Dec 2nd, 12:00 AM

Earthworms in Agriculture

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EARTHWORMS IN AGRICULTURE

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Earthworms have many important roles in agroecosystems. Their feeding and burrowing activities incorporate organic residues and amendments into the soil. These activities enhance residue decomposition, formation of humus, nutrient cycling, and soil structure development. Burrows formed by earthworms also provide low resistant channels for root growth, water infiltration, and gas exchange.

Not all earthworms perform the same role in these activities. For example, *Lumbricus terrestris*, better known as the night crawler, lives in a permanent vertical burrow and feed on plant residue located on the soil surface. When the night crawler is feeding, residue is collected from the soil surface and pulled down into the burrow. Undigested food and waste products are then deposited on the surface of the soil. On the other hand, *Octolasion tyrtaeum*, often referred to as garden worms, spend their lives in temporary horizontal burrows. They constantly ingest soil and partially decomposed plant residue. Waste material is deposited within old burrows. *Aporrectodea trapezoides*, better known as gray worms, are intermediate in their feeding, tunneling, and casting.

Benefits of Earthworms

Infiltration

Earthworms can increase the rate of water infiltration by as much as ten times when compared to areas where worms are absent. A series of experiments were conducted in southern Iowa comparing plots with L. terrestris to plots without earthworms (Table 1). Measurements were collected with single ring infiltrometers. The data are presented as time required for water to infiltrate below the soil surface. The largest differences were recorded at the Burlington site in 1991. In plots containing L. terrestris, approximately 8 minutes were required to infiltrate three inches of water in the soil. In plots without earthworms, approximately 80 minutes were required to lose identical amounts of water.

Inches	*L. terrestris*	Without worms
	Burlington, IA 1990	
1	2	9
	Burlington, IA 1991	
1	2	9
2	4	30
3	8	80
	Danville, IA 1992 (Site 1)	
1	6	58
	Danville, IA 1992 (Site 2)	
1	4	10

Residue Breakdown and Nutrient Release

Earthworms are important in the process of residue breakdown and the subsequent release of nutrients into the soil matrix. L. terrestris moves plant residue from the surface into the soil matrix by collecting the residue from the surrounding areas and pulling it into its burrow. Within the burrow, smaller species of earthworms, insects, and microorganisms complete the process of decomposition. On the average, research has shown that earthworms are able to consume an average of 27 mg per day of residue per gm wet weight of the earthworm. It has also been shown that the amount of residue earthworms consume is limited by the amount of residue available.

Earthworm casts are sources of nutrients for plants. Earthworms increase the amount of nitrogen mineralized from organic material in the soil. Because nitrification is enhanced in earthworm casts, the ratio of nitrate-N to ammonium-N tends to increase when earthworms are present. Nitrogen-fixing bacteria are found in the gut of earthworms and in earthworm casts, and higher nitrogenase activity, meaning greater rates of N-fixation, are found in casts when compared with soil.

Population Management

Tillage

Several studies have shown that as tillage increases the number of earthworms decrease. There are many reasons for the reduction in the number of earthworms. In some cases, earthworms may actually be damaged by the tillage implements. Tillage also alters the placement of food sources and the microenvironment. Tillage may also expose the earthworms to predators such as birds. Table 2. shows a comparison of four tillage systems in plots near Ankeny, Iowa. The greatest number of earthworms (all species) were found in the plots with the least amount of tillage.

Table 2. Effect of tillage systems on earthworms, Ankeny, IA. (Mean number of earthworms M^{-2}).

System	Immatures	Adults	Total	Biomass[1]
		Lumbricus terrestris		
Plow	3.4	0.0	3.4	0.0
Chisel	3.4	1.7	5.1	3.9
Disk	6.9	5.1	12.0	13.5
Notill	17.1	3.4	20.5	13.4
		Aporrectodea trapezoides		
Plow	1.7	0.0	1.7	1.5
Chisel	3.4	1.7	5.1	1.3
Disk	6.9	5.1	12.0	8.2
Notill	15.4	10.3	25.7	14.6
		Octolasion tyrtaeum		
Plow	0.0	1.7	1.7	1.7
Chisel	3.4	12.0	15.4	14.8
Disk	13.7	13.7	27.4	11.1
Notill	22.3	25.7	48.0	25.6

[1] Biomass of adult worms expressed as ml displacement of distilled water.

Pesticides

Effects of agricultural pesticides on earthworms depends on the chemical used. Some pesticides are extremely toxic to earthworms while others are not as toxic. A report from Ohio State University ranked 200 major pesticides as to their effect on earthworms. This report showed that while organophosphate insecticides are relatively non-toxic to earthworms, specific insecticides within this group may be extremely toxic. For example, in our studies Lorsban was found to be safer than some of the other organophosphate insecticides that are currently used for corn rootworm control. In general, all carbamates have been reported to be extremely toxic to earthworms. Herbicides have low toxicity to earthworms, but can cause population reductions by decreasing organic matter input and cover from weed plants.

Conclusions

1. Benefits of earthworms include, increased infiltration, reduced runoff, and increased residue turnover.
2 Earthworm populations are reduced by tillage.
3. Earthworm populations should be a factor when considering pesticide control programs.