Are treated seeds an ecological trap for birds?

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Introduction

Due to reductions in winter food resources, newly sown cereal seeds have become a key component of many bird species' diet, but these seeds are often treated with pesticides that may cause toxic effects. Systemic insecticides (neonicotinoids and fipronil), widely used for seed treatment, have been proven to be highly lethal and to affect some species reproduction at the doses used for seed treatment [1,2]. Toxic effects on birds have also been reported for the most used fungicides, like dithiocarbamates and triazoles [3,4]. However, to complete an appropriate risk assessment, these data on treated seed toxicity need to be combined with information about the risk of exposure of birds in the field and the factors that modulate such exposure. The aims of the present work are to characterize the exposure of farmland birds to pesticide-coated seeds in the wild, and to estimate the risk of poisoning of animals as a consequence of such exposure. To do this we analysed crop and gizzard contents of hunted partridges to detect residues of pesticides used for seed treatment. Moreover, we measured the contribution of cereal seeds in the winter diet of partridges in order to assess the potential risk of exposure to pesticide-treated seeds. We also studied the abundance of pesticide-treated seeds available for birds in the field, the pesticides and their concentrations in these treated seeds, and the bird species observed in the field that were feeding on them.

Material and Methods

The availability of sown seeds was studied in Spain in fields at four fields of the Northern Plateau and 44 fields around Tablas de Daimiel National Park, a continental protected wetland located in the Southern Plateau. We determined seed availability on the soil surface within the 48 h following sowing. Additionally for the Southern Plateau, we recorded the sowing technique and weather conditions from sowing to sampling days. From each field we collected a sample of sown seeds for pesticide analysis.

Moreover, we performed a total of 89 bird censuses in 23 of the studied fields around Tablas de Daimiel shortly after finishing sown seed sampling. All the species feeding in the sown fields were counted and the feeding behaviour recorded.

Finally, we analysed 189 red-legged partridges' upper digestive tracts donated by hunting associations in order to detect residues of pesticides used for seed treatment. Samples came from 51 locations from seven provinces in Spain. All partridges were hunted between October and February. We also determined the percentage of each food category (i.e. green plant material, weed seeds, winter cereal seeds, insects and others) in the total biomass content.

The determination of pesticides in sown seeds and digestive contents was performed by LC-MS. We determined a total of nine active ingredients out of the 12 approved for use as seed treatment in Spain, two insecticides (imidacloprid and fipronil) and seven fungicides (metalaxyl, thiram, triticonazole, tebuconazole, difenoconazol, flutriafol and fludioxinil).

Results

Seed availability was influenced by the sowing method and the location within the field. Regardless of the sowing technique, there were more seeds on the surface in the headland (43.4 ± 5.5 seeds/m^2) than in the field centre (11.3 ± 1.2 seeds/m^2) (t_{151}=-4.67, p<0.001).

Six pesticides, mostly fungicides, were detected in the seeds collected from recently sown fields. 55.2 % of the seed samples contained detectable levels of pesticides, with tebuconazole being the most frequently found active ingredient.

During the sowing period, 31 species were observed feeding on sown cereal seeds.

We detected pesticide residues in the digestive content of 32.3% of the analysed red-legged partridges (Figure 1), including insecticides in a 3.7% of the analysed samples and fungicides in a 29.6% of them. As observed in seeds, tebuconazole was the most frequently detected pesticide (19.1% of the samples).

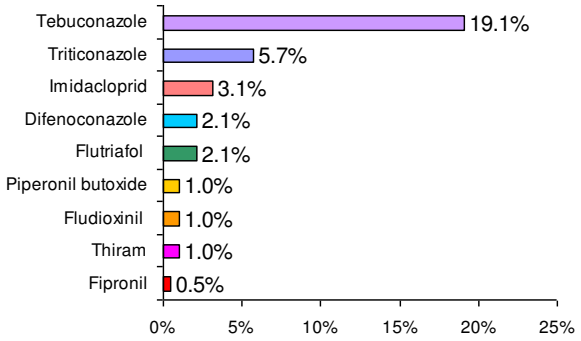

Figure 1. Percentage of crops (n=189) in which each kind of pesticide was detected.

Winter cereal seeds represented a 53.4% of the biomass found in the digestive content of red-legged partridges but significant differences were observed between provinces ($F_{6,104}$=3.7, p=0.002). The presence of pesticides in the digestive content of partridges was not explained by the amount of any type of food in the digestive content but was positively explained by the percentage of cereal seeds relative to the total biomass of the digestive content (Wald=3.9, d.f=1, p=0.04) and was also positively explained by the percentage of the territory used for winter cereal cultivation at each location (Wald=4.1, df=1, p=0.04).

Conclusion

The present study demonstrates that the use of pesticide-treated seeds constitutes an important way of exposure of farmland birds to pesticides, and that there exists a potential risk for these birds to suffer toxic effects from ingestion of treated seeds in the wild. In the light of these results, the use for seed treatment of some pesticides, including insecticides such as imidacloprid or fipronil and fungicides such as thiram or tebuconazole, should be reconsidered to avoid further adverse impacts on farmland birds.

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