

Response of earthworm population on herbicide application intensities within a conventional and a reduced tillage system in sugar beet crop in Germany



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Introduction

The application of low dosage herbicide rates is a new herbicide strategy in sugar beet crop. This strategy implies high numbers of ingredients and strongly reduced application rates. However, the environmental effects of this strategy are still poorly understood.

Materials & Methods

- 19 field trials in 2008 and 2009 (Fig. 1), resulting in a high variation of soil types and weather conditions of representative sugar beet growing regions in Germany
- half of each field trial (yellow mustard as intercrop) was conventionally ploughed, the other half was conservatively tilled (ploughing and mulching system)
- three herbicide strategies with different intensities (Table 1), randomized completely in four replicates in each tillage system (Fig. 2)
- earthworms were expelled in spring and autumn using the formalin extraction method



Fig. 1: Field trial sites.

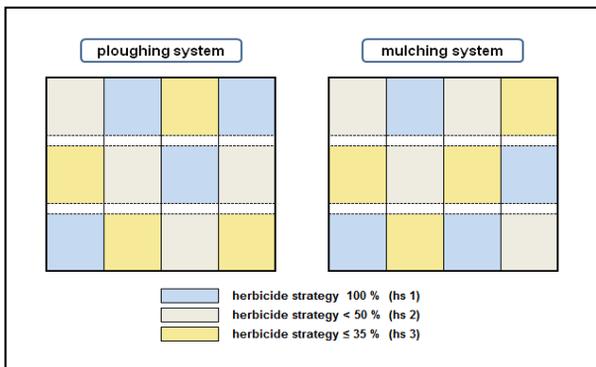


Fig. 2: Field trial design.

Table 1: Herbicide strategies (hs).

hs	herbicide	pe ¹			total application rate (kg/ha ² or l/ha ³)	share of authorized application rate (%)	active ingredient			t ²
		1	2	3			trivialname	share (%)	total rate (kg/ha ² or l/ha ³)	
1	Goltix 700 SC	1	2	2	5	100	metamitron	0.70	3.5	2
	Betanol Expert	1.75	1.75	1.75	5.25	100	desmedipham ethofumesate phenmedipham	0.025 0.15 0.75	0.13 0.79 0.39	
	Goltix 700 SC	0.8	0.8	0.8	2.4	48	metamitron	0.70	1.68	
2	Goltix 700 SC	0.8	0.8	0.8	2.4	46	desmedipham ethofumesate phenmedipham	0.025 0.15 0.75	0.06 0.36 0.18	1.42
	Betanol Expert	0.8	0.8	0.8	2.4	46	desmedipham ethofumesate phenmedipham	0.025 0.15 0.75	0.06 0.36 0.18	
	Rebell	0.8	1	1.2	3	48	chlorthalozon quinmerac	0.40 0.05	1.2 0.14	
3	Goltix 700 SC	0.35	0.7	0.7	1.75	35	metamitron	0.70	1.23	1.87
	Betanol Expert	0.61	0.61	0.61	1.83	35	desmedipham ethofumesate phenmedipham	0.025 0.15 0.75	0.05 0.28 0.14	
	Rebell	0.29	0.58	0.88	1.75	35	chlorthalozon quinmerac	0.40 0.05	0.70 0.09	
	Spectrum	0.05	0.11	0.16	0.32	35	dimethenamid-p	0.72	0.23	
	Debut	0.01	0.01	0.01	0.03	35	trifluraluron-methyl	0.48	0.01	
	Lortrel 100	0.14	0.14	0.14	0.42	11.7	glyphyrid	0.10	0.04	
	Oleo FC ³	0.35	0.35	0.35	1.05	35				

¹post-emergence treatment; ²treatment index; ³additive consisting of paraffin oil and emulsifiers

Results & Discussion

Environments (year x site) led to the major effect in variability of earthworm population which is assumed to correspond with differing regional specific soil and weather conditions resp. cultivation histories. In spring, the **tillage effect** was consistent between all 19 environments with 80 % lower mean earthworm abundance in the ploughing compared to the mulching system. This reflected the deleterious effect using the plough which disturbed their habitat more intensive than mulching technique. In the ploughing system, an increase of earthworm abundance during vegetation period was observed at 17 environments with a mean growth rate of 360 %, whereas in the mulching system changes showed a non-uniform development. The re-building capability demonstrated the high resilience and adaptability of the earthworm population. Earthworm abundance did not reveal detrimental effects among **herbicide strategies**. Actually, earthworm response was expected considering that herbicides are intentionally designed to eliminate competition from weeds and not to affect earthworms.

Table 2: Statistical results.

factor	d.f.	parameters (age level)		
		abundance		
		total	juvenile	adult
spring (n = 380)				
environment ^a	18	***	***	***
tillage system ^b	1	***	***	***
environment x tillage system	18	***	***	***
autumn (n = 1824)				
environment	18	***	***	***
tillage system	1	***	***	***
hs ^c	2	n.s.	n.s.	n.s.
environment x hs	36	n.s.	n.s.	n.s.
environment x tillage system	18	***	***	***
hs x tillage system	2	n.s.	n.s.	n.s.
environment x hs x tillage system	36	n.s.	n.s.	n.s.

^a environment = site x year; ^b tillage system = ploughing system x mulching system; significance: * at p ≤ 0.05, ** at p ≤ 0.01, and *** at p ≤ 0.001, n.s. = non significant; Mixed Model with post hoc Tukey and Kramer adjustment; total sample size in parenthesis

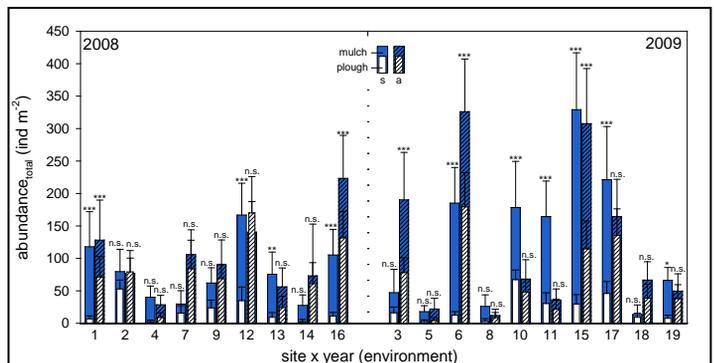


Fig. 3: The total abundance of earthworm in sugar beet crop as affected by tillage system and season (spring (s) and autumn (a)) in 2008 and 2009. Means and standard deviations for samples: spring n = 10 and autumn n = 48. Environments are arranged alphabetically. Detailed information of statistical analysis see legend table 2.

