

Field Monitoring of Soil Mesofauna in conventional (chlorpyrifos-treated) and organic Cider-Apple Orchards in Herefordshire UK: Differences in Collembolans, Mites and Enchytraeids



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Integrating Ecotoxicology & Sustainable Crop Protection

Introduction

As normal practice, chlorpyrifos (CP) is applied once before & once after flowering to cider-apple orchards to control blossom weevil & sawfly. Possible effects of CP on soil mesofauna (Collembola, soil mites, enchytraeids) were studied in a 2-year monitoring field study (April '13 to March '15). Three conventionally-managed (CP-treated) bush orchards were used. Three untreated traditional orchards ('organic') and margins of the conventional orchards, served as 'references'.

Materials and methods

A. Study location:

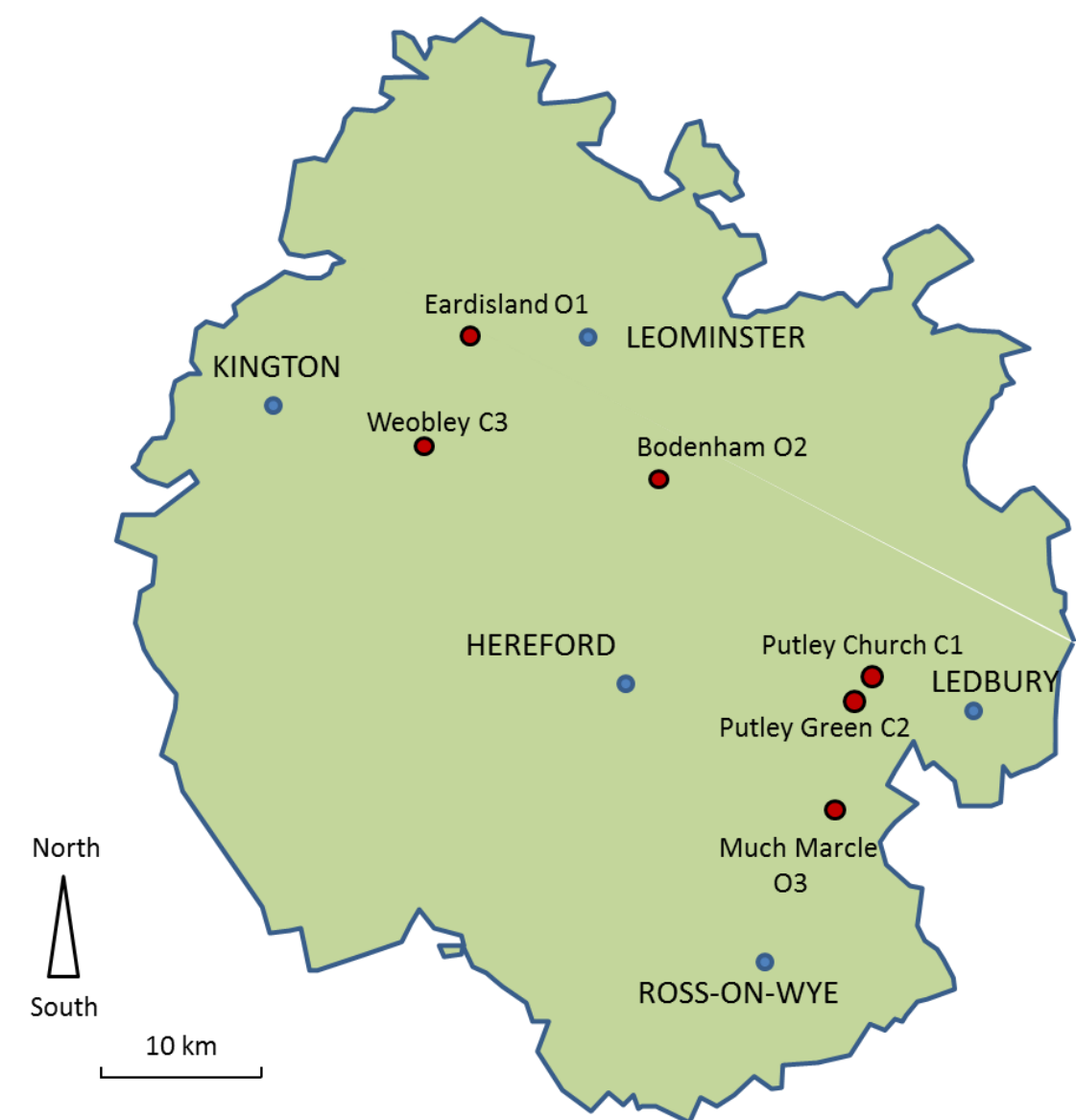
All trial sites were located in Herefordshire, a major cider-apple growing area in England.

C1 - C3: conventional bush orchards

O1 - O3: untreated traditional orchards*

*for convenience these are referred to as 'organic'

B. Plot size: ca. 30 m x 40 m per site



field margin

(Putley Green, May 2014)

conventional orchard

(Weobley, Sept. 2013)

organic orchard

(Eardisland, May 2014)

C. Sampling areas:

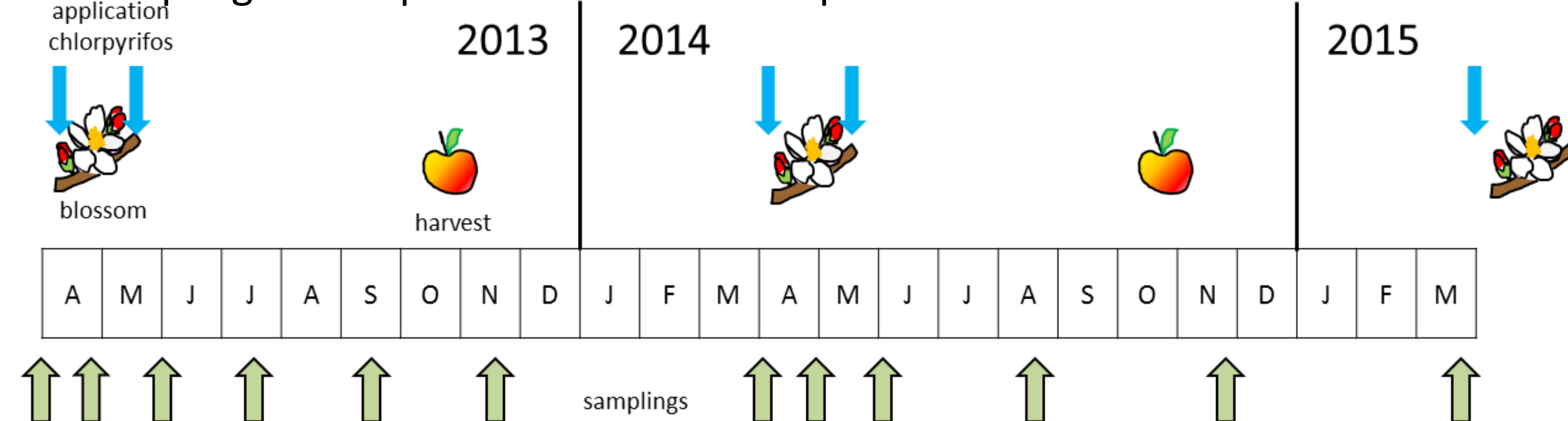
- tramline (2 per site)
- tree row (2 per site, vegetation-free at conv. orchards)
- field margin (1 per site, at the edge of conv. orchards)

D. Sampling methods/sample size:

- **Wet extraction of enchytraeids with Baermann funnels:**
5 soil cores (0-20 cm, diameter 5 cm) per per tramline/tree row, 5 additional specimens per field margin (10 or 15 per site)
- **Funnel pitfall traps/sampling of epedaphic arthropods:**
2 x 3 traps per tramline/tree row, 6 additional traps per field margin, opened for 3 days (12 or 18 per site)
- **Mac Fayden heat extraction of soil cores/sampling of euedaphic arthropods:**
2 x 4 soil cores per tramline/tree row (0-5 cm, diameter 5cm), 8 additional soil cores per field margin (16 or 24 per site)

E. Number of sampling occasions/study duration:

12 samplings were performed between April 2013 and end of March 2015.



Conclusions

- The application of chlorpyrifos had no observed adverse effect on any of the studied soil organisms.
- Climatic conditions and factors caused by cultivation measures like herbicide usage [i.e. bare soil] under the trees seemed to have distinct influences on the population development & composition of the soil organism community.

Acknowledgement

We thank the owners and farmers in the surroundings of Hereford for their permission to perform this study in their orchards and for their constant, selfless willingness to help and their interest in this study. The study was funded jointly by Dow AgroSciences and Adama Agricultural Solutions.

Results & Discussions

A. Wet extraction of enchytraeids:

- In conventional orchards higher densities on grassy tramlines, compared with bare-soil (herbicide-treated) tree rows (fig. 2)
- In organic orchards even distribution between tramlines and tree rows
- Highest densities on the tramlines of conv. orchards, lowest densities under tree rows of conventional orchards
- The applications of chlorpyrifos had no observed influence on the population development of enchytraeids at the conventional orchards (fig. 1).
- Drastic reduction of densities by dry and hot weather conditions in July 2013 at all study sites (lowest soil humidity). Similar effect in August 2014.

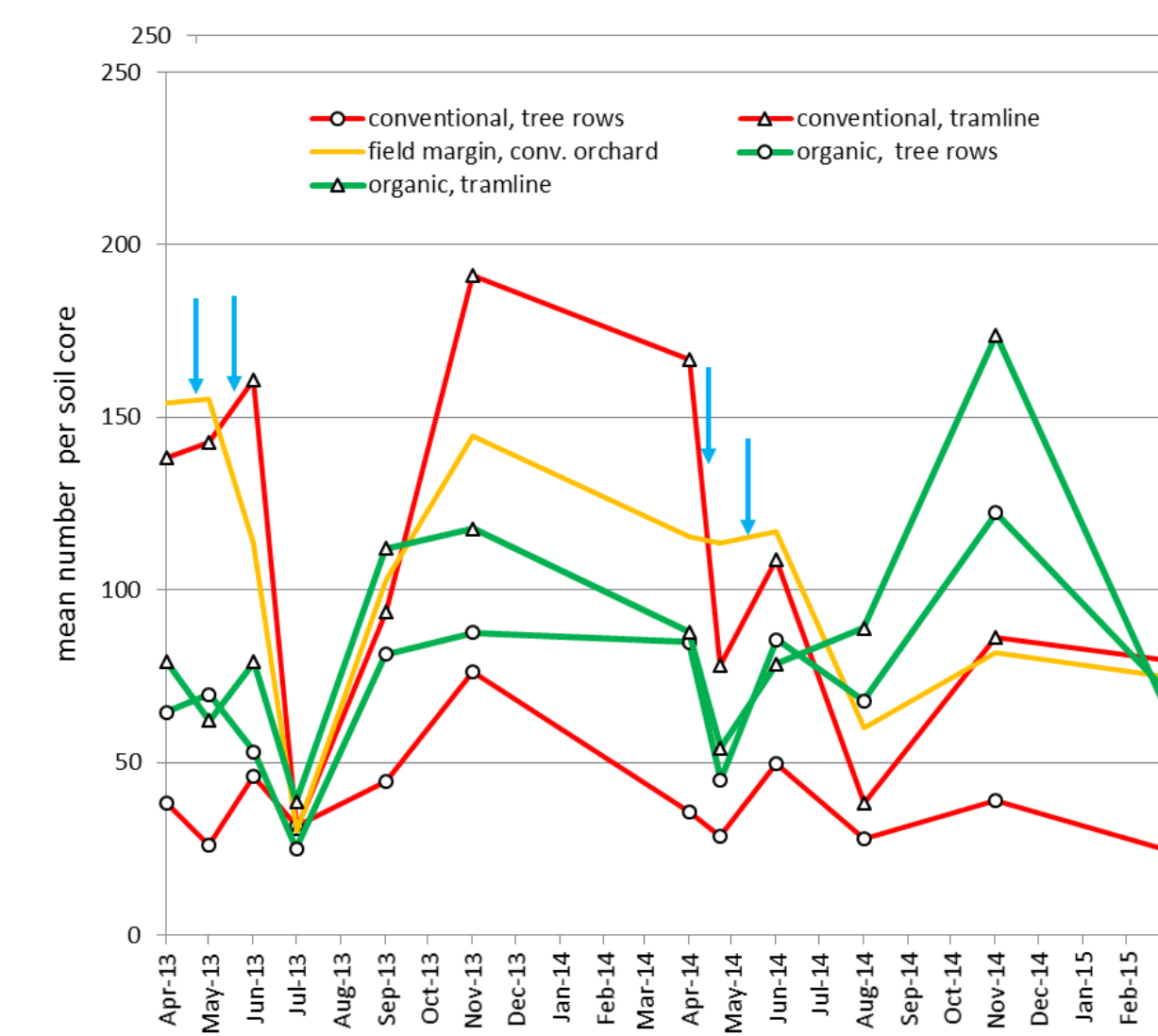


Fig. 1: Population development of enchytraeids 2013-2015 (mean values per specimen)

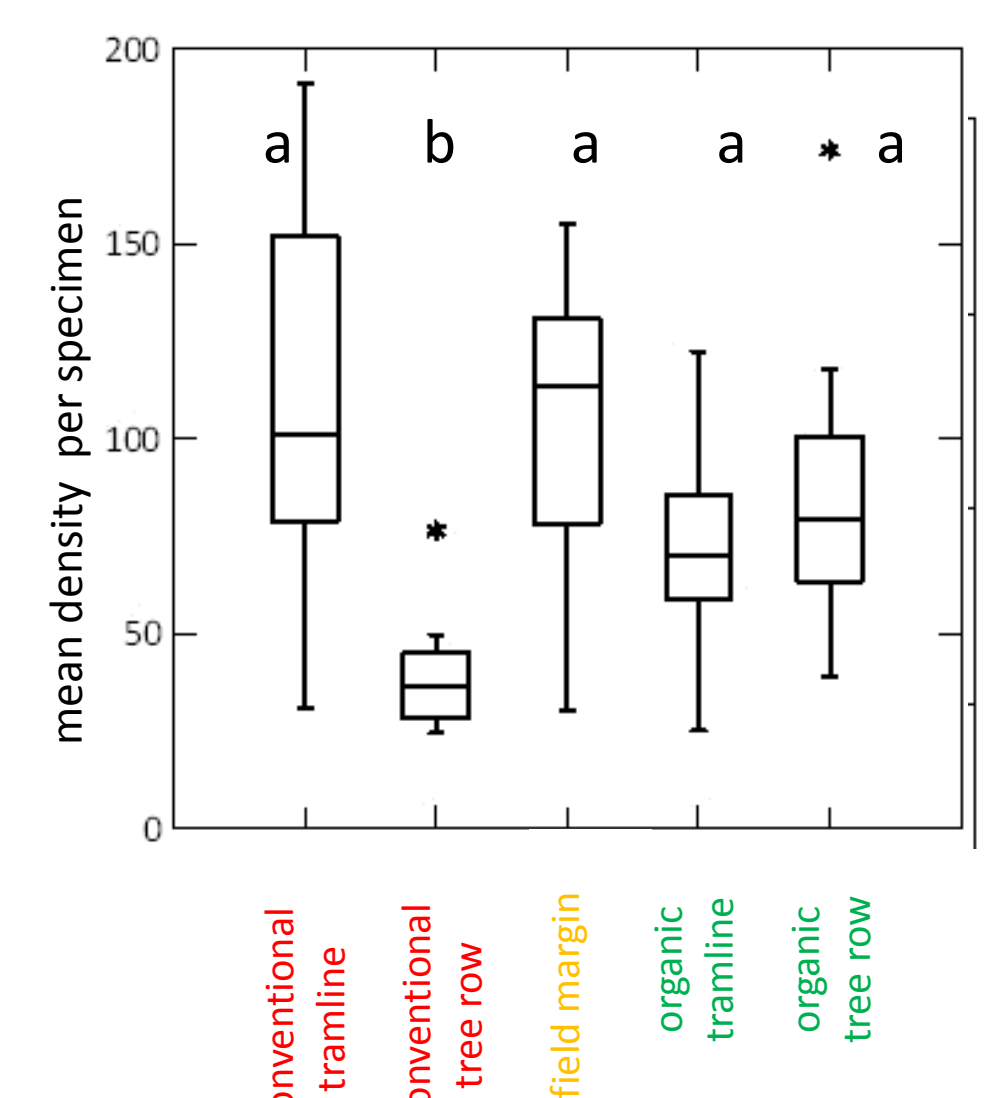


Fig. 2: Mean values of enchytraeids (ANOVA/ Tukey, $p \leq 0.005$)

B. Pitfall traps: Epedaphic soil arthropods

- Similar activity densities of total Collembola in conv. and organic orchards (fig. 4a), highest mite numbers in field margins and conv. orchards (fig. 4b)
- Isotomidae & Katiannidae more abundant in organic orchards, Sminthuridae, Hypogastridae, Oribatida, Prostigmata more frequent in conv. orchards

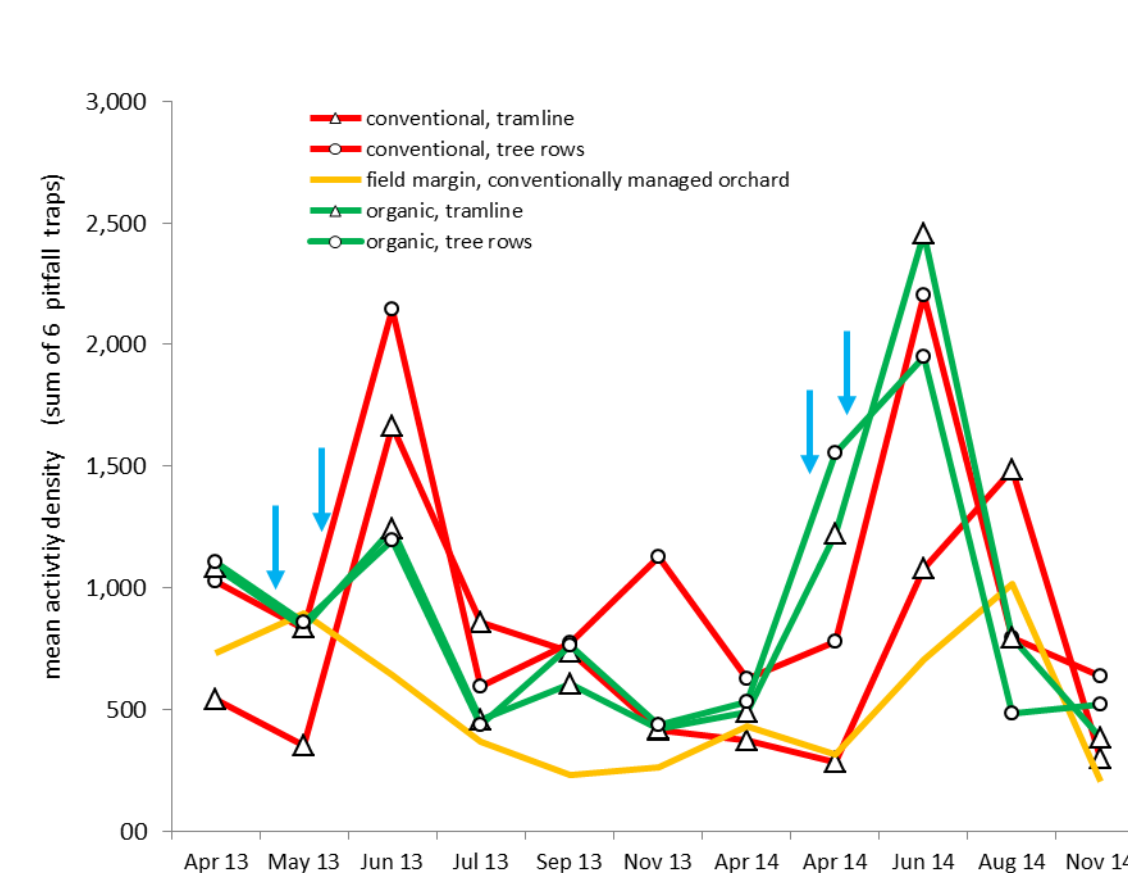


Fig. 3: Mean activity densities of total Collembola 2013-2014

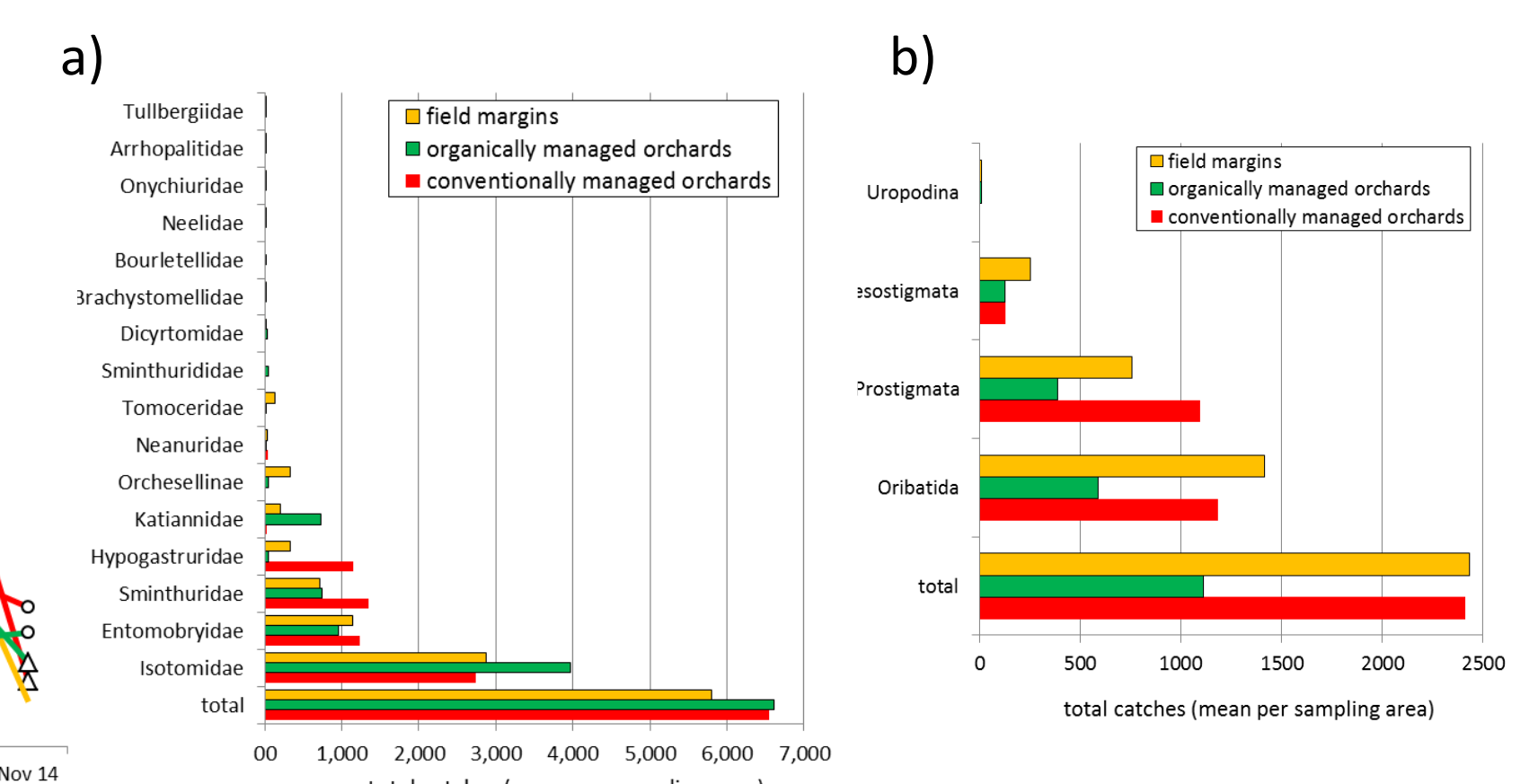


Fig. 4: Total catches of Collembola (a) and soil mites (b) 2013-2014 (mean per sampling area)

C. Soil cores: Euedaphic soil arthropods

- Highest mite and Collembola abundances in field margins, followed by organic and conv. orchards (fig. 6)
- Katiannidae, Isotomidae and Tullbergiidae more abundant in organic orchards and field margins, Hypogastridae more frequent in conv. Orchards (fig. 6a)

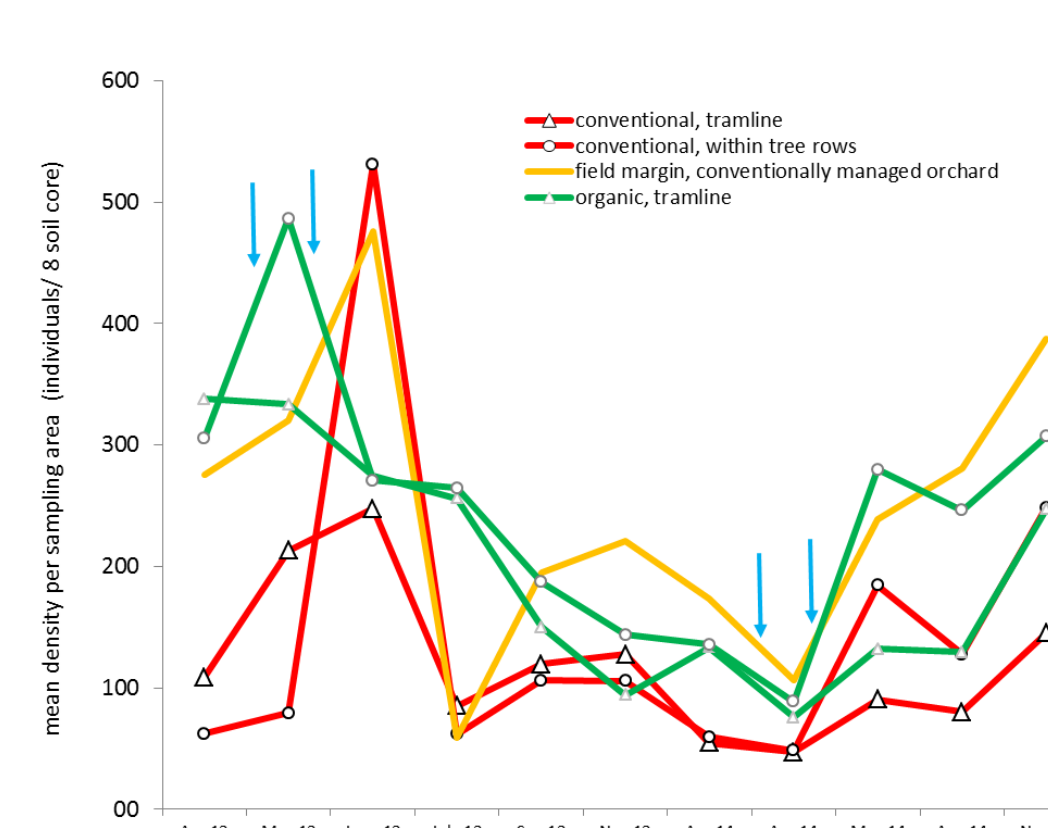


Fig. 5: Mean abundance of total Collembola 2013-2014

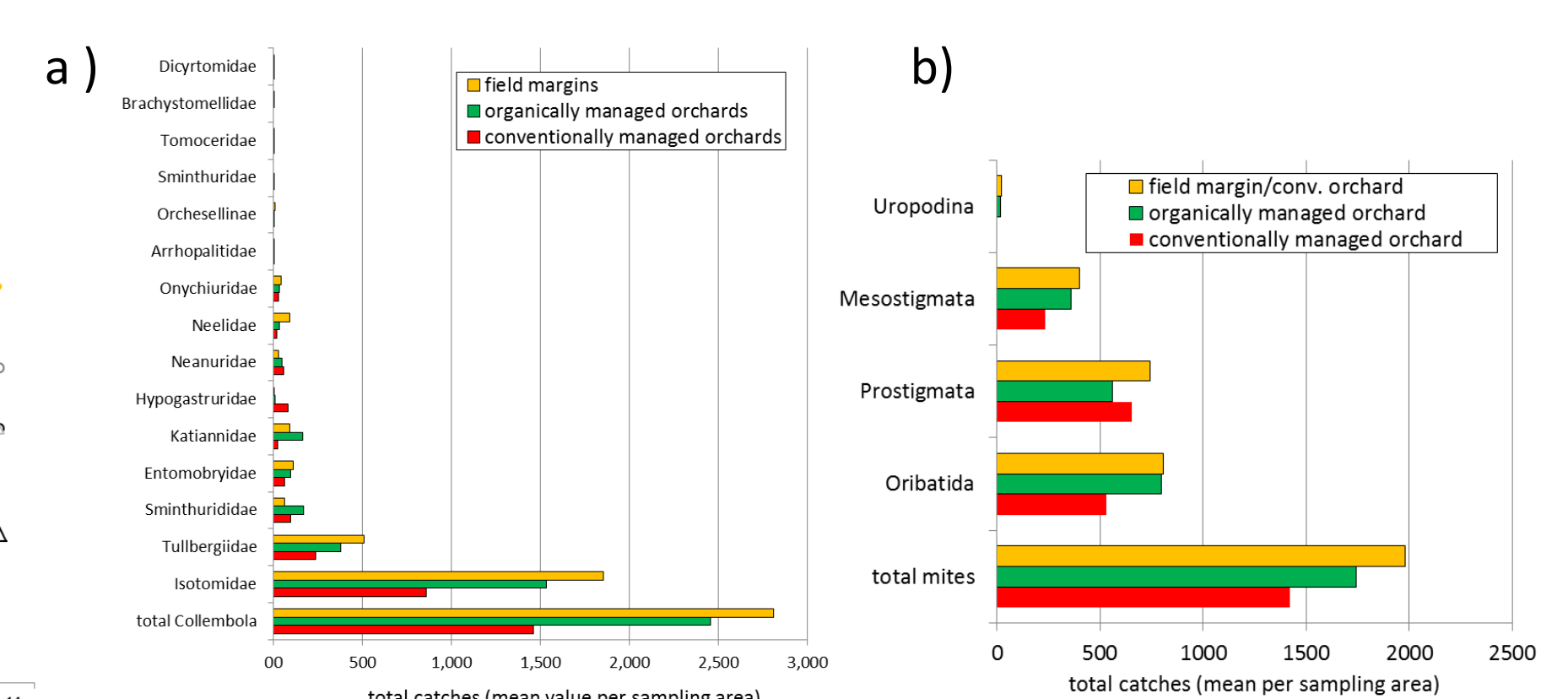


Fig. 6: Total catches of Collembola (a) and soil mites (b) 2013-2014 (mean per sampling area)

D. Community response of soil arthropods:

- No adverse effects on community level at conventional orchards (fig. 7)

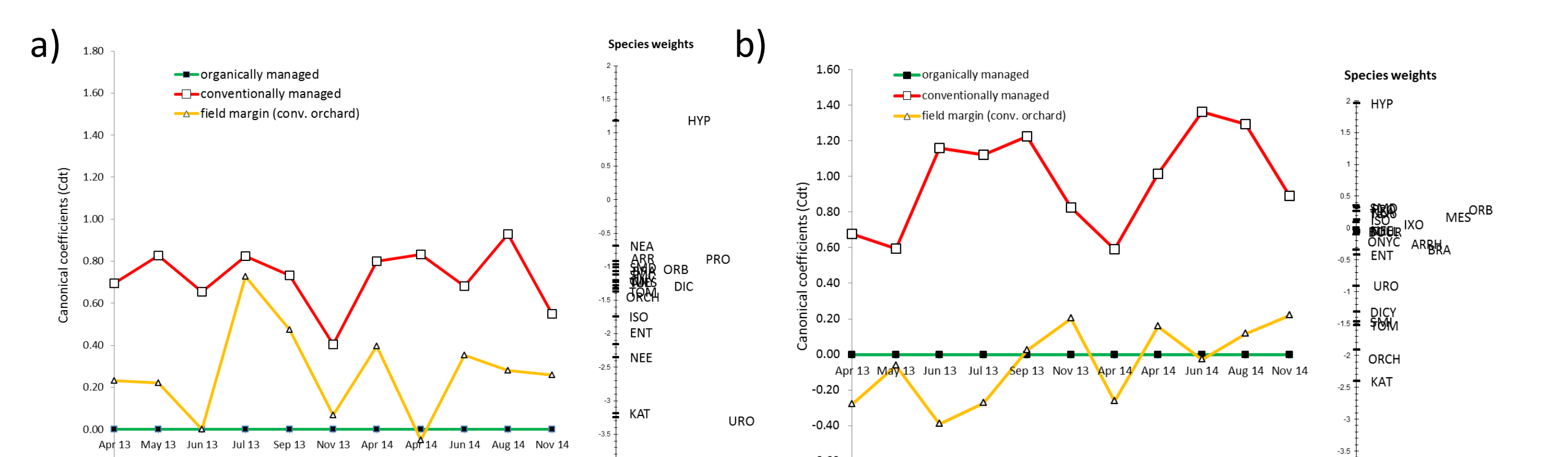


Fig. 7: Principal response curves of soil arthropod community. a) epedaphic ($p = 0.005$) and b) euedaphic ($p = 0.005$) (Organic orchards used as 'reference' and set at zero)