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Effect of Chemical And Organic Fertilizer on Earthworm

Shivani Sood, Charu, Chhavi, Kanika, Meera, Richa and Neetu Garg
MLN College, Yamuna Nagar
Email: Neetu.gargneetu@rediffmail.com

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Abstract

Fertilizers have become essential to modern agriculture to feed the growing population. Chemical fertilizers make the soil more acidic and create unfavorable conditions for earthworms and other helpful soil organisms. The effect of soil fertilization with inorganic and organic fertilizers on earthworms' population and biomass was studied under different doses of the fertilizers for 105 days in lab conditions. The work indicates the deleterious effect of inorganic fertilizers on the survival of earthworm community in soil.

Keywords: *Fertilizers, agriculture, Earthworm*

Introduction

Increased crop productions mostly depend on the type of fertilizers used to insert essential nutrients for plants. Application of fertilizers is required to replace crop land nutrients that have been consumed by previous plant growth to attain the goal of maximum productivity and economic returns. The application of chemical fertilizers on agricultural land not only affects the soil quality but also to the survival of soil organisms dwelling there in.

Presence of chemical fertilizers is toxic for soil organisms but on the contradictory they have been supported too to be beneficial as far as their food supply is concern. The intense toxicity of urea on earthworm by using a simple paper contact method was studied by Abbiramy *et al*., 2013, where the respective toxicity grade of urea was categorized as "very toxic" to earthworm.

Inorganic fertilizers may also be helpful in increasing earthworm population by increasing the quantity of crop residues returned to the soils, despite it the long-term use of inorganic nitrogen fertilizers may sometimes cause a reduction in earthworm abundance and biomass, particularly if it is ammonia based (Ma *et al*., 1990, Whalen *et al*.,1998).

The general approval for urea in agricultural lands as per the Indian soil testing manual released in 2011 by the department of agriculture, Ministry of agriculture, India is 120 kg per hectare. But Indian farmers overuse urea to achieve more productivity by ignoring its harmful and negative effects on soil organism. Our study was a short investigation aimed to find out whether there is some difference in effect of inorganic and organic fertilizers on earthworm, which are considered one of the vital soil organisms favorable for maintaining fertility of soil. Urea was selected as the inorganic fertilizer and as organic fertilizer "organic manure" was used for this purpose.

Material And Methods

Experimental model

Earthworms were taken from the Botanical garden of Mukand Lal National College, Yamuna Nagar through digging. They were maintained in the laboratory conditions and acclimatized for 105 days. The worms used in the experiment were approximately of same size and same biomass.

Urea (46%): The inorganic fertilizer used in the experiment was Urea which was purchased from the local market. Once applied to the soil, urea is converted to ammonia, which reacts with water to form ammonium ions within two to three days (faster under warm conditions).

Organic manure: Manure is organic matter used as fertilizer in agriculture. It is derived from animal feces. Manure contributes to the fertility of the soil by adding organic matter and nutrients, such as nitrogen, that are utilized by bacteria, fungi and other organisms in the soil. **Decomposed leaves:** These are the dead plant material such as

leaves, bark, needles, twigs and cladodes that have fallen to the ground. Decomposed leaves are a very good fertilizer which provides nutrition to plants and soil organisms.

Preparation of Soil Beds

Wooden baskets were used for preparations of soil beds. Dried soil (from nearby farmland) was crushed and filtered through a fine mesh sieve. Ten kg of fine soil was then poured in each container and water was added to moisten the soil. 2 kg dried powdered (3 week old) cow dung was also added to each wooden basket to avoid starvation.

Addition of urea: Urea was added in two containers at different concentrations. One with 34.8 gm urea in 10 kg soil which was of high concentrations and on another hand 15 gm urea was added in 10 kg soil at low concentration.

Addition of organic manure: 2 kg of organic manure was added in 10 kg of soil and mix them properly.

Addition of decomposed leaves: Compost of leaves was also in a wooden basket with 10 kg of soil. This compost contains wet leaves, twigs, bark, needles etc. which has good source of nutrients.

15 mature earthworms were added to each basket. The baskets were covered with wet muslin cloth so that the moisture level needed by the worm is maintained and it also prevents them to crawl out of basket. One control set with 10 kg soil and cow dung was also prepared. 3 replicates were used for each set. To maintain up to 70 percent moisture level, water was supplied regularly. After 15, 30, 45, 60, 75, 90 and 105 days the changes were observed in the activity, morphology, growth of earthworms as well as number of earthworms were also counted.

Different setups showing addition of different fertilizers

Statistical analysis

1. Number: Earthworms were counted from basket by hand sorting method in a large tray as described by Julka (1998).

2. Soil moisture: For moisture content 25 gm of soil sample was dried overnight at 105 f C in an oven, cooled in desiccators and weighed. Loss in weight reflected the moisture content which was converted into percentage by following formula as described by Santhanam *et al*., 1989.

Moisture content (%) = (I-F) × 100 ÷ I

Where I = Initial weight of sample, F = Final weight of sample

3. Soil pH:

The pH determination involved suspension of soil: water ratio of 1: 5, following Misra (1968). To a 25 g of air dried and powered soil in a beaker, 50 ml of distilled water was added. The mixture was thoroughly stirred for 60 min with an electromagnetic stirrer. The pH of freshly stirred suspension was recorded by immersing electrode of digital 'AMKAY' pH meter.

4. Wet Biomass: For wet biomass estimate, the worms was washed in fresh water and soaked dried over a blotting paper before weighing.

Result And Discussion

Urea is the most commonly used nitrogen fertilizer by the farmers worldwide. The overuse of urea may affect the soil organisms especially, the earthworms which have a great role in soil fertility (Bremner, 1995). There was a positive relation between earthworm mortality and the concentration of urea added to soil. The biomass of earthworms exposed to urea decrease with the increase in the urea dose. The loss in body weight changed with increased exposure time. The mortality reached 100% when the dose of urea reached 34.8 gm in 10 kg soil which is the actual dose being practiced by the farmers in the agricultural land. At low concentration of urea there was a significant change in number and a decrease in wet biomass was observed. This decreases in number and biomass of earthworms shows that the high concentration of urea was very toxic to the worms or could be lethal for the total population. Healthy earthworms in the organic fertilizers show a constant number and biomass. Studies shows significant increase in the number and biomass of earthworms treated with fertilizers containing nitrogen and phosphorus (Iordache *et al*., 2010, Yang *et al*., 2007, Tran *et al*., 1995, Bilalis *et al*., 2009, Bunemann *et al*., 2006). In some studies, it was reported that organic nitrogen had a greater effect on earthworm population than inorganic nitrogen (Mathews *et al*., 2001, Smetak *et al*., 2007, Estevez et al., 1996). Fertilizers with nitrogen create acidic conditions in soil which is lethal for earthworm (Chen Jen-Hshuan., 2006, Zhou Qi-xing *et al*., 2006).

In our experiment, mortality of all the 15 earthworms were seen at 45th day in the dose of urea which is practically been applied in the agricultural land by the farmers i.e. 34.8 gm/10 kg soil. The deleterious effect of

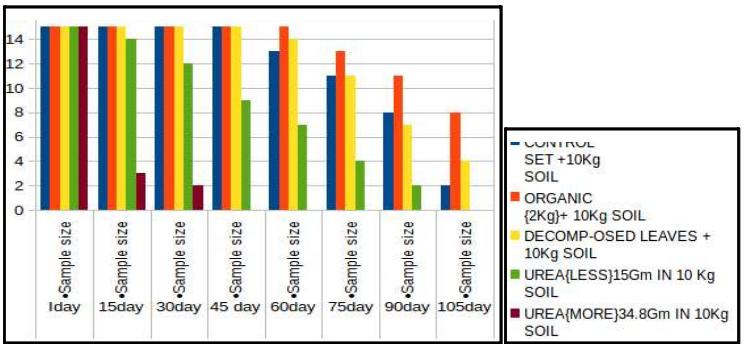
urea on earthworm was found to start under this dose within 24 hours. As the number of days increased, the number of earthworm rapidly started decreasing in the urea set with high dose. In another set of urea i.e.15 gm/ 10 kg soil, the number of worms also decreased but at a slow rate. It shows that more or less urea had a toxic effect on earthworms (Bremner, 1995).

In rest of the doses, variation in number and biomass of worms were observed which indicate that the inorganic fertilizer had a sound effect on the reproductive activity of the earthworms. On the other hand, in the organic fertilizer 'organic manure' positive effects were found on the worms. At 105th day maximum worms were found in this set. Another set with decomposed leaves, somewhere also found beneficial for the worms because it contain adequate amount of nutrients for the worms.

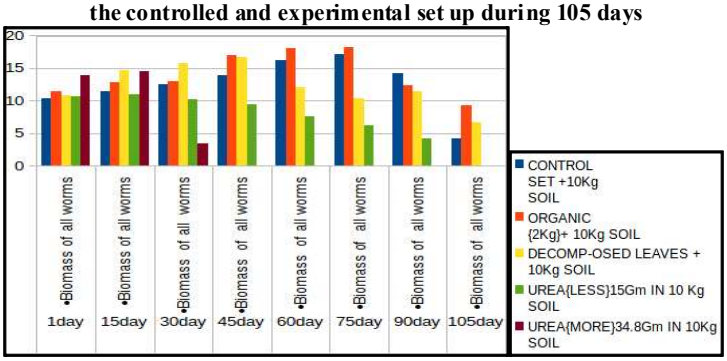
The mortality seen after 45th day in all the sets was due to decrease in the atmospheric temperature because earthworms prefer temperature between 50 to 70 degrees. So, after 45th day, as the temperature started decreasing, the number of earthworms in all sets also starts decreasing.

DAYS	PARAMETERS	CONTROL SET +10Kg SOIL	ORGANIC {2Kg}+ 10Kg SOIL	DECOMP-OSED LEAVES + 10Kg SOIL	UREA {LESS}15 Gm IN 10 Kg SOIL	UREA {MORE} 34.8Gm IN 10Kg SOIL
Ist day	Sample size	15	15	15	15	15
	Biomass of all worms	10.38gm	11.42gm	10.82gm	10.67gm	13.93gm
	Biomass of one worm	0.54gm	0.46gm	0.32gm	0.74gm	1.05gm
	Moisture content{25gm}	15.28gm	17.52gm	20.01gm	19.27gm	14.28gm
	pH of soil	7	7	7	8	9
15thday	Sample size	15	15	15	14	3
	Biomass of all worms	11.49gm	12.81gm	14.69gm	11.01gm	14.52gm
	Biomass of one worm	0.61gm	1.05gm	0.43gm	1.01gm	2.92gm
	Moisture content	16.83gm	14.21gm	17.62gm	20.01gm	16.98gm
	pH of soil	7	7	7	8	10
30thday	Sample size	15	15	15	12	2
	Biomass of all worms	12.53gm	12.95gm	15.75gm	10.22gm	3.42gm
	Biomass of one worm	1.38gm	2.24gm	2.14gm	0.96gm	1.28gm
	Moisture content	19.83gm	19.20gm	20.20gm	20.01gm	9.29gm
	Juvenile	2	4	3	1	0
	pH of soil	7	7	7	8	11
45thday	Sample size	15	15	15	9	--
	Biomass of all worms	13.92gm	16.98gm	16.72gm	09.43gm	NA
	Biomass of one worm	2.12gm	2.97gm	2.25gm	0.85gm	NA
	Moisture content	20.02gm	17.23gm	19.28gm	16.04gm	21.00gm
	pH of soil	7	7	7	8	11
60thday	Sample size	13	15	14	7	--
	Biomass of allworms	16.25gm	18.13gm	12.11gm	07.52gm	NA
	Biomass of one worm	3.48gm	3.07gm	2.04gm	0.66gm	NA
	Moisture content	19.41gm	20.08gm	19.23gm	18.72gm	17.81gm
	pH of soil	7	7	7	7	7
75thday	Sample size	11	13	11	4	--
	Biomass of allworms	17.12gm	18.27gm	10.40gm	06.17gm	NA
	Biomass of one worm	3.32gm	2.09gm	1.79gm	0.48gm	NA
	Moisture content	21.14gm	19.62gm	18.16gm	20.08gm	NA
	pH of soil	7	7	7	8	7
90thday	Sample size	8	11	7	2	--
	Biomass of allworms	14.28gm	12.42gm	11.48gm	4.17gm	NA
	Biomass of one worm	4.16gm	2.17gm	1.22gm	0.36gm	NA
	Moisture content	17.26gm	20.41gm	18.62gm	17.81gm	19.17gm
	pH of soil	7	7	7	8	7
105thday	Sample size	2	8	4	0	0
	Biomass of allworms	4.16gm	9.28gm	6.62gm	--	--
	Biomass of one worm	1.06gm	2.28gm	1.18gm	--	--
	Moisture content	19.48gm	21.02gm	18.06gm	17.68gm	14.29gm
	pH of soil	7	7	7	7	7

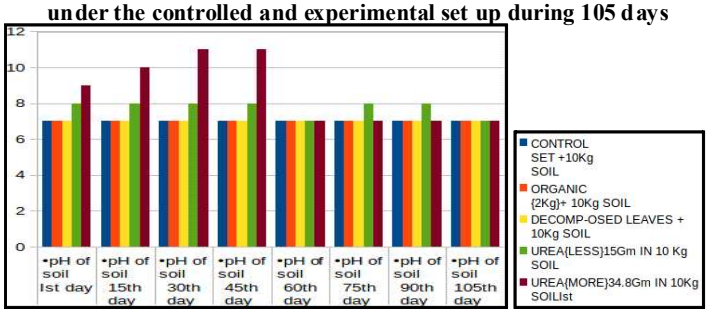
Varion in number and biomass of earthworms under different sets



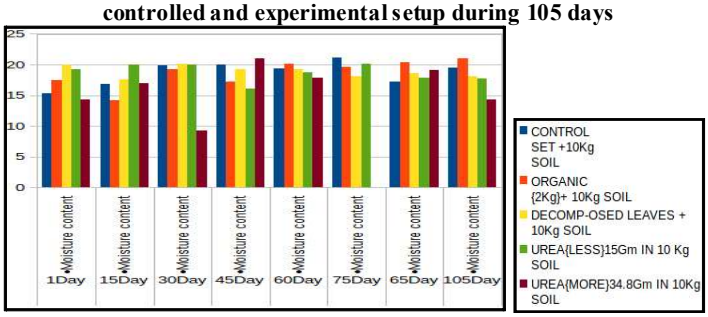
Graphical representation of variation in the number of earthworms under the controlled and experimental set up during 105 days



Graphical representation of variation in the biomass of adult worms under the controlled and experimental set up during 105 days



Graphical representation of variation in the pH of soil under the controlled and experimental setup during 105 days



Graphical representation of variation in moisture content of soil under the controlled and experimental setup during 105 days

Conclusion

The result of the present investigation clearly showed that treatment with inorganic fertilizer is very harmful for earthworms. On the other hand organic fertilizer 'organic manure' was found to have a favorable and beneficial effect all over. This study is useful to evaluate ecological risk from agricultural activities such as application of different chemicals fertilizers. Excessive use of urea leads to several adverse implications on soil, crop quality and overall ecosystem. So, it is advised that use of nitrogen fertilizer like urea should be minimized in agricultural land. Instead of nitrogen fertilizers use of organic fertilizers should be preferred which is beneficial for soil plants, soil and soil organisms.

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