*PROJECT GUIDELINES INTEGRATED PEST MANAGEMENT IN SUGAR BEET*

# 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), randomomized completely in four replicates in each tillage system (Fig. 2)
- earthworms were expelled in spring and autumn using the formalin extraction method

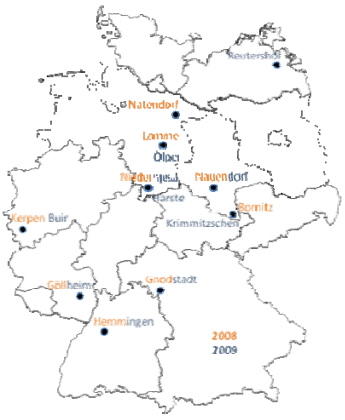


Fig. 1: Field trial sites.

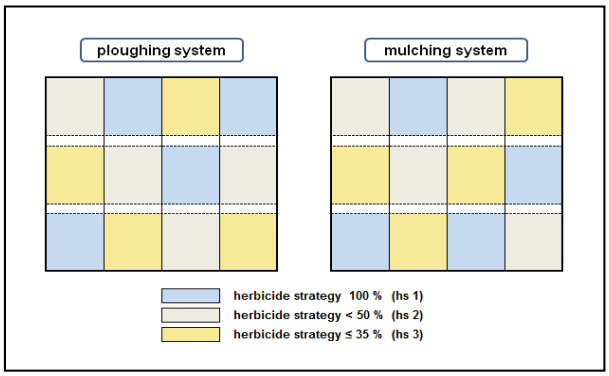


Fig. 2: Field trial design.

Table 1: Herbicide strategies (hs).

| hs | herbicide | pet[1] 1 | 2 | 3 | total application rate (kg ha-1 or l ha-1) | share of authorized application rate (%) | active ingredient trivialname | share (%) | total rate (kg ha-1 or l ha-1) | ti[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Goltix 700 SC | 1 | 2 | 2 | 5 | 100 | metamitron | 0.70 | 3.5 | 2 |
| | Betanal Expert | 1.75 | 1.75 | 1.75 | 5.25 | 100 | desmedipham<br>ethofumesate<br>phenmedipham | 0.025<br>0.15<br>0.75 | 0.13<br>0.79<br>0.39 | |
| 2 | Goltix 700 SC | 0.8 | 0.8 | 0.8 | 2.4 | 48 | metamitron | 0.70 | 1.68 | 1.42 |
| | Betanal Expert | 0.8 | 0.8 | 0.8 | 2.4 | 46 | desmedipham<br>ethofumesate<br>phenmedipham | 0.025<br>0.15<br>0.75 | 0.06<br>0.36<br>0.18 | |
| | Rebell | 0.8 | 1 | 1.2 | 3 | 48 | chloridazon<br>quinmerac | 0.40<br>0.05 | 1.2<br>0.14 | |
| 3 | Goltix 700 SC | 0.35 | 0.7 | 0.7 | 1.75 | 35 | metamitron | 0.70 | 1.23 | 1.87 |
| | Betanal Expert | 0.61 | 0.61 | 0.61 | 1.83 | 35 | desmedipham<br>ethofumesate<br>phenmedipham | 0.025<br>0.15<br>0.75 | 0.05<br>0.28<br>0.14 | |
| | Rebell | 0.29 | 0.58 | 0.88 | 1.75 | 35 | chloridazon<br>quinmerac | 0.40<br>0.05 | 0.70<br>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 | triflusulfuron-methyl | 0.48 | *0.01* | |
| | Lontrel 100 | 0.14 | 0.14 | 0.14 | 0.42 | 11.7 | clopyralid | 0.10 | 0.04 | |
| | Oleo FC[3] | 0.35 | 0.35 | 0.35 | 1.05 | 35 | | | | |

[1] post-emergence treatment; [2] treatment index; [3] additive 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 test Tukey and Kramer adjustment; total sample size in parenthesis

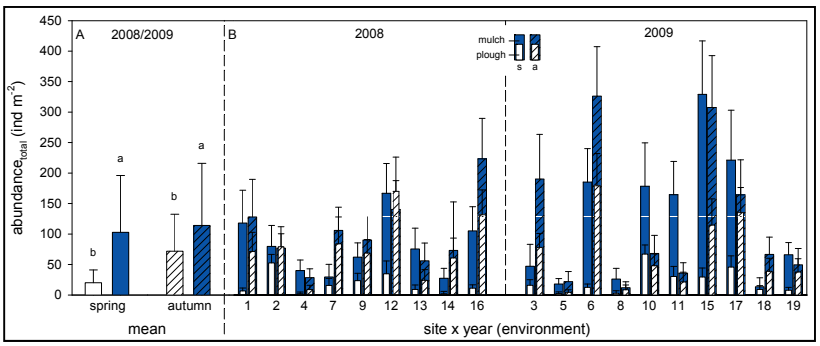


Fig. 3: Total abundance of earthworms (juvenile + adult, ind = individuals) in sugar beet as affected by tillage system in different seasons (s = spring and a = autumn). Different letters above bars indicate significant differences (P ≤0.001). Means and standard deviations across 19 environments (spring n = 190 and autumn n = 912) (A) and for 19 environments (spring n = 10 and autumn n = 48 as the mean over herbicide strategies) (B), arranged first chronologically and named alphabetically by the numbers, Germany 2008/2009.

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