The Neonicotinoid Era:

The case for monitoring insecticide use on bee-attractive crops

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Beekeepers' arguments against the EU moratorium on neonicotinoid seed treatment for oilseed rape included absence of harm to honey bees and concern that replacement sprays might be more harmful. John Hoar reviews these arguments in the light of the UK vote to ban their outdoor use.

Introduction

On 27 April 2018, the EU voted to ban all outdoor use of three neonicotinoid insecticides: clothianidin, imidacloprid and thiamethoxam. These had already been subject to a moratorium on crops attractive to bees since 2013. The 2018 vote was supported by eighteen European countries, including the UK, opposed by four and with eight abstentions.[1]

When the EU proposed the moratorium in 2013, the UK Government voted against it but was bound to comply. Prof Ian Boyd, from Defra, noted that '*The evidence base supporting this restriction has been weak but there are indications, based mainly upon laboratory studies, that neonicotinoids could have non-target environmental effects.*'[2] The, then, UK Advisory Committee on Pesticides (ACP) also noted '*... the weight of evidence is growing that there could be an impact on bee populations in the UK.*'[3]

By 2017, the, now, UK Expert Committee on Pesticides (ECP) decided to support the moratorium, stating: *'Following several years of carefully reviewing new studies, data and information, we concluded that the weight of evidence had reached a point at which it could no longer be concluded that use of these chemicals posed an acceptable risk.'* Furthermore, *'In the light of emerging evidence of environmental contamination arising from the use of these insecticides, the ECP considered that extension of the restrictions to non-flowering crops could also be justified.'*[4]

Despite this, leading UK beekeepers cast doubt on the moratorium, citing weak scientific evidence of harm to honey bees and concern that replacement insecticides might be more harmful. This was in contrast to European beekeepers, who applied to the European Commission in 2013 for a complete ban.[5]

The purpose of this article is to review leading beekeepers' views in the light of the UK Expert Committee on Pesticides decision and to propose improvements in pesticide recording and monitoring.

Claims of absence of harm to honey bees

Leading beekeepers questioned the moratorium from the start. Norman Carreck from International Bee Research Association (IBRA) and Laboratory of Apiculture and Social Insects (LASI) stated: *"...many experiments and wide-scale studies in many countries over the years have failed to demonstrate harm to bees in the field."*[6] The British Beekeepers' Association (BBKA) agreed: *'The BBKA has continually asked for evidence that shows that honey bees in field conditions in the UK have suffered harm (lethal or sub-lethal) from exposure to neonicotinoid insecticides. To date none is in the public domain.'*[7]

Dr Chris Hartfield of the National Farmers' Union (NFU) told the House of Commons Environmental Audit Committee (EAC) Inquiry into 'Pollinators and Pesticides' on 21 November 2012 that "*Beekeepers, in my experience - and I talk to a lot of beekeeping groups - are not concerned about neonicotinoids and insecticides.*"[8] In 2014, John Whitaker, Master Beekeeper and author, said that his bees were adjacent to hundreds of hectares of oilseed rape (OSR) and appeared to thrive: "*It appears to me that the application of systemic pesticides, such as the neonicotinoids, as a seed dressing must be safer than spraying when the crop is growing.*"[9] In 2016, Carreck said that oilseed rape treated with neonicotinoid seed dressing is *'...prized by beekeepers as a honey crop, without adverse effects on the bees being noted.'*[10] In 2017, Peter Tomkins, formerly apiarist at Rothamsted Research, questioned the need for the moratorium and asked, albeit tongue in cheek, whether the UK could ignore the moratorium once it left the EU.[11]

Comment

The ECP decision in 2017 to support the moratorium and its extension to all non-flowering crops was significant for two reasons. First, the decision to ban neonicotinoids was reached four years after the start of the moratorium in 2013. Second, the evidence confirmed that the subtle, but accumulating, damage from neonicotinoids was beyond the ability of beekeepers to observe. This is confirmed in the references listed in the ECP advice entitled: '*Risks arising from the use of neonicotinoid pesticides*'.[12]

The view that seed treatments are less harmful to pollinators than insecticide sprays is correct in respect of acute exposure, but not for chronic exposure. Neonicotinoid seed treatments provide primary exposure via nectar and pollen of treated crops, and secondary exposure via residues in the soil, which can be taken up by subsequent crops or translocate to wildflowers adjacent to treated crops, resulting in chronic persistence and exposure to bees and other pollinators. Neonicotinoids target the part of the insect brain which is responsible for learning and memory. Accumulation in the bee brain causes neuronal dysfunction that limits a bee's capacity to learn and remember (Figure 1).[13]

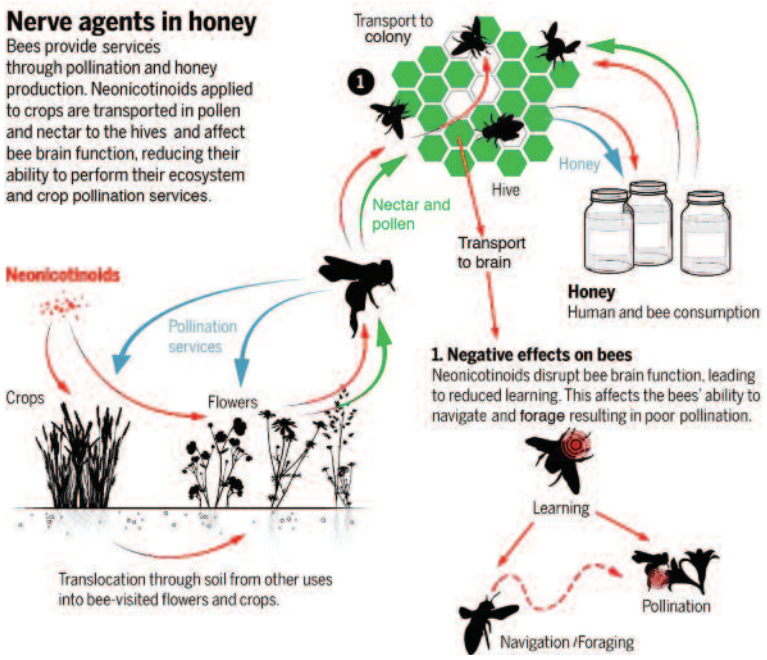

Figure 1. Nerve agents in honey (Connolly, 2017).

Prolonged chronic exposure may eventually impact on colony function. Although the effects on large, healthy colonies foraging on flowering oilseed rape is expected to be negligible, buffered as they are by tens of thousands of bees, smaller or diseased colonies are likely to suffer. The impact of a harsh winter may also increase susceptibility to neonicotinoids.[14]

In conclusion, it was not possible for beekeepers to reach an informed view on the effects of neonicotinoids simply by observation. Furthermore, by focusing on bees and oilseed rape alone, the issue of environmental contamination arising from secondary exposure appears to have been overlooked.

Claims about older, more hazardous chemicals sprayed on oilseed rape

Before the moratorium, leading beekeepers warned that any replacement sprays might be more harmful to bees. In 2013, Dr David Aston said *'...the BBKA does not wish to see any action taken that may in itself cause damage to pollinators for example by the inevitable re-adoption by farmers of older superseded and more hazardous chemical agents being re-employed in crop protection.'*[15]

Although the pyrethroids were identified as the likely alternative insecticide spray,[10,16] other leading beekeepers referred to unidentified older and more hazardous chemicals.[9,17] It was also stated that neonicotinoids reduced the number of sprays when they were introduced in 2002, so that the moratorium would result in more frequent spraying.[11,16]

Once the moratorium was in progress it was reported that farmers had resumed spraying older chemicals. In 2016, Tim Lovett (BBKA) said: *'It's ironic that the ban on neonicotinoid pesticides has meant that farmers have had to revert to older chemical formulas which are sprayed.'*[18]

On 23 September 2016, Carreck told listeners of BBC Radio 4 Farming Today, *"...we've seen much older chemicals, which we actually know less about, being used and beekeepers, I think, are concerned what the consequences of that might be."*[19] He later wrote: *'The neonicotinoid moratorium has undoubtedly led to the increased use of older insecticides...'*[10]

Comment

Before the 2013 moratorium, it was understandable to be concerned that replacement sprays might present a greater risk to bees, even if they were only to be sprayed on seedling oilseed rape in the autumn. Although pyrethroids were cited as the alternative to neonicotinoid seed treatments, others referred ambiguously to older, more hazardous chemicals, even during the moratorium. No distinction was made between authorised and unauthorised insecticides and data sources were not identified.

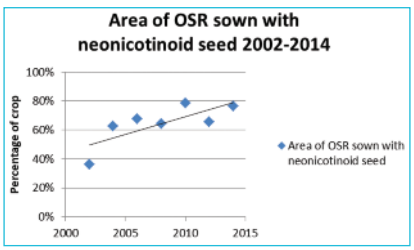

Figure 2. Area of oilseed rape crop sown with neonicotinoid seed (Fera Science).

Figures 2 to 5 are compiled from Fera Science Pesticide Usage Survey Reports and illustrate insecticide use on oilseed rape during the neonicotinoid era (2002–2014) and the moratorium (2016). Figure 2 shows the percentage of the annual oilseed rape crop sown with treated seed.

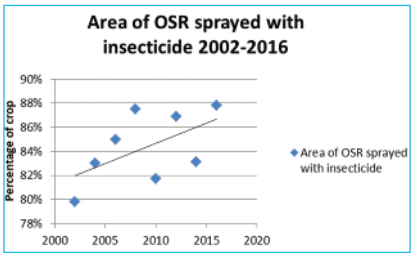

Figure 3. Area of oilseed rape (OSR) crop sprayed with insecticide (Fera Science).

Figure 3 shows the percentage of oilseed rape sprayed with insecticide. Thus, the majority of oilseed rape received both neonicotinoid treated seed and insecticide sprays until the moratorium in 2013.

Figure 4 shows the average number of insecticide sprays increasing from 2002, showing no reduction when neonicotinoids were introduced.

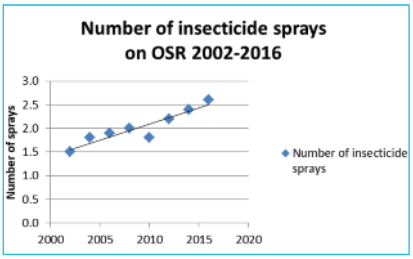

Figure 4. Number of insecticide sprays on oilseed rape (Fera Science).

Furthermore, the number of sprays in 2016 was consistent with previous increases. Finally, Figure 5 shows that pyrethroids were the dominant insecticide throughout this period, including the moratorium.

It would be interesting to find out if the same trends in insecticide use are occurring in other bee-attracting crops. As farmer, David Walston, observed *'The more we use artificial fertilisers and pesticides, the more we need to use them again next year'*.[20]

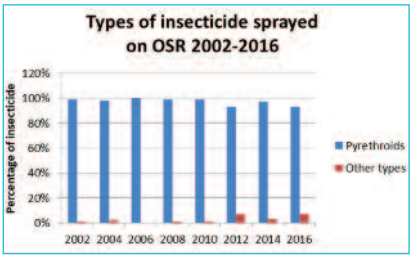

Figure 5: Types of insecticide sprayed on oilseed rape by area (Fera Science).

In conclusion, Fera Science data shows no reduction in the number of sprays when neonicotinoid seed treatments were introduced in 2002, nor that older or more hazardous chemicals were sprayed on oilseed rape during the moratorium.

The case for monitoring insecticide use on bee-attractive crops

Between 2013 and 2017, leading beekeepers presented a negative view of the moratorium on neonicotinoids. Although the original evidence supporting the moratorium was weak, they did not take the opportunity to update their position in the light of the post-2013 evidence, for example the studies listed in ECP (2017).[12] Their main argument in defence of neonicotinoids was that the moratorium obliged farmers to revert to spraying older, more hazardous chemicals on oilseed rape. In both cases this was incorrect because farmers never stopped spraying the same pyrethroid insecticides when neonicotinoids were introduced in 2002. This view on neonicotinoids and oilseed rape was very similar to that of the crop protection industry.

Sean Sparling, Chair of the Association of Independent Crop Consultants, told Scottish beekeepers in April 2017 that *'Seeds coated in neonicotinoid dressing were placed out of the way, buried under ground away from non target species and their use directly led to a huge reduction in the foliar application of insecticides in oilseed rape.'*[21] Yet, despite these apparent advantages, within six months the ECP decided to extend the moratorium to non-flowering crops, which must have left Scottish beekeepers somewhat bemused.

In 2014, Aston observed: *'The continuing use of pesticides in today's intensive agriculture, whether we like it or not, is something that we and our bees (and other pollinators) have to contend with.'*[22] Given the disparate views on insecticide use on oilseed rape, it is remarkable that there is no agreed position on a crop prized by beekeepers. Monitoring trends in pesticide use on bee-attractive crops using verifiable records seems to be a common-sense exercise, rather than having to rely on anecdotal accounts.

Towards a pesticide monitoring scheme fit for purpose

In a keynote paper on pesticide regulation, Milner and Boyd (2017)[23] stated that pesticides such a neonicotinoids and glyphosate can harm the environment when used at industrial scales, admitting that '*...the effects of dosing whole landscapes with chemicals have been largely ignored by regulatory systems.*'[23] Furthermore, the UK '*...has no systematic monitoring of pesticide residues in the environment...*'.[23]

Pesticide residues in honey are an indication of contamination in the local landscape. In a worldwide survey of neonicotinoids in honey, 75% of 198 samples collected between 2012 and 2016 were found to contain neonicotinoids, nearly half of which were at levels known to be neuroactive in bees (Figure 1).[24]

Milner and Boyd also noted: *'There is little information about where, when and why pesticides have been used, making it very difficult to quantify potential environmental effects.'*[23] The Fera pesticide usage reports, comprehensive as they are, only provide a UK-wide account of pesticide use on individual crops, based on a sample of farms which are surveyed every other year. Furthermore, the surveys take more than one year to collect, analyse and publish.

Arguably the existing scheme is not fit for purpose in today's intensive agricultural system. If farmers' use of pesticides was uploaded following application to a searchable database, it would provide a record of actual pesticide use. This would allow correlation of local pesticide use with ecosystem damage i.e. insect abundance and biodiversity.[13] In addition, Milner and Boyd noted that: *'such a system would promote genuinely risk-based pesticide use that would make the trade-offs between the environmental costs and food production more explicit.'*[23] BeeConnected is a web-based crop spray alerting system, a joint venture between the BBKA, NFU and the Crop Protection Association (CPA). It suggests that arable farmers have the capability to upload pesticide use direct to Fera Science. This would satisfy Milner and Boyd's need for where, when and why pesticides are used. If the BBKA, together with other UK NGOs, were to engage with the NFU, CPA and Fera Science, it would provide a long overdue improvement in pesticide recording and monitoring and a significant step in environmental protection.

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