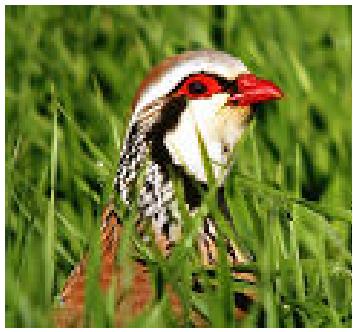
Risk of imidacloprid-treated seeds for red-legged partridges

Ana Lopez-Antia, Jordi Feliu, Pablo R. Camarero, Manuel E. Ortiz Santaliestra, Francois Mougeot, Rafael Mateo.

INTRODUCTION

MOTIVATION OF THE PROJECT

Hunters concerned by pesticide effects on red-legged partridge



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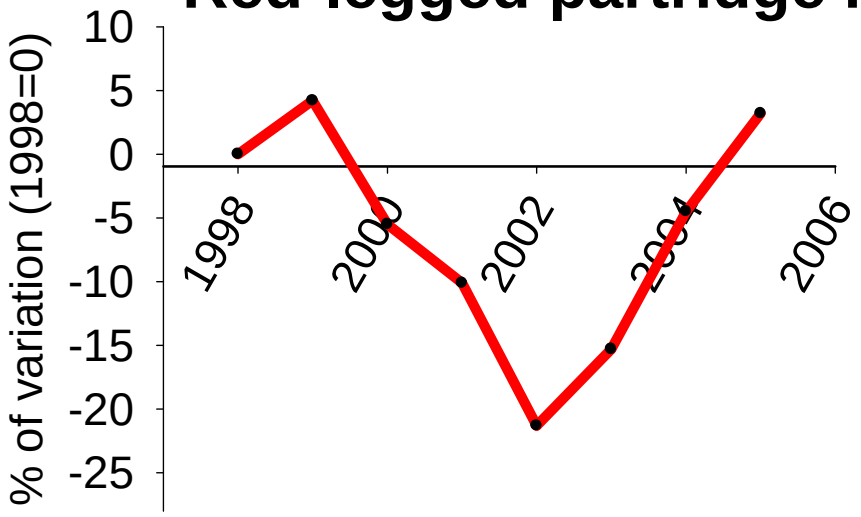
Red-legged partridge in Spain



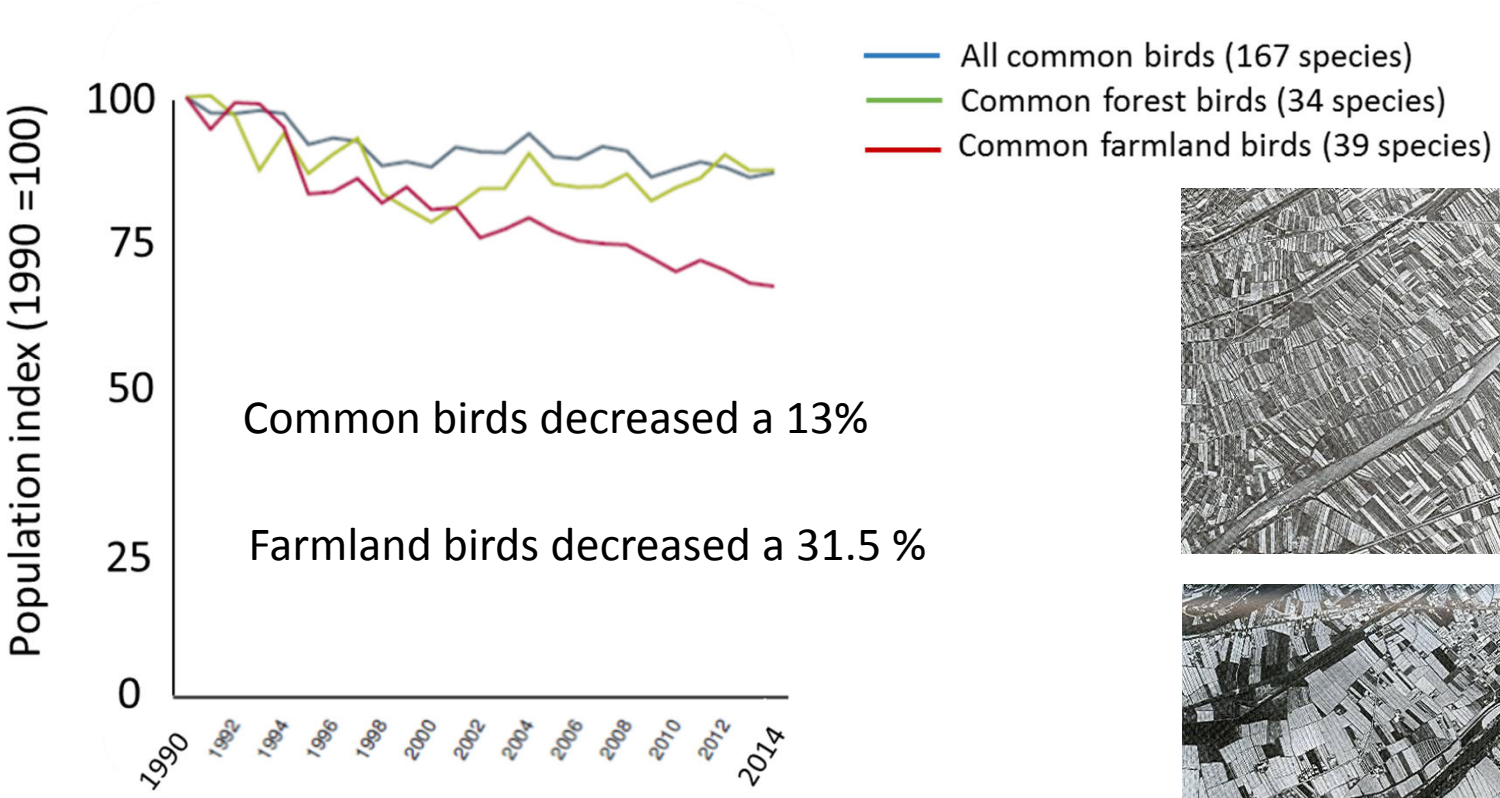
Around 5 million of farm-reared partridges are released every year for hunting.

[1]SEO/Birdlife (2010).

INTRODUCTION

DECLINE OF FARMLAND BIRDS

EU countries – Common Birds-population index



Common birds decreased a 13%

Farmland birds decreased a 31.5 %

Intensification of agriculture

European Environmental Agency 2017 (population index provided by European Bird Census Council).

INTRODUCTION

PESTICIDE IMPACT ON BIRDS

PESTICIDES

Indirect effects

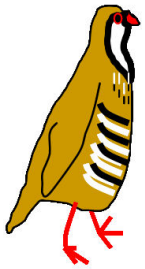
Loss of animal food (e.g. invertebrates)

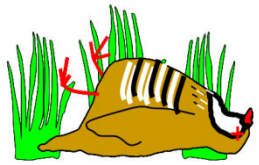
Herbicide use

Herbicide use

Insecticide use

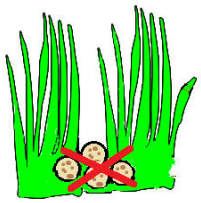
Loss of condition





Mortality

Reduced breeding output



Rands, 1985

Direct effects

Sub-lethal effects

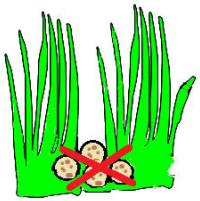
Loss of condition

Endocrine disruption

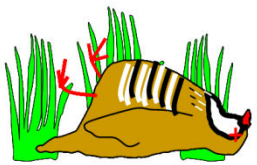
Neurologic effects

Effects of immune system

Lethal effects



Reduced breeding output



Mortality

Stoate et al. 2001; Moreby, 1997; Fry, 1995; Campbell et al. 1997; Evans and Smith, 1994; Boatman et al. 2007; Green, 1984; Potts, 1991.

INTRODUCTION

TREATED SEEDS

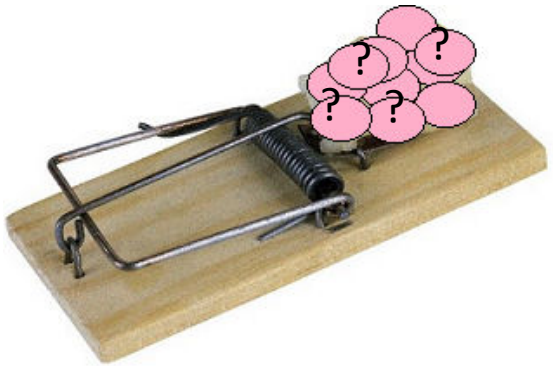
Seeds coated with pesticides (insecticides, fungicides)

Used in >80% of annual crop fields

- Place the pesticide where it is needed – eliminate the need of spraying
- Seeds not properly buried
- Spillage spots
- Can induce the ingestion of large amounts of pesticides in short time

Accidental spillage in France ©P. Tripault/FDC 77

- Potentiated by the scarcity of other food resources



Stanley and Bunyan,1979; Murton and Vizoso,1963); Turtle et al. 1963; Flickinger and King, 1972; Hamilton et al. 1976; Blus et al. 1979; White et al. 1983; Blus et al. 1984; Stone and Gradoni, 1985; Blus et al. 1991; De Snoo et al. 1999; Lelievre et al. 2001; Berny et al. 199

INTRODUCTION

IMIDACLOPRID

- EU moratorium on the use of neonicotinoids (Regulation 485/2013)
- Still used: seed treatment of winter cereal, after crop flowering and in crops harvested before flowering.

Environ Sci Pollut Res
DOI 10.1007/s11356-016-8272-y

RESEARCH ARTICLE

Field evidence of bird poisonings by imidacloprid-treated seeds: a review of incidents reported by the French SAGIR network from 1995 to 2014

Florian Millot[1] · Anouk Decors[1] · Olivier Mastain[2] · Thomas Quintaine[1] · Philippe Berny[3] · Danièle Vey[3] · Romain Lasseur[3] · Elisabeth Bro[1]

732 dead birds (11 species) / 105 incidents

- 4 cereal treated seeds = LD50
- 1.2 sugar beet seeds = LD50

Berny et al. 1999; Ibañez et al. 2011; Mineau and Palmer 2013; Millot et al. 2016;

INTRODUCTION

OBJECTIVES

- Study the toxicity of seeds treated with imidacloprid to red-legged partridges: effects on survival, reproduction and other functions

- Study the acceptance-avoidance of treated seeds under different experimental conditions to assess the risk of poisoning in the field

- Study the availability for birds of treated seed after sowing and detect the pesticide in the crop of hunted birds

METHODS

TOXICITY TRIALS

	Trial 1 Spring 2010	Trial 2 Autumn 2010-Spring 2011
Pesticides	Difenoconazole **Imidacloprid** Thiram	**Imidacloprid** Thiram
Doses		
Exposure tim		
Pairs / treatment		
Laying perio		

Environmental Research 136 (2015) 97–107

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Imidacloprid-treated seed ingestion has lethal effect on adult partridges and reduces both breeding investment and offspring immunity ☆

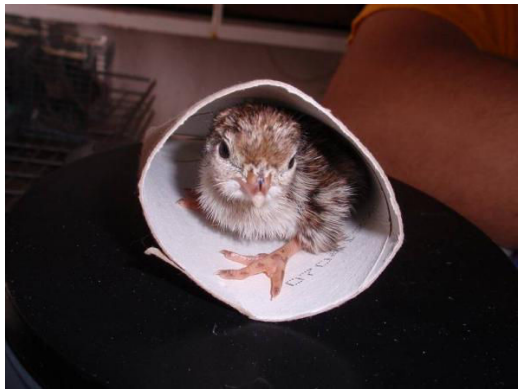
Ana Lopez-Antia [a,*], Manuel E. Ortiz-Santaliestra [a,b], François Mougeot [c], Rafael Mateo [a]

[a] Instituto de Investigación en Recursos Cinegéticos (IREC) CSIC-UCLM-JCCM, Ronda de Toledo s/n, 13071 Ciudad Real, Spain
[b] Institute for Environmental Sciences, University of Koblenz-Landau, Fortstraße 7, 76829 Landau, Germany
[c] Estación Experimental de Zonas Áridas (EEZA) CSIC, Ctra. de Sacramento s/n La Cañada de San Urbano, 04120 Almería, Spain

METHODS

TOXICITY TRIALS-ENDPOINTS

Adult health	Reproductive output	Chick health
Survival	Fecundation	Survival
Physical condition	Hatching rate	Birth condition
Ornamentation	Egg size	Growth
Immune response (PHA-SRBC)	Eggshell thickness	Immune response
Oxidative stress	Carotenoids and vitamins in eggs	Sex ratio
Plasma biochemistry		
Hormone, vitamin and carotenoid levels		



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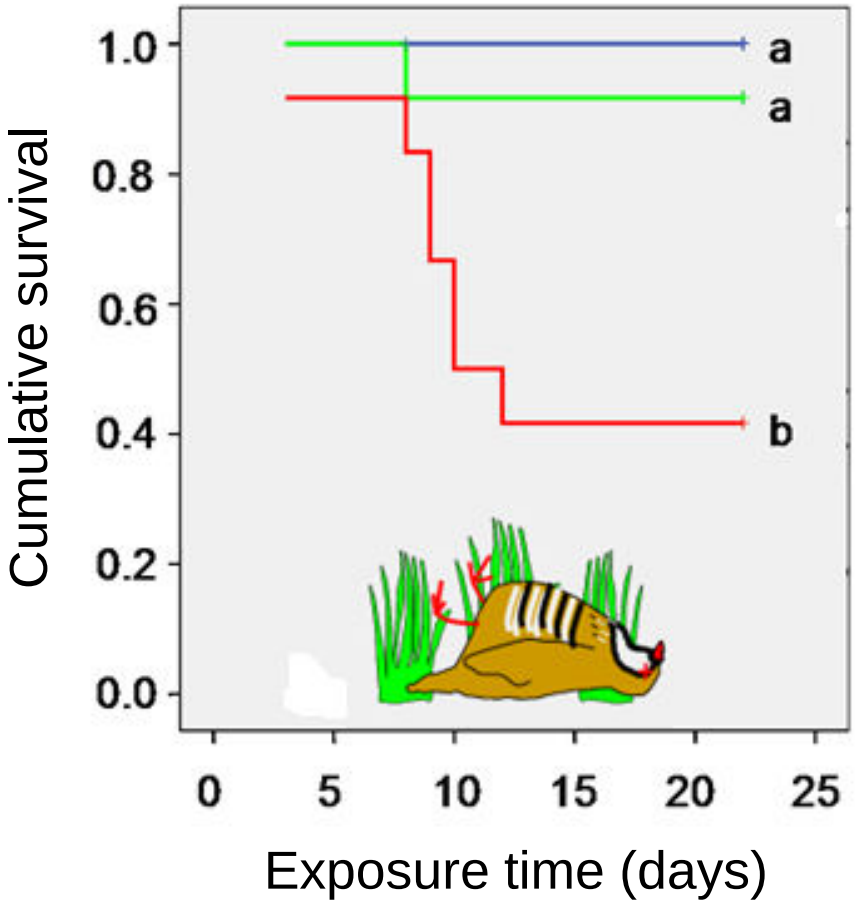
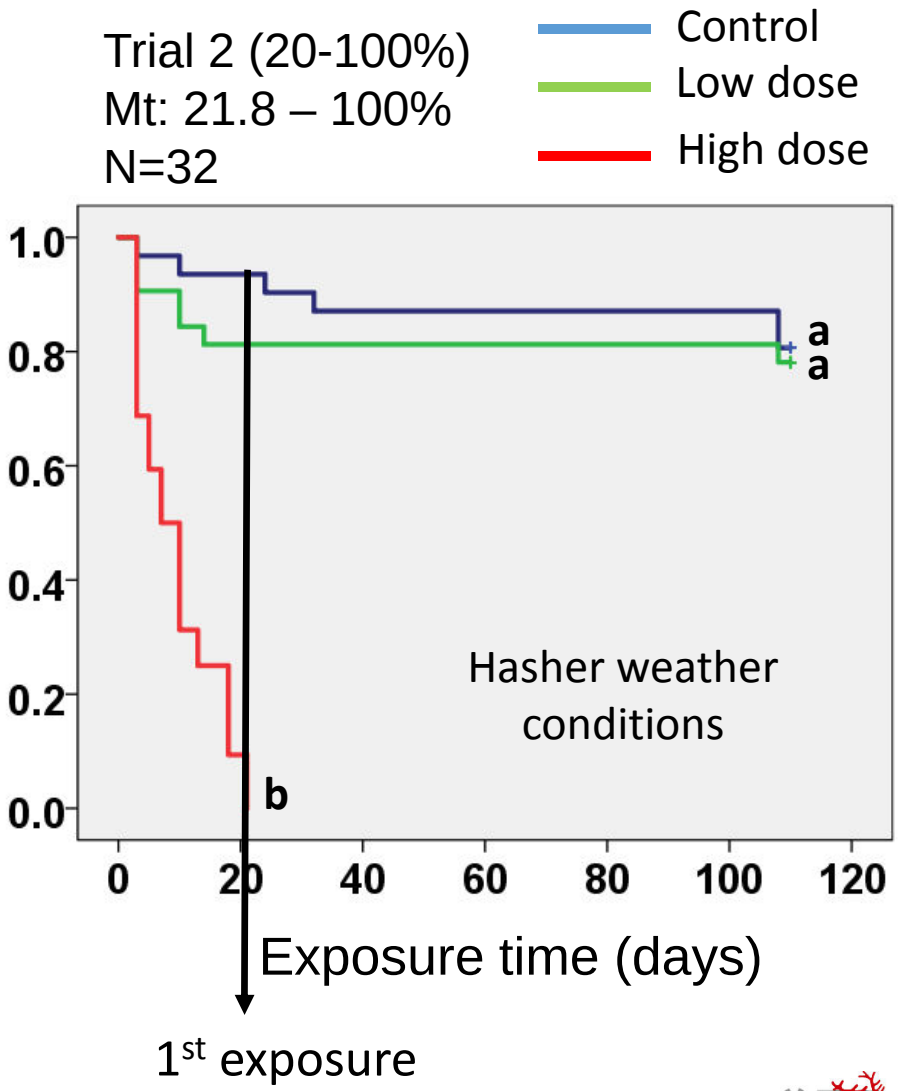
RESULTS & DISCUSSION

TOXICITY TRIALS

Trial 1 (100-200%)
Mt: 8.3-58.3%
N=12



Trial 2 (20-100%)
Mt: 21.8 – 100%
N=32

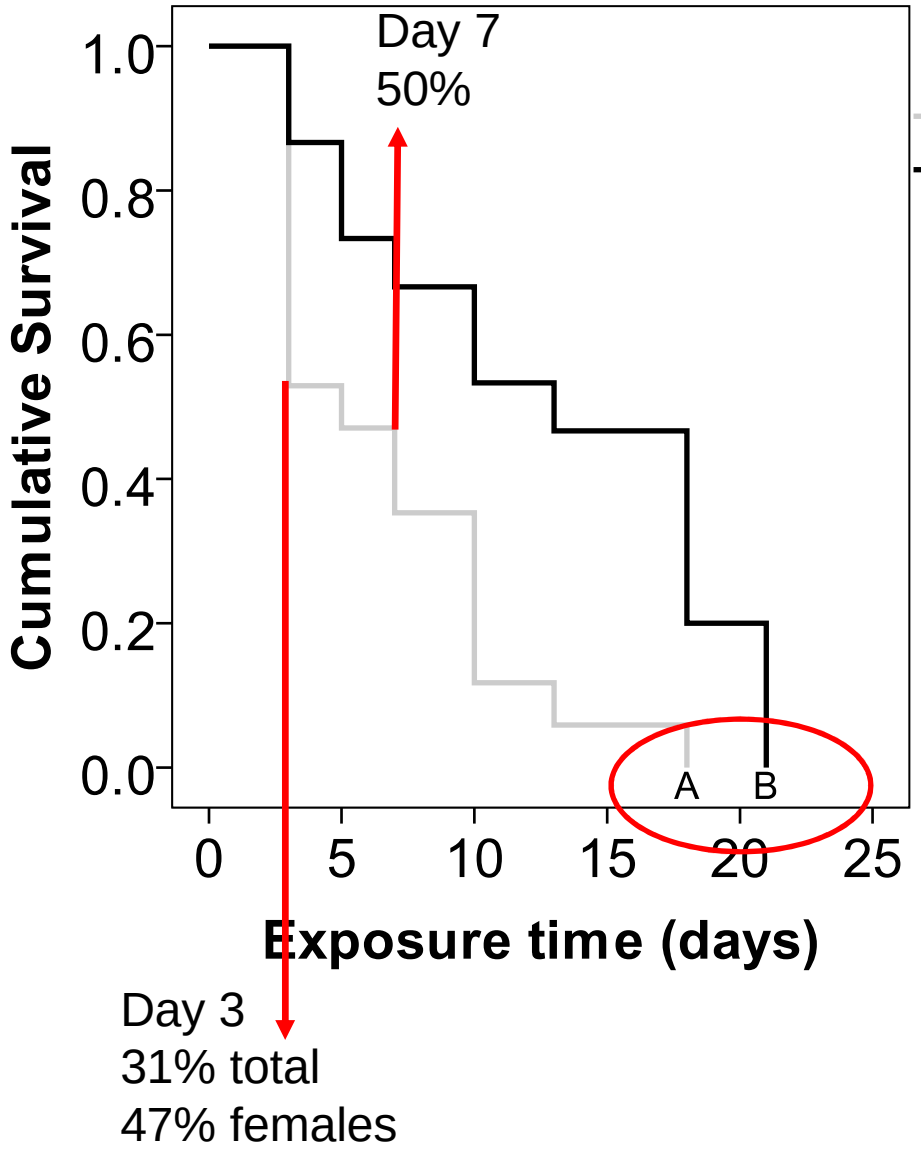


Chatelain et al. 2013

RESULTS & DISCUSSION

TOXICITY TRIALS

Trial 2: 100%

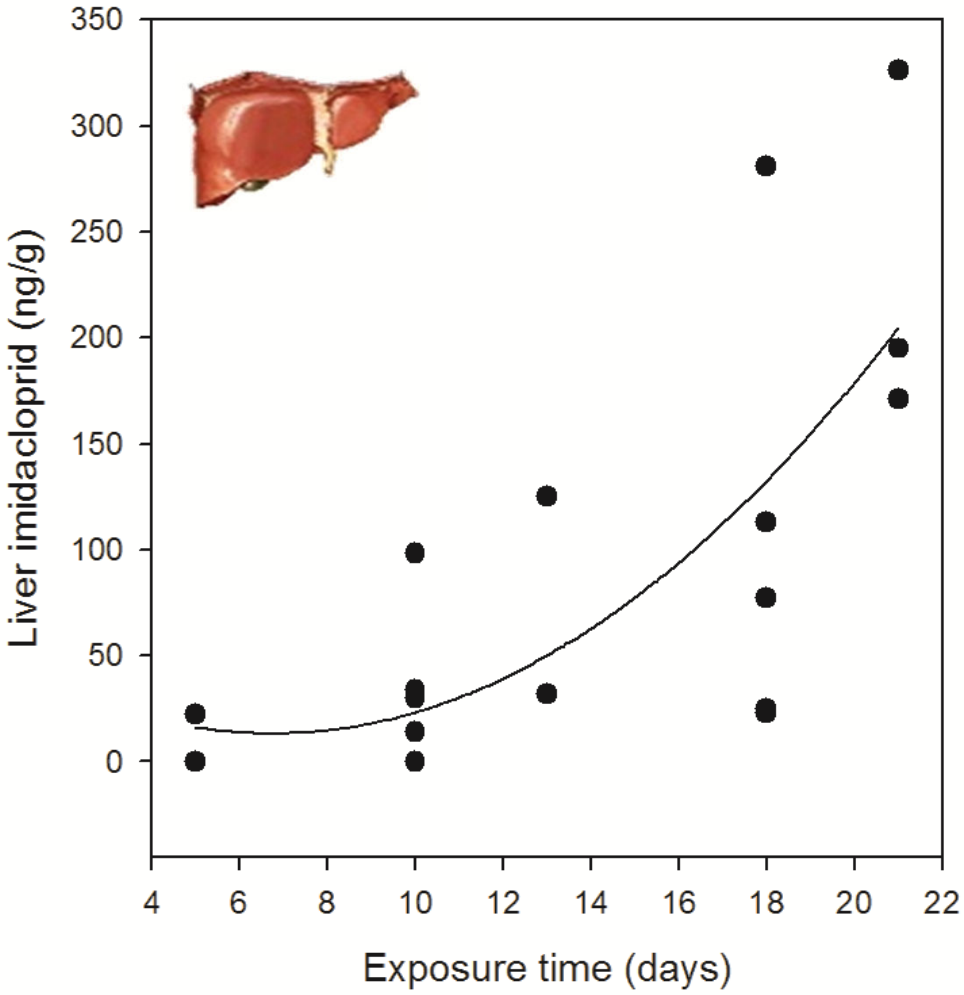


- Seeds are only partially refused
- No protected from acute intoxication
- Greater risk for smaller birds (↑↑ingestion rate / body mass)

RESULTS & DISCUSSION

TOXICITY TRIALS

Trial 2: 100%



- Accumulated in liver
- 1st time in animal tissue
- Important for risk assessment

Berny et al. 1999; Yokota et al. 2003.

RESULTS & DISCUSSION

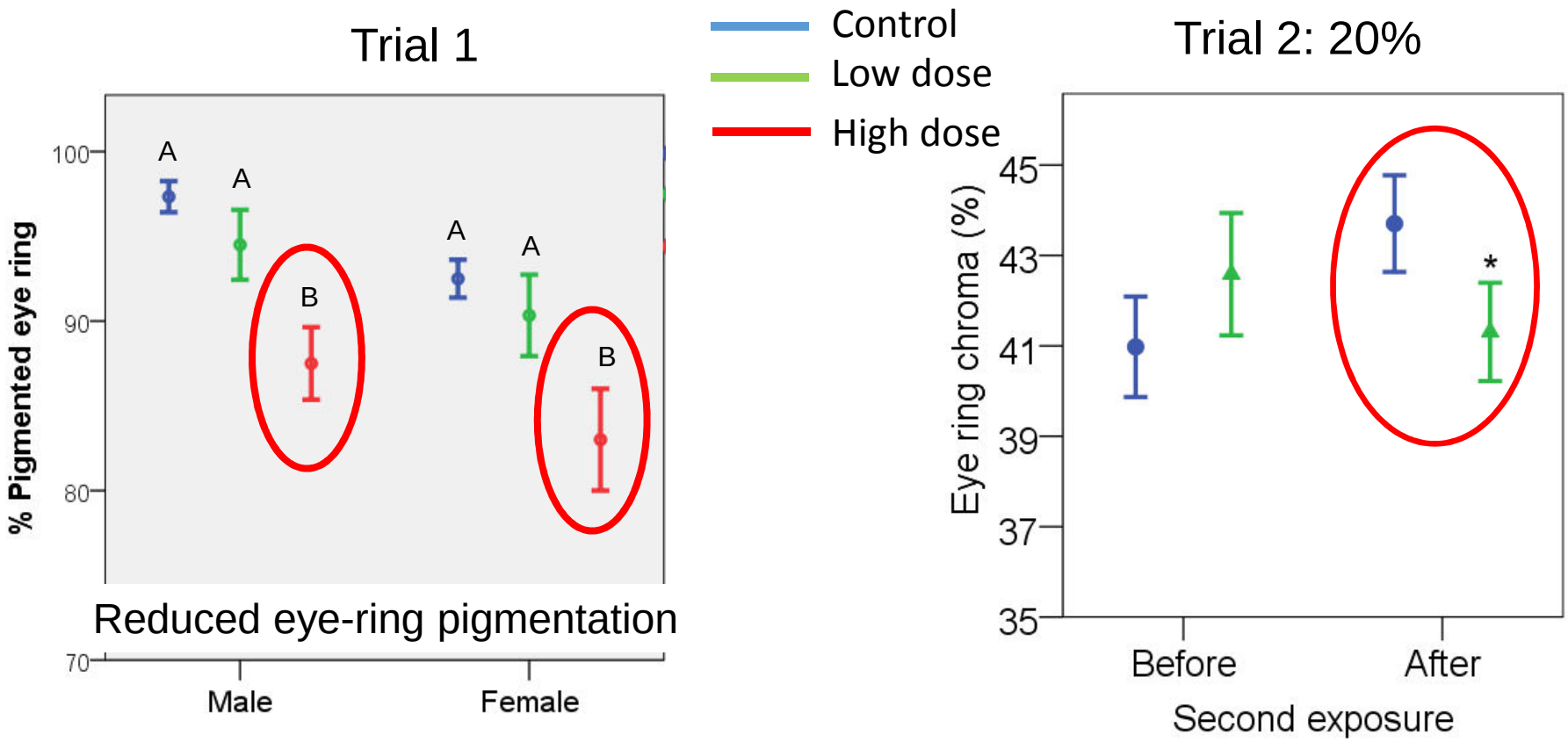
TOXICITY TRIALS

Physiological parameters		Imidacloprid		
		Trial 1		Trial 2
		200%	100%	20%
	↓Body condition	**	**	
	↓Hematocrit	*	**	
Stress	↓GPX	*	*	
Stress	↑SOD			*
Stress	↓GSH		*	
Plasma biochemistry	↓Albumin	*	**	
Plasma biochemistry	↓Alkaline phosphatase	*	*	
Plasma biochemistry	↓Aspartate aminotransferase		*	
Plasma biochemistry	↓Lactate dehydrogenase			*
Plasma biochemistry	↓Calcium	*	*	
Plasma biochemistry	↓Cholesterol	*	*	
Plasma biochemistry	↓Glucose			*
Plasma biochemistry	↓Magnesium			*
Plasma biochemistry	↓Phosphorus			
Plasma biochemistry	↓Total protein	*	**	
Plasma biochemistry	↓Uric acid			

First line of antioxidant defense

RESULTS & DISCUSSION

TOXICITY TRIALS



- Dependent on body condition and very sensitive to changes in the immunological and oxidative status
- Sexual signal: influence mate choice and reproductive investment

Alonso-Alvarez et al. 2008; Mougeot et al. 2009; Perez-Rodriguez et al. 2013.

RESULTS & DISCUSSION

TOXICITY TRIALS

Parameter	Control	20% RAR
Number of pairs	12	12
Number of laying females	7	9
Total number of eggs	138	83
Clutch size per laying female	19.7 ± 4.4	9.2 ± 2.3*
Days to the first egg	10.3 ± 4.2	21.0 ± 3.5*
Egg length (mm)	39.25 ± 0.11	39.84 ± 0.21
Egg width (mm)	29.87 ± 0.07	29.22 ± 0.11
Shell thickness fertile eggs (mm)	0.225 ± 0.002	0.227 ± 0.003
Shell thickness unfertile eggs (mm)	0.217 ± 0.003	0.207 ± 0.007
Fertile eggs (%)	70.2	82.8
Hatching rate of fertile eggs (%)	85.4	82.5
Number of chicks	70	47
Chick body condition at hatching	5.88 ± 0.05	5.73 ± 0.09
% Female chicks[a]	0.50 ±0.07	0.54 ± 0.12
Chick mortality (%)	35.71	41.66
Wing web swelling (mm)	0.34 ± 0.03	0.17 ± 0.09*

Mineau, 2005; Siddiqui et al. 2007; Kammon et al. 2012

INTRODUCTION

OBJECTIVES

•Study the toxicity of seeds treated with imidacloprid to red-legged partridges: effects on survival, reproduction and other functions.

•Study the acceptance-avoidance of treated seeds under different experimental conditions to assess the risk of poisoning in the field.

•Study the availability for birds of treated seed after sowing and detect the pesticide in the crop of hunted birds.

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METHODS

AVOIDANCE TEST

Exper		24 h
		eated
		eated
Con		eated
Cont		eated

ntal group

Science of the Total Environment 496 (2014) 179–187

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Experimental approaches to test pesticide-treated seed avoidance by birds under a simulated diversification of food sources

Ana Lopez-Antia, Manuel E. Ortiz-Santaliestra, Rafael Mateo *

Instituto de Investigación en Recursos Cinegéticos (IREC) CSIC-UCLM-JCCM, Ronda de Toledo s/n, 13071, Ciudad Real, Spain

HIGHLIGHTS

- Partridges avoid pesticide treated seed when alternative food is available.
- Avoidance of imidacloprid treated seeds is due to post-ingestion distress.
- Refusal to thiram treated seeds decreases over time without alternative food.
- Diversity of food sources increases the risk of pesticide treated seed ingestion.
- Imidacloprid poisoning still occurs when alternative food is present.

GRAPHICAL ABSTRACT

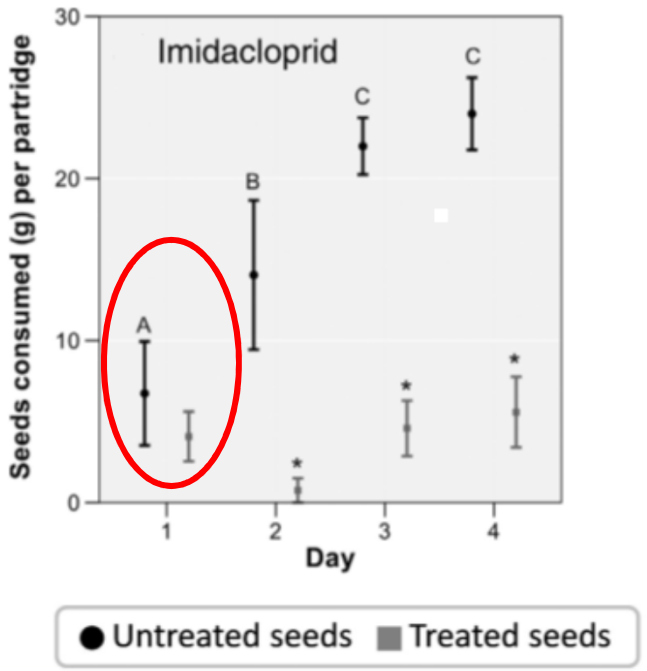
EFSA 2009; Avery et al. 1993, 1994, 1997

RESULTS & DISCUSSION

AVOIDANCE TEST

Experimental group (n=6)	Ingested grain	
	Type	Mass (g)
Untreated	Untreated	169.1 ± 31.2^{a}
Treated → 2 females dead	Treated	28.5 ± 7.9^{bA}
Two-choices without shifting	Untreated	172.9 ± 18.4*
	Treated	6.2 ± 1.9^{B}*
	All	179.0 ± 18.2^{a}
	%Treated	3.7 ± 1.3
Two-choices shifting	Untreated	176.8 ± 30.9*
↓	Treated	7.0 ± 3.0^{B}*
1 male dead on day 4	All	183.9 ± 29.1^{a}
	%Treated	7.5 ± 5.6

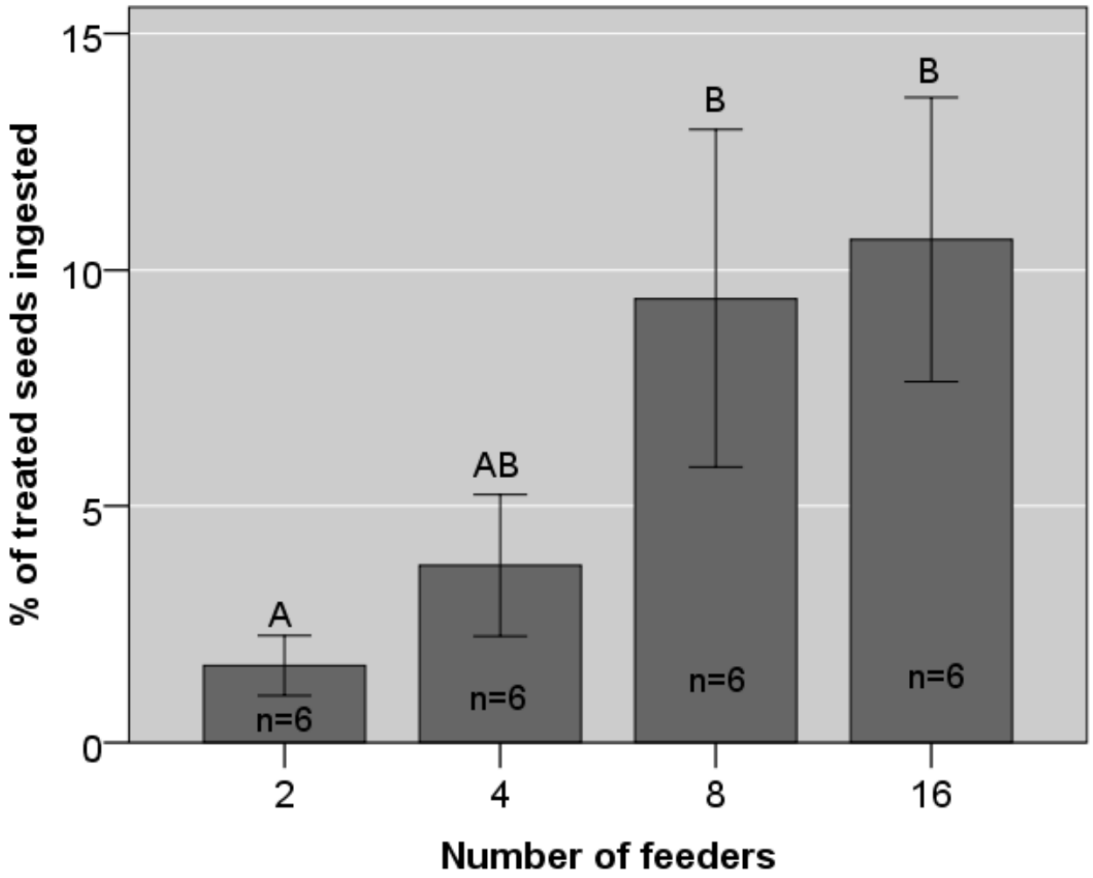
- Selected untreated seeds against treated ones.
- Avoid treated seeds even if there is no alternative food.
- Aversion conditioned by sickness.
- Possible lethal intoxication.



Avery et al. 1993, 1994, 1997

RESULTS & DISCUSSION

AVOIDANCE TEST



More ingestion in less predictable conditions

Avery et al. 1993, 1994, 1997

INTRODUCTION

OBJECTIVES

•Study the toxicity of seeds treated with imidacloprid to red-legged partridges: effects on survival, reproduction and other functions.

•Study the acceptance-avoidance of treated seeds under different experimental conditions to assess the risk of poisoning in the field.

•Study the availability for birds of treated seed after sowing and detect the pesticide in the crop of hunted birds.

METHODS

FIELD STUDY

Journal of Applied Ecology

Journal of Applied Ecology 2016, 53, 1373–1381 doi: 10.1111/1365-2664.12668

Risk assessment of pesticide seed treatment for farmland birds using refined field data

Ana Lopez-Antia*, Jordi Feliu, Pablo R. Camarero, Manuel E. Ortiz-Santaliestra and Rafael Mateo

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Species feed on treated seeds and frecuency

Exposure of red-legged partridge

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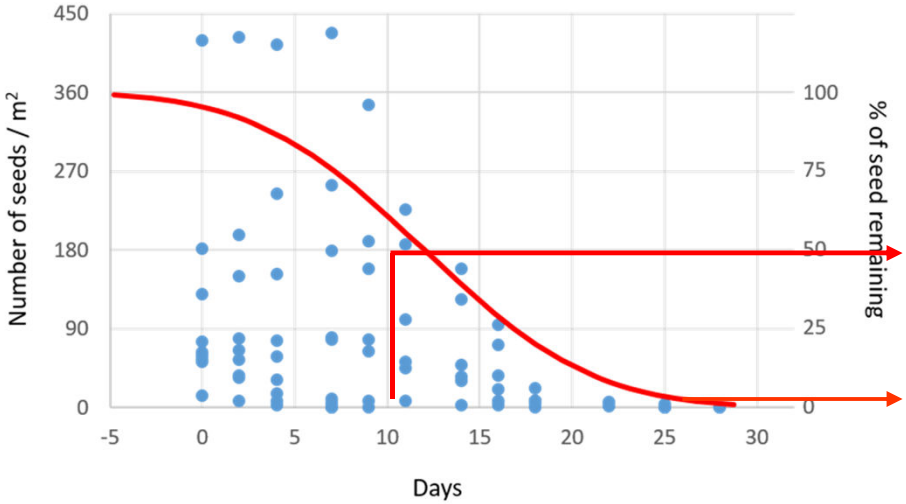
RESULTS & DISCUSSION

FIELD STUDY

Sowing technic	Sampled fields	Field centre (seeds/m^2)	Headland (seeds/m^2)
Fertilizer + harrowing	2	12.7 ± 2.4 ^{ab}	44.9 ± 14.5
Precision drilling	18	10.3 ± 1.4 ^{a}	48.1 ± 9.2
Precision drilling + rolling	11	28.3 ± 6.9 ^{b}	37.8 ± 8.7
Unknown	11 (17)	7.2 ± 0.8	39.7 ± 12.1
Overall	42 (48)	11.3 ± 1.2	43.4 ± 5.5*

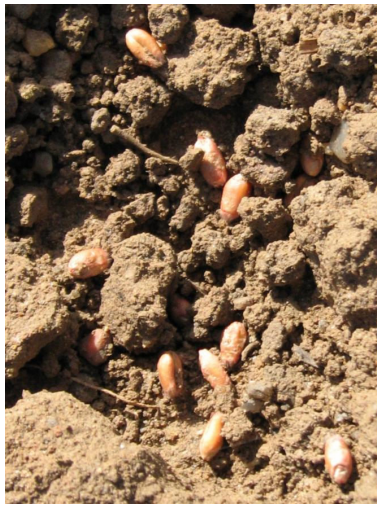
Most used by birds[1]

How long do seeds remain?



10.93 days

+20 days



[1] Prosser and Hart (2005);

RESULTS & DISCUSSION

FIELD STUDY

- 30 bird species detected.

Species	Density	Frequency (%)	Population trends			Habitat EBCC
			Europe (%)	Spain (%)	Class*	
Miliaria calandra	5.67±7.3	41.5	-59	12.2	↔	Farmland
Galerida cristata	0.79±1.2	40.4	-95	-9.6	↓	Farmland
Pica pica	0.92±0.8	35.9	4	-22.1	↓	Other
Passer hispaniolensis	9.99±15.5	29.2		55.9	↕	Farmland
Alauda arvensis	3.09±3	17.9	-51	-22.1	↓	Farmland

Corn bunting

Crested lark

Magpie

Spanish sparrow

Skylark

Perkins et al. 2007

RESULTS & DISCUSSION

CROP ANALYSIS

Pesticide	Crops (n=189)		Mean (µg/g)	Max (µg/g)
	N+	% +		
Imidacloprid	6	3.1	0.082	0.104
Flutriafol	4	2.1	0.035	0.047
Thiram	2	1.0	0.178	0.261
Triticonazole	11	5.7	0.010	0.015
Tebuconazole	36	19.1	0.351	9.313
Difenoconazole	4	2.1	1.038	3.791
Piperonyl butoxide	2	1.0	0.139	0.303
Fipronil	1	0.5	0.004	0.007
Fludioxonil	2	1.0	0.030	0.046

32.2% of the crops +.

Insecticides / Green material

Sprayed crop

Contaminated natural vegetation

Germinated treated seeds

Chronic exposure to small amounts of insecticides

CONCLUSIONS

- Feeding on seeds treated with imidacloprid can have not only a lethal effect, but also many deleterious sub-lethal effects on redox balance, secondary sexual traits and reproduction in birds at sublethal levels equivalent to 20% of treated seed in diet during sowing periods.

- Imidacloprid treated seeds were probably avoided as a consequence of **post-ingestional distress**, but in an **unpredictable environment** treated seeds were consumed by partridges at sublethal or even lethal levels.

- Treated seeds are **widely available** for birds after sowing and constitutes an important way of exposure of farmland birds to pesticides.

- There exists a potential risk for these birds to suffer toxic effects from ingestion of treated seeds in the wild.

CONCLUSIONS

- Our results suggest that the prophylactic use of pesticide-treated seeds should be avoided, being the approval of this treatment considered on a case-by-case basis.

- In these cases, specific treatments should be selected among those that pose the lowest risk to wildlife.


Thank
you very
much!
IREC
fedenca

RESULTS & DISCUSSION

CROP ANALYSIS

Province	Type of food (%)‡(mean ± SE)				
	Winter Cereal Seeds	Weed Seeds	Green Plant Material	Insects	Other
Madrid	44.4 ± 19.1 [ab]	14.0 ± 14.0	41.7 ± 20.1	0.0 ± 0.0	0.0 ± 0.0
Toledo	50 ± 50 [ab]	49.6 ± 49.6	0.4 ± 0.4	0.0 ± 0.0	0.0 ± 0.0
Burgos	60.7 ± 6.4 [b]	20.8 ± 5.3	9.6 ± 3.7	1.4 ± 1.4	7.4 ± 3.7
Valladolid	89.3 ± 7.13 [c]	3.6 ± 3.6	3.6 ± 1.9	0.0 ± 0.0	3.6 ± 3.5
Soria	47.2 ± 18.5 [ab]	22.2 ± 16.5	30.5 ± 16.3	0.0 ± 0.0	0.0 ± 0.0
Lleida	42.1 ± 10.1 [ab]	1.3 ± 1.3	30.0 ± 8.6	0.0 ± 0.0	26.8 ± 8.2
Murcia	26.5 ± 10.3 [a]	18.6 ± 9.0	30.8 ± 10.2	5.9 ± 5.9	12.4 ± 6.5
Overall	53.4 ± 4.3	14.5 ± 2.9	19.0 ± 3.2	1.4 ± 1.0	10.8 ± 2.6
Previous study 1981[1] →	22.4%	47.2%	24.6%		

Natural vegetation loss.

↓

Increased dependence on cereal seeds.

↓

Red-legged partridge decline of 60% since 1973.[2,3]

[1] Pérez y Pérez, 1981; [2] Blanco-Aguiar et al. 2003; [3] Viñuela et al. 2013.

INTRODUCTION

TREATED SEEDS - INCIDENTS

Pesticide Science *Pestic Sci* 55:47–54 (1999)

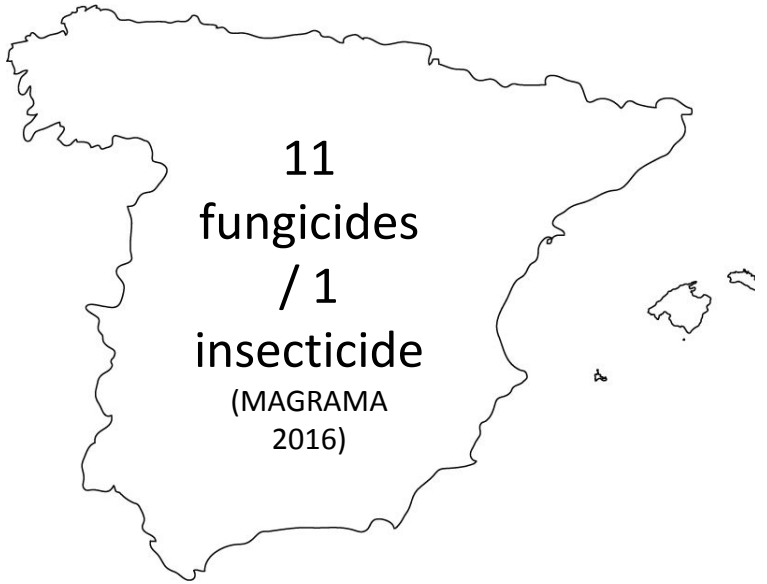
Vertebrate wildlife incidents with pesticides: a European survey

Geert R de Snoo,* Nathalie M I Scheidegger and Frank M W de Jong
Centre of Environmental Science, Leiden University PO Box 9518, 2300 RA Leiden, The Netherlands

Hazards to Wintering Geese and other Wildlife from the Use of Dieldrin, Chlorfenvinphos and Carbophenothion as Wheat Seed Treatments

P. I. Stanley and P. J. Bunyan

Proc. R. Soc. Lond. B 1979 **205**, 31-45
doi: 10.1098/rspb.1979.0047



RESULTS & DISCUSSION

CROP ANALYSIS

Precission drilling 0.03 seeds/m^2 (sugar beet) (Snoo and Luttik 2004)

2 seeds/m^2 necessary for birds to exploit a field.

Sugar beet seeds treated with 0.9 – 1 mg/seed (Goulson et al. 2013)

Cereal seeds treated with 0.035 mg/seed (0.14 mg/g)

House sparrow LD50= 41mg/Kg (1,2 seeds)