

Seed spillage from grain trailers on road verges during oilseed rape harvest: an experimental survey

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Cualifiered Control











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an experimental survey.

Context



Human-mediated seed dispersal (i.e. anthropochory) greatly increases the dispersal of crop species across agroecosystems.

In the case of oilseed rape (OSR, Brassica napus L.), concerns have been raised about feral OSR populations growing on roadverge which could constitute reservoirs of modified genes in the context of the coexistence of genetically modified (GM) and non-GM plants (Squire et al. 2011).

These OSR feral populations are assumed to originate from grain trucks losses (Crawley & Brown 1995; Aono et al. 2006; Knispel & McLachlan 2010) and

spillage from grain trucks during harvest has never been quantified.



Field hard-working team.

Materials and Methods

Survey of an agricultural area of 41 km² around the grain silo of Selommes (Loir-et-Cher, France).

Experimental approach: 85 seed trap-sites on the road verges. Record of trap-sites characteristics (see Table 1) and OSR spillage (see Figure 1) during harvest.

Choice of the best fitted linear model for the data. Prediction of losses at road scale on R2 road that serviced 66ha of OSR fields.

One-day seeds trapped.

Results We collected 7710 seeds in 8 days, with a unique deposition event of 1548 seeds (R12 road, Fig.1). Seed spillage increased with the surface area of OSR fields serviced (see Table 2), whereas local elements (e.g. distance from the trap-site to the verge of the road and to the nearest field) decreased the amount of seed deposited at a given site.

We detected an interaction between the number of lanes and the distance to the main silo: seed loss

	Туре	Modalities	Description	
Surface_OSR	Quantitative	From 2.8 to 147.5	Total area of all OSR fields adjacent to	
(ha)			the road and connected to the road by	
			network ¹	
Lanes	Qualitative	1 or 2	Number of lanes on the road	
Dist_field	Qualitative	0, 40 or 400	Distance between the trap-site and the	
(in m)		then 0 or faraway	nearest OSR field	
Dist_road	Quantitative	from 2.4.10 ⁻² to	Distance between trap-sites and the edge	
(in m)		1.72	of the road	
Dist_Silo	Quantitative	From 1073 to 8848	Distance between the trap-site and the	
(in m)			grain silo at Selommes ³	

Table 1. The five explanatory variables for the number of seeds recorded in trap-sites. ¹Based on a farmer survey concerning trips between fields and silos (from CETIOM data, 1999). ²Only four trap-sites were placed at more than 1m. ³Calculated along a given road from georeferenced data with R software.

decreased with distance to the main silo on one-lane roads but was constant on two-lane roads.

On R2 road we predicted the spillage on the verge in the direction of transportation to be nearly two million seeds (mean: 404 seeds.m⁻² \pm 94).

$\leq 10\%$; * $\leq 5\%$; ** $\leq 1\%$; *** $\leq 0.1\%$.				
	Estimate	Standard error	P-value	
(Intercept)	4.259	0.820	$1.81 \cdot 10^{-6***}$	
Surface_OSR	9.93·10 ⁻³	$4.23 \cdot 10^{-3}$	$2.35 \cdot 10^{-2*}$	
Dist_field_faraway	-0.644	0.236	7.84.10-3**	
ln(Dist_road)	-0.470	0.183	$1.21 \cdot 10^{-2*}$	
Lanes_2	-0.617	0.800	0.442	
Dist_Silo	-4.45.10-4	1.13.10-4	1.97.10-4***	
Dist_Silo:Lanes_2	2.95.10-4	1.71.10-4	8.83·10 ⁻² .	

Table 2. Summary of the linear model describing relationships between the natural logarithm of seeds lost +1 and landscape elements. On a two-lane road, when Dist_field is 0m, the expected response equals $(4.259 - 0.617) + 9.93 \cdot 10^{-3} \cdot Surface_OSR - 0.470 \cdot \ln(Dist_road) + (-4.45 \cdot 10^{-4} + 2.95 \cdot 10^{-4}) \cdot Dist_Silo = 3.642$ $+9.93 \cdot 10^{-3} \cdot Surface_OSR - 0.470 \cdot \ln(Dist_road) - 1.491 \cdot 10^{-4} \cdot Dist_Silo.$

Discussion

Spillage of OSR seed from grain trailers during harvest appears to be a very common phenomenon, affecting both main roads to the grain silo and other roads. We show that grain trailers frequently disperse seeds up to a distance of 400 m which is the farthest dispersal distance for OSR seed ever quantified.

Aono, M., Seiji, W., Masato, N., Nobuyoshi, N., Masanori, T., Akihiro, K. & Hikaru, S. (2006) Detection of feral transgenic oilseed rape with multiple-herbicide resistance in Japan. Environ. Biosafety Res., 5, 77-87. Crawley, M.J. & Brown, S.L. (1995) Seed limitation and the dynamics of feral oilseed rape one the M25 motorway. Proceedings of the Royal Society of London Series B-Biological Sciences, 259, 49-54. Knispel, A. & McLachlan, S. (2010) Landscape-scale distribution and persistence of genetically modified oilseed rape (Brassica napus L.) in Manitoba, Canada. Environmental Science and Pollution Research, 17, 13-25 Pivard, S., Adamczyk, K., Lecomte, J., Lavigne, C., Bouvier, A., Deville, A., Gouyon, P.H. & Huet, S. (2008a) Where do the feral oilseed rape populations come from? A large-scale study of their possible origin in a farmland area. Journal of Applied Ecology, 45, 476-485. Squire, G.R., Breckling, B., Pfeilstetter, A.D., Jorgensen, R.B., Lecomte, J., Pivard, S., Reuter, H. & Young, M.W. (2011) Status of feral oilseed rape in Europe: its minor role as a GM impurity and its potential as a reservoir of transgene persistence. Environmental Science and Pollution Research, 18, 111-115.



Figure 1. Global map of the Selommes area with daily barplots of OSR seed collected at each trap-site location. Seed amounts are $\ln(x + 1)$ transformed; all barplot axes have the same scale between 0 and 8 (which indicates 0 to 2980 seeds). Each trap-site is associated with a number. Each road is represented by an R-number code.

Feral populations of OSR originate from seed transportation (15%) and also from immigration of seed from fields (35-40%), local recruitment (10%) and persistent seed banks (35-40%; Pivard et al. 2008) but only spillage from grain trailers can disperse OSR seeds farther than hundreds of metres.

In a context of OSR GM coexistence, it might be quite impossible to completely eliminate the spillage of small seeds from grain trailers. However, this spillage could be reduced by appropriate policies: covering the top of grain trailers, not overfilling trailers and reducing the distances travelled between fields and silos could limit the loss of seed.

Our results emphasize that seed spillage from grain trailers must be considered in order to model seed dispersal and the persistence of feral populations of OSR. Furthermore, our study highlight the role of the surface area of fields and the transportation to grain silos in seed dispersal by grain trailers. So, local and landscape elements and rare events of massive seed deposition should be integrated into models.

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