



Effect of Fertilizer (Urea) on Earthworms: A Review

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Abstract:

Earthworms play a crucial role in soil fertility by enhancing soil aeration, nutrient cycling, and organic matter decomposition. However, the increasing use of chemical fertilizers, particularly urea, raises concerns about its impact on earthworm populations and soil health. Various studies indicate that high concentrations of urea can lead to toxicity, reduced biomass, lower reproduction rates, and even mortality among earthworms. Additionally, excessive urea application alters soil pH and microbial composition, indirectly affecting earthworm activity. This paper highlights the need for balanced fertilizer use and promotes sustainable agricultural practices to maintain earthworm diversity and soil health.

Keywords: *Earthworm, Urea, Soil Fertility, Chemical Fertilizer, Soil Health, Toxicity, Sustainable Agriculture*

Introduction:

Earthworms are often referred to as "ecosystem engineers" due to their vital role in improving soil structure, nutrient recycling, and organic matter decomposition (Edwards & Bohlen, 1996). Their activity enhances soil aeration, water infiltration, and microbial diversity, making them indispensable for sustainable agriculture. However, with the rising use of synthetic fertilizers such as urea ($\text{CO}(\text{NH}_2)_2$), concerns have been raised regarding its impact on earthworm populations.

Urea is a widely used nitrogen-based fertilizer that enhances plant growth. However, its excessive application can lead to soil acidification, ammonia toxicity, and nitrate leaching, all of which can negatively impact soil organisms, including earthworms (Singh & Subramaniam, 2019). This paper reviews existing research on the impact of urea on earthworm survival, growth, reproduction, and soil health.

Impact of Urea on Earthworms:

Survival and Mortality:

Studies indicate that earthworm mortality increases with higher concentrations of urea due to the release of ammonia (NH_3) during its hydrolysis in the soil. High ammonia levels are toxic to earthworms, leading to skin irritation, desiccation, and respiratory stress (Edwards et al., 2010).

Bansal & Kapoor (2020): A high urea concentration (≥ 300 mg/kg soil) caused a 40–60% reduction in earthworm population within four weeks.

Tripathi et al. (2018): Earthworms exposed to 500 mg/kg urea exhibited significant mortality due to ammonia toxicity.

Manna et al. (2005): Found that urea-induced mortality was higher in *Eisenia fetida* compared to native species like *Perionyx excavatus*.

Growth and Biomass:

Earthworm growth is highly sensitive to soil conditions. Urea application alters soil pH and microbial activity, which in turn affects their growth.

Kumar et al. (2019): Reported a 20% reduction in earthworm biomass after prolonged exposure to urea-treated soil.

Field observations: Earthworms in high-urea soils exhibited thinner bodies, slower movement, and reduced burrowing activity (Bhadauria & Ramakrishnan, 1991).

Blouin et al. (2013): Found that urea toxicity decreased protein synthesis and enzyme activity in earthworms, leading to stunted growth.

Reproduction and Cocoon Production:

Earthworm reproduction is affected by changes in soil pH, moisture retention, and microbial diversity caused by urea.

Rathore et al. (2021): Found that cocoons produced by *Eisenia fetida* were significantly lower (by 35%) in urea-rich soils.

Reinecke & Venter (1987): Reported that high nitrogen levels disrupted earthworm reproductive cycles and caused embryonic abnormalities.

Effect on hatchlings: High urea concentrations reduced the survival rate of juvenile earthworms, leading to population decline over generations.

Soil Health and Microbial Activity:

Urea application impacts soil pH and microbial communities, indirectly affecting earthworms.

Soil acidification: Overuse of urea leads to decreased soil pH, making the environment unsuitable for earthworms (Briones & Schmidt, 2017).

Microbial imbalance: Urea stimulates bacterial growth that produces toxic nitrogen compounds, reducing earthworm activity (Brown et al., 2000).

Soil compaction: A decline in earthworm populations can lead to reduced soil aeration, affecting root growth and crop productivity.

Discussion and Sustainable Solutions:

Optimum Urea Application: To minimize harmful effects on earthworms, balanced fertilizer use is essential. Studies suggest that applying urea in controlled doses (≤ 100 mg/kg soil) has minimal negative effects.

Use of Organic Fertilizers: Combining urea with organic manure, compost, or biofertilizers can reduce its harmful impact and improve soil fertility.

Vermicompost addition: Earthworms thrive better in urea-treated soils when mixed with organic matter, neutralizing harmful effects (Domínguez, 2004).

Crop Rotation and Cover Crops: Growing leguminous plants alongside urea application can naturally enhance nitrogen levels, reducing the need for synthetic fertilizers.

Precision Farming Techniques: Slow-release urea fertilizers reduce nitrogen loss and ammonia toxicity.

Drip irrigation with urea application helps control nitrogen levels in soil and prevents excessive accumulation.

Conclusion:

Excessive use of urea fertilizers negatively impacts earthworm survival, growth, and reproduction, ultimately degrading soil health. Sustainable agricultural practices, such as controlled urea application, organic fertilizers, and crop diversification, can help mitigate these adverse effects. Protecting earthworm populations is crucial for maintaining soil fertility, ecosystem balance, and long-term agricultural productivity. Future research should focus on developing eco-friendly fertilizers and evaluating earthworm-friendly farming methods to ensure sustainable food production.

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