Diversity of soil biota in Canadian grasslands in relation to agricultural cropping systems

O Olfert, N Melnychuk and R Weiss

Agriculture and Agri-Food Canada, 107 Science Place, Saskatoon Saskatchewan, Canada
Contact email: owen.olfert@agr.gc.ca

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Introduction

The Prairie Ecozone of the northern Great Plains of North America is a major contributor to world food production, encompassing the majority of the Canada's productive agricultural cropland, rangeland, and pasture. This has come with some ecological costs. Only small remnants of native short-grass prairie remain and field boundary habitats at best provide only narrow corridors between these remnant natural areas. The desire to maintain the capacity of the soil to sustain biological productivity has positively influenced the study of soil biota that contribute to the quality and health of our prairie soils. Soil meso-fauna (mites, millipedes, collembolans) also are thought to be involved in processing organic matter and augmenting processes involved in soil structure (Behan-Pelletier 1999). Because soil meso-fauna are still relatively sedentary they do reflect the conditions of the soil habitat more than mobile macro-fauna. Meso-fauna are abundant in agricultural soils but much more needs to be learned about their contribution to soil processes (Gulvik 2007). It has been reported that they are sensitive to agricultural chemical inputs and, as a result, they may also have potential as biological indicators of chemical impact on the ecosystem.

Objective

A multidisciplinary team initiated field trials in 1995 to study of the effects of inputs and cropping diversity on sustainability of farming systems over an 18-year period (three six-year rotational cropping cycles) (Thomas *et al*. 2001). The study was based on three levels of inputs (Organic, Reduced, High) combined with three levels of cropping diversity: (Low, Diversified Annual Grains, Diversified Annual Perennial) to give a matrix of nine treatments. In addition, three undisturbed grass sites, adjacent to the cultivated plots, were characterized to establish baseline biodiversity data in relation to soil arthropods. The objective of the study described in this paper was to quantify the temporal effect of the management systems (including inputs and cropping strategies) on the diversity of soil mites (Class Arachnida Subclass Acari)

Method

The biodiversity of soil biota were characterized in the cultivated field plots and in three undisturbed grass sites by extracting their populations from soil cores. Of the three grass sites, one was native grassland (never cultivated); a second was briefly cultivated for two years about 75 years ago, and the third was a perennial forage crop (mostly brome grass) that had been in production for about 40 years. The latter grass site had been cultivated for about 20 years prior to the forage use.

Soil core samples were taken annually from research plots and grass areas in May of each year, prior to any agronomic activities. Each sample consisted of 4 cores (4 cm diameter) divided into upper 7.5 cm and lower 7.5 cm. The samples were bulked and stored at 2°C until being placed in Tullgren funnels to extract soil biota. All soil mites were identified to Family, the more common specimens were identified to Genus.

Results and Discussion

A. Suborder Oribatida

The species composition of the Oribatid fauna was found to differ between the grassland and cultivated systems. Overall the grassland systems had a higher number of taxon groupings with the alfalfa brome (AB) having 13 superfamilies and 12 in the native grassland site. The percent abundance was also more evenly split among the observed groups in the two grassland systems. This was not the case in the cultivated systems where the Oppioidea was the most prevalent superfamily. It comprised 96.9% of the Oribatid fauna in the intensive rotation and 86.6% in the diversified annual perennial rotations. The Oppioidea superfamily is ubiquitous and is known to contain species that are among the first to colonize cultivated areas (Gulvik; 2007). Also of note is the difference in the Nothroidea proportion of the fauna. The highest percentage was found in the native grassland site (10.6%) followed by alfalfa-brome grass site (7.2%), diversified annual perennial rotation (1.1 %) and lastly the intensive cultivation rotations (0.3%). This group is characterized by a longer lifecycle and lower fecundity making them more likely to occur in more stable environments (Behan-Pelletier; 1999; Gulvik; 2007).

B. Suborder Mesostigmata

Mesostigmata mites are primarily predator species and are common inhabitants of disturbed habitats. Members of this group such as Family Ascidae are epedaphic (living and hunting on the soil surface) while others such as Family Rhodacaridae are euedaphic (inhabiting soil pores). Comparing the percent composition of the Mesostigmata fauna among the four systems shows the Ascidae fauna is more prevalent in the grassland systems comprising 61.6% of the Mesostigmata fauna in the native grassland site and 35.7% in the alfalfa-brome grass site. By comparison Ascidae comprised 4.4% of the fauna in the diversified annual perennial rotations and 3.6% of the intensive cultivation rotations. Rhodacaridae, on the other hand, represented 11.0% at the native grassland site versus 59.1% in the diversified annual perennial rotations, 39.9% alfalfa-brome grass site, and 37.5% in the intensive rotation. The difference in the pattern of abundance in the Ascidae and Rhodacaridae may be related to their habitat requirements. The more stable grassland systems may provide a more favorable microclimate for the epedaphic Ascidae, likewise, the smaller euedaphic Rhodacaridae are better able to survive the regular mechanical disturbance found in the cultivated systems.

Conclusions

The design of the experiment has proven effective for the study of the effects of inputs and cropping diversity on sustainability of farming systems in relation to grasslands. Oribatid fauna were found to differ between the grassland and cultivated systems. Overall the grassland systems had a higher number of taxon groupings. Also, the more stable grassland systems tended to provide a more favorable microclimate for the epedaphic Ascidae mites. It is anticipated that the knowledge generated will serve to provide early indications of potential problems and to guide development of improved systems.

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