POTENTIAL FOR ADDITIONAL ECOLOGICAL REALISM IN PESTICIDE RISK ASSESSMENTS FOR SPRING SEED TREATMENTS?

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Introduction

Pesticides intended for agricultural use in Europe are subject to environmental risk assessment under EC Regulation 1107/2009. This includes an evaluation of the potential toxicity to wild birds and mammals under a tiered risk assessment system. Murfitt (2012) summarised the history of the risk assessment process for birds and mammals and provided a discussion of key elements. These include the difficulties involved in long term (reproductive) risk assessments, which are typically conducted at the individual bird level, whereas the focus of concern is generally accepted to be population level effects (e.g. EFSA, 2009).

Long term assessments for seed treatments may be particularly challenging, due to the direct loading of the pesticide onto the seed and potential attractiveness of seed as food for wildlife. Compound specific decay rates on treated seed, consideration of dietary information and proportion of time spent foraging in the treated area for a representative bird species may be included in higher tier assessments to refine default assumptions. Nonetheless, the assessment may still indicate the potential for concern at the individual level. This is particularly so for spring drilled treated seed, where exposure of breeding birds is considered more likely than for autumn drilled crops. This article explores the potential to assess the exposure of birds to spring seed treatments at the population rather than individual level, thereby adding ecological realism to long term risk assessments. prior to the start of the breeding season and acceptable long term risk may (although not necessarily) be concluded on this basis. For spring drilled seed, however, there will be an assumption of potential exposure during the breeding period. This assumption is a key element of potential conservatism in the long term risk assessment. Another is that assessments are made on an individual bird and one-field basis with no formal consideration of exposure at the population level. While an assessment of Proportion of Time (PT) spent foraging in the treated area is routinely included in refined risk assessments (EFSA, 2009; e.g. Murfitt, 2012), this is conducted on an individual bird basis and does not constitute an assessment of exposure at the population level.

The risk assessment guidance (EFSA, 2009) states that the proportion of a population that is exposed to an active substance at any one time (including the area likely to be treated in relation to population distributions) may offer a way forward in terms of adding context to risk assessments. In addition, provision is made for discounting the need to conduct a long term risk assessment if exposure during breeding can be ruled out, as for autumn-drilled crops mentioned above. One potential exception is for potential endocrine disrupting compounds which may exert an effect on reproduction following earlier exposure outside of the breeding period.

Population modelling provides a potential route for refining risk estimates (EFSA, 2009) and models that consider wider landscape issues and indirect effects of pesticides have been developed for species such as Skylark Alauda arvensis (e.g. Topping & Odderskær, 2004). A recent report from the EU (EU, 2012) highlighted the need for added realism in risk assessments and the issues surrounding extrapolation from individual level assessments to populations and ecological communities; Forbes et al. (2001) suggested that individual level risk assessments, when extrapolated to population level effects, may be overly protective. Populations are dynamic and may have the capacity to recover from effects which appear unacceptable when assessed at the individual level. Work is ongoing to develop population level approaches for regulatory use (e.g. Marie Curie CREAM initiative: http:// cream-itn.eu/). Currently, however, there is no formal mechanism to account for exposure to spring drilled treated seed at the population level for birds. Is there potential, therefore, within the protective risk assessment framework, to add realism to exposure estimates through consideration of spatial and temporal factors?

Risk assessment exposure assumptions

The exposure of breeding birds to autumn drilled treated seed is generally considered to be low as drilling is completed



Figure 1. Comparison of percent of spring barley drilled per month in 2004 (ADAS data holdings) and cumulative percentage first egg dates for Skylark (Joys & Crick, 2004).

Timing of breeding and drilling

The key assumption with regards to spring drilled seed is that drilling at this time may lead to exposure of breeding birds. This is, therefore, a useful place to start to test exposure assumptions. The Skylark is commonly used as a focal species for refined long term risk assessments in the UK and other EU Member States, due to its ubiquitous occurrence as a breeding species of arable farmland. Information on breeding milestones is available (e.g. for UK, Joys & Crick, 2004). This may be combined with information on timing of drilling activity to arrive at an estimate of the proportion of breeding bird activity that may occur during the drilling period. A schematic example is shown in Figure 1. Here, breeding activity is shown by cumulative first egg dates - note that adjustment of breeding data may be required to account for pre-egg laying aspects of the breeding period such as pair bonding, nest site selection and copulation. In this case, the drilling data is from ADAS data holdings.

For seed treatments, however, other species may also be relevant. For instance, Yellowhammer (*Emberiza citrinella*), Linnet (*Carduelis cannabina*) and Rook (*Corvus frugilegus*) may also take seed. Figure 2 shows that breeding activity in the Skylark may not represent the worst case in terms of coin-





cidence with spring drilling activity. Due to differing body mass, food intake rates and foraging ecology, the estimated exposure may, however, vary significantly between species. Selection of a worst-case, representative species, on which to focus the risk assessment will, therefore, depend upon a combination of diet selection (proportion of seeds in diet) and timing of breeding. For example, breeding in the Rook is likely to coincide to a greater degree with drilling of spring crops, but dietary exposure (per unit of body mass) will be lower than for smaller species due to lower food intake rate per unit body mass in larger animals.

Key data considerations for this aspect of the assessment are that the breeding data are adequately interpreted in terms of pre-egg laying activities and multiple broods, and that the seed drilling data sufficiently reflect variability that may occur between years. The latter may be achieved through using data collected over several years.

Density of crop in the landscape

The extent of a crop in the agricultural landscape may, intuitively at least, be considered relevant to the extent of exposure of breeding bird populations to treated seed. The foraging behaviour of the birds is, however, crucial. For instance, a particular crop may occupy only 1% of a farmed landscape, but if the seeds are attractive to widely dispersive birds, the seed of that crop may occur in the diet at a rate higher than that indicated by land cover alone, i.e. the foraging ecology of the bird allows it to exploit the seed as a food source preferentially. In comparison, a bird with a reduced foraging flight distance during breeding would be less likely to encounter the seed and therefore its exposure would, at the population level, be closer to the extent of the crop in the landscape. There is an interaction, therefore, between the geography of the crop and the behavioural ecology of the focal species. Figure 3 shows spring barley as a percent of farmed area in East England from 2000 - 2010 (DEFRA Agricultural census). The average land cover is 3.3% in East England. Poulsen et al. (1998) reported breeding Skylark foraging flight distance in England and showed this to be approximately 270 m in spring barley, falling to 200 m as chicks developed. It is clear, then, that Skylark would be unlikely to encounter seed of a particular crop in the wider landscape, beyond the confines of the field in which the nest was located and those immediately adjacent.

This leads to another, hypothetical, scenario under which birds such as Skylark may be exposed to treated seed - nesting directly on the recently drilled field and foraging there; exposure could occur regardless of foraging distance. In fact, while Skylarks will regularly nest in cereal fields, this only occurs after crop emergence. Preferred nest sites consist of established vegetation (e.g. grass or cereals), reported as 15–60 cm height and 35-60% ground coverage in Germany (Toepfer & Stubbe, 2001) and 20-50 cm height in England (RSPB Skylark advisory sheet for England), for example. This is driven by the need for sufficient cover to avoid detection by predators while allowing adequate access to the soil surface for invertebrate foraging opportunities (very dense crops hinder both foraging and escape flight) (e.g. Eggers, 2011 and references therein). Therefore, exposure of Skylarks to treated seed in the field in which the birds are actively nesting is unlikely, since the seed





Figure 3. Spring barley as a percentage of farmed area, years 1999–2010, East England (DEFRA June Survey of Agriculture and Horticulture).

would have already germinated. Exposure to treated seed may be considered most likely, therefore, from adjacent fields and this should be considered in relation to the limited foraging range exhibited by birds such as Skylark.

Consequences for exposure

It is clear, therefore, that there is potential to add significant realism to exposure estimates when assessing the risk of pesticide, via spring drilled treated seed, to farmland birds. The timing of breeding in relation to recent data on drilling timing may help refine focal species, by discounting some and focusing effort on others. The amount of breeding activity that may occur during the relevant exposure window (drilling period and decay of residues on seed) may also be calculated. The extent of the crop in the landscape (often relatively low for spring drilled crops, depending upon country and region) may be combined with ecological knowledge and the temporal aspects of timing of breeding and drilling activity to arrive at an estimate of likely exposure at the population level for a particular focal species and crop scenario. Such information, which may consist of the likely fraction of breeding activity potentially exposed, may be used to contextualise an accompanying dietary assessment in a risk management decision or as input into landscape-based models of population productivity.

Summary

Long term pesticide risk assessments for birds are typically conducted at the individual level, whereas the aim is to protect populations. For seed treatments, long term assessments may be challenging and indicate potential for unacceptable risk even after considerable refinement. Through considering landscape, cropping and ecological factors in a population level assessment, however, there is potential to add realism while remaining protective of populations. The disconnect between individual level effects and exposure assumptions versus population level risk assessments is widely recognised as a challenge facing environmental risk assessors in the EU.

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