A Survey of the Microarthropod Populations Under Conventional Tillage and No-tillage Systems

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Extensive entomological research in the United States relative to various residue management systems was not initiated until the early 1970s. Since then there has been increased interest in the effects of agricultural practices on the soil fauna (Edwards and Lofty, 1975). Most of the entomological research that has been conducted on residue management systems involves macroarthropods such as cutworms, armyworms, seedcorn maggots, corn rootworms and the European corn borer.

The present study investigated the effects of conventional tillage and no-till on the microarthropod populations in the soil. Collembola or springtails (Figure 1) and Acarina or mites (Figure 2) are the most abundant soil fauna. These minute organisms reduce and decompose plant debris and increase soil fertility. This study was conducted under a conventional tillage system of fall plowing, spring cultivation, harrowing and a no-till system of seeding directly into the standing stubble.

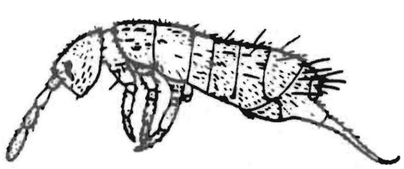

Figure 1. Collembola (35 ×)

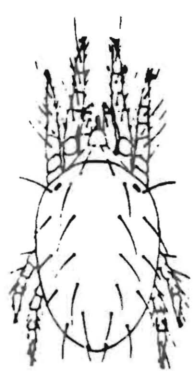

Figure 2. Acarina (60 ×)

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When the soil is disturbed and exposed with conventional tillage, many soil arthropod populations are severely affected. Mortality, fertility, and distribution of populations can be greatly affected by soil compaction, sudden drastic changes in temperature, and changes in relative humidity (Wallwork, 1976).

The objective of this study is to survey the composition of the soil microarthropod population under conservation tillage and no-till systems.

MATERIALS AND METHODS

Trials were established in silty clay soil at Fargo. The tillage treatments consisted of conventional tillage (fall plowing, spring cultivation and harrowing) and no-till (seeding directly into the standing stubble). Both treatments have been established since 1977.

Soil cores were sampled from wheat and soybean plots. Three soil cores were taken at random in each of the 16 plots on June 5, July 2, August 6, September 17, and October 29, 1985. Microarthropods were extracted from the top, middle and bottom layers of each core. The mites were identified to superfamily and family according to Krantz (1978). The Collembola were identified to family according to Christiansen and Bellinger (1980).

RESULTS AND DISCUSSION

The four suborders of mites recognized by Krantz (1978) and five families of Collembola listed by Christiansen and Bellinger (1980) were extracted from the soil (Table 1). The mesostigmatid mites are predators of nematodes, Collembola and other arthropods. The prostigmatid mites are predators and parasites. Some prostigmatid mites feed on fungi. The Astigmatid mites are often associated with insect nests while some feed on plant matter, fungi and decaying organic matter. The cryptostigmatid mites mainly feed on fungi.

A total of nine superfamilies and 16 families of mites have been identified, 10 families in the Prostigmata, nine superfamilies in the Cryptostigmata, five families in the Mesostigmata and one family in the Astigmata. Collembola feed on decaying plant material, fungi, bacteria, arthropod feces, pollen and algae. Five families of Collembola were also identified: Hypogastruridae, Onychiuridae, Isotomidae, Entomobryidae and Sminthuridae.

Total mite populations were higher under conventional tillage than in no-tillage with 57 percent of the population

Table 1. Overall population levels of Collembola and Acarina at different sampling dates Fargo, North Dakota. 1985.

Microarthropod	Sampling date									
	June 5		July 2		August 6		September 17		October 29	
	till	no-till	till	no-till	till	no-till	till	no-till	till	no-till
Mesostigmata	30	35	50	45	11	93	34	40	35	31
Prostigmata	42	56	159	59	674	254	253	120	104	106
Astigmata	30	32	42	47	52	79	68	65	44	83
Cryptostigmata	96	111	82	51	55	99	50	55	66	103
Hypogastruridae	82	310	76	214	19	75	22	168	56	88
Onychiuridae	32	194	86	350	150	625	146	510	53	320
Isotomidae	231	135	557	233	568	479	387	559	182	354
Entomobryidae	3	—	1	—	2	1	2	1	1	0
Sminthuridae	3	2	—	1	—	3	—	—	3	6

occurring under conventional tillage and 43 percent occurring under no-till. The prostigmatid mites were the dominant suborder with the highest numbers occurring under conventional tillage. The Collembola totaled 36.5 percent under conventional tillage and 63.5 under no-till.

Some groups of mites, namely the Prostigmata, are apparently well adapted to cultivated conditions and can reach considerable population densities (Loring et al., 1981). Some prostigmatids are microbial feeders. Microbial-feeding soil fauna mineralize and decompose organic matter (Rosswell and Paustian, 1984). Densities of prostigmatid mites may be closely related to the amount and microbial status of the decaying crop residue (Emmanuel et al., 1985). Cultivation accelerates organic residue decomposition. This may be why the dominant mite suborder of the cultivated plots is favored by this tillage system in contrast to larger soil arthropods like the Collembola which are favored by minimum tillage practices (Emmanuel et al., 1985). Soil and surface organic residues were the apparent main source of the prostigmatids colonizing the growing crop (Emmanuel et al., 1985).

The moisture content of the soil is a main factor affecting the distribution of the Collembola. The vertical distribution of the Collembola usually shows the largest populations in the upper centimeters of the soil profile (Wallwork, 1970). The Collembola populations were therefore lower under conventional tillage mainly because the upper centimeters of the soil profile under conventional tillage would make the Collembola more vulnerable to drying.

An increase in organic matter results in a decrease in soil pH. Correlations between microarthropod populations and soil pH have been made. However, the effects cannot be stated in general terms because these correlations tend to be species specific (Hagvar and Abrahamsen, 1980).

There are many unanswered questions remaining about the role of microarthropods in crop residue decomposition. More information about the biology and feeding preferences of microarthropods is needed.

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