failing to understand risk saying: "This potentially legitimises an overly precautionary approach in the absence of scientific evidence showing any risk."

In the USA, the Environmental Protection Agency (EPA) similarly has been petitioned by activist groups, including beekeepers, to likewise ban NNIs. A USDA report[4] describes several possible causes of national decline in honeybees, including: habitat loss, poor diet, diseases, parasites (especially *Varroa destructor*) and pesticide exposure (including sub-lethal effects that affect bee behaviour). Research so far points to a combination of these factors: which may be responsible for the 30% decline in honeybees annually since 2006. As in the EU, engineering controls can help minimise off-site dust movement from treated seeds, together with other standard good agricultural practices.

Implications for cocoa producers

In terms of global sales, NNIs are the most important group of insecticides with some 22% world sales in 2010[5]: with imidacloprid and thiamethoxam constituting the top two best sellers, having combined sales of more than $1.8 billion. The largest sectors for insecticide usage are fruit & vegetables, non-crop applications, rice, cotton and soybeans. Cocoa is very much a 'secondary market' for agro-chemistry companies, but these compounds are competing only with pyrethroids for mirid control in more than one cocoa-growing country. Systemic action (see below) was considered an advantage for replacement of older insecticides that had a fumigant action: which helped mitigate inadequacies in application. The introduction of thiamethoxam (under Syngenta stewardship) was initially attractive since it provided

[1] http://ec.europa.eu/food/animal/liveanimals/bees/pesticides_en.htm (April 2013)
[2] http://www.efsa.europa.eu/en/press/news/130116.htm?utm_source=homepage&utm_medium=infocus&utm_campaign=beehealth (January 2013)
[3] http://www.defra.gov.uk/environment/quality/chemicals/pesticides/insecticides-bees/ (May 2013)
[4] http://www.usda.gov/documents/ReportHoneyBeeHealth.pdf (October 2012)
[5] Phillips McDougall AgriService Products Section – 2010 Market (November 2011)

effective mirid control that was relatively safe to operators, with formulations that were in toxicity class III (previously all insecticides were in the most toxic classes I and II).

Residues of NNI

Neonicotinoid residues have been a matter of concern for cocoa producers: especially those shipping to Japan. Following the introduction of imidacloprid at the beginning of the century, regular and increasing cases of rejection of consignments at the Japan border (of more than one AI) date back to 2009. Special focus has been placed on Japanese MRLs since residue analysis is on whole beans without the husk removed. However, the highly systemic nature of NNIs raises the question of whether husk removal would have a reduced effect on residues.

Classification and Properties

There are now about a dozen NNIs that have been developed since imidacloprid was introduced in 1991 by Bayer AG and Nihon Tokushu Noyaku Seizo KK. They belong to three chemical sub-groups, of which two are of current interest in cocoa; the table below (data mostly from the *Pesticide Manual*) shows that the cyano-substituted NNIs are more than 3 orders of magnitude less toxic to bees orally and >2 orders by contact action. All NNIs are systemic having a high solubility and log P values of <1.

	solubility (g/l)	log P (K_{OW})	bee oral tox. (µg/bee)	bee contact (tox. µg/bee)	MRL (EU): husked (ppm)	MRL (Japan): whole bean
nitro(guanidine)-substituted ***neonicotinoids***						
clothianidin	0.3+ (dep. pH)	0.7	0.0038	>0.044	0.05	0.02
imidacloprid	0.61	0.57	0.005 - 0.07*	0.018 - 0.024*	0.05	0.05
thiamethoxam	4.1	-0.13	0.005	0.024	0.05	(0.01)
cyano-substituted (pyridylmethylamine) ***neonicotinoids***						
acetamiprid	4.25	0.8	14.5	8.1	0.1	(0.01)
thiacloprid	1.85	0.73	17.3	38.8	0.05	0.02
phenylpyrazole						
fipronil	0.002	4.0	0.004[6]		0.005	0.01

*: various studies in brackets: default MRL

At this stage, we can only speculate on the practical medium-long term consequences of this moratorium and any further restrictions in cocoa consuming countries. Withdrawal from use in the EU could result in diversion of products to secondary markets (with possible consequent 'price competitiveness' or 'dumping' depending on the viewpoint). Also expect cyano-substituted NNIs to be promoted, justifiably, as 'more bee-friendly' or similar. The immediate priority is residue management. Our understanding[7] is that there is generally a poor knowledge of dosage, concentration level of AI and consequently whether existing field application practices (and pre-harvest intervals) risk residue levels downstream exceeding of MRLs.

Fipronil

Fipronil is a broad-spectrum insecticide belonging to the phenylpyrazoles: chemically un-related but having a similar mode of action as lindane (HCH) and cyclodienes such as endosulfan. It has shown a steady increase in global sales since introduction (by Rhone-Poulenc) in 1993: it was the no. 3 best-selling insecticide in 2010 and is now under BASF stewardship. It is highly insecticidal by contact and ingestion, with reports of limited xylem systemicity in some monocotyledons (in spite of having low solubility and a logP of 4). Fipronil is highly toxic to honeybees, both by direct contact and by ingestion, but risk to bees was considered "minimal when used as a soil or seed treatment" until the EFSA re-evaluation of May 2013.

[6] Tingle CC, Rother JA, Dewhurst CF, Lauer S, King WJ. (2003) Fipronil: environmental fate, ecotoxicology, and human health concerns. *Rev Environ Contam Toxicol*.;**176**:1-66.

[7] including information provided by a concerned pesticide distributor at COPAL 2012

In the EU, fipronil is not permitted for use as spray treatments. "The specific provisions of the approval were amended by Commission Directive 2010/21/EU[8], to permit only use as a seed treatment and only where the seed coating is performed in professional seed treatment facilities, which must apply the best available techniques to ensure that the release of dust during application to the seed, storage and transport can be minimised, and where adequate drilling equipment is used to ensure a high degree of incorporation in soil, minimisation of spillage and minimisation of dust emission." In spite of being used in a number of veterinary products for flea and tick control fipronil, together with its more toxic sulfone metabolite, has a very low ADI value (JMPR) of 0.0002 mg/kg: thus it is typically formulated and used at very low concentrations. Its EU MRL in cocoa is notable in that it (uniquely) is less than the normal 'default' value of 0.01 mg/kg.

By 2012, the commercial fipronil product Regent SC had been registered in Ivory Coast and Cameroun as a spray for control of cocoa mirids; it has also been registered and used for several years in Indonesia against cocoa pod borer. The compound has a well-known efficacy against termites and is very useful in this respect for protecting cocoa seedlings: usually as a soil treatment and thus more compatible with standard international practice. In previous editions of the ICCO Manual *Pesticide Use in Cocoa,* fipronil has been listed as a 'Strategically useful' (group 'a') crop protection AI for termite control. Applied as sprays, a BASF representative has agreed that it should now be placed in 'group b' (Compounds to be used with great CAUTION) in Appendix 3 of the ICCO Manual. The criteria for this group have been clarified by adding: "compounds with an uncertain future and a history of issues, such as with (eco)toxicology or frequent exceeding of MRLs".

Conclusion and Recommendations

Registration Authorities in cocoa growing countries should remain vigilant and likewise maintain their on-going review of registered pesticide products appropriate to 21st century needs. However, as with other crops, policy makers must also foster a strategy for 'sustainable intensification': in this case maintaining a diversity of appropriate and efficacious range of active substances in various (>2) modes of action for control of key cocoa pests.

Those concerned with pesticide policy in cocoa should be aware that NNIs and fipronil are now very much 'in the firing line' of environmental activists and that their regulatory status in Europe and N. America could change eventually. Short and medium-term strategies to manage these issues are required now.

Imidacloprid-based insecticides in particular are now widely marketed in cocoa growing countries and MRL violation cases appear to be increasing. Attention to label rates (and clarity) for NNIs, field application practices and pre-harvest intervals in cocoa are clearly a priority issue for registration and extension staff.

We propose to re-assign imidacloprid and thiamethoxam[9]: moving them from 'group a' to 'group b' (Compounds to be used with great CAUTION) in Appendix 3 of the ICCO Manual. It may also be appropriate to place acetamiprid on the 'b' list until a Japanese MRL is established.

Has any organisation carried-out experiments to determine the degree to which husk removal affects measured residue levels in batches of cocoa thought to have high NNI content?

The insecticide fipronil will likewise be placed in group 'b', having now been registered for use as sprays, increasing operator hazards and the risk of residues in produce. Could its widespread use as a spray treatment on cocoa become an issue for criticism by pressure groups (given that it is forbidden in the EU)?

Toxicity of AIs to honey bees is of obvious interest to cocoa growing areas where hives are maintained. There is also a research need to assess the impact of insecticide products to principal cocoa pollinators such as *Forcipomyia* spp. *sensu lato* (Diptera: Ceratopogonidae). In his 1972 book[10] Entwistle stated "It is doubtful if the effects of insecticides on insect pollination of cocoa or on the pollination mechanism have been adequately investigated". This has perhaps become even more true today.

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[8] http://www.efsa.europa.eu/en/efsajournal/pub/3158.htm (EFSA Journal 2013;11(5):3158, 51 pp.) Fipronil was included in Annex I to Directive 91/414/EEC on 1 October 2007 by Commission Directive 2007/52/EC, and has been deemed to be approved under Regulation (EC) No 1107/2009, in accordance with Commission Implementing Regulation (EU) No 540/2011, as amended by Commission Implementing Regulation (EU) No 541/2011.

[9] clothianidin appears to have had little use in cocoa to date, but note: Nauen R, Ebbinghaus-Kintscher U, Salgado VL, Kaussmann M (2003) Thiamethoxam is a neonicotinoid precursor converted to clothianidin in insects and plants. *Pesticide Biochemistry and Physiology* **76**: 55-69.

[10] Entwistle PF (1972) *Pests of Cocoa*. Longman, London. 779 pp.