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Comparative Study on Effect of Pesticides and Vermicompost on the Growth of *Eisenia foetida*

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Abstract: Earthworms are important soil invertebrates and play an important role in improving soil quality. They act as nature´s best fertilizers and have beneficial role in the process of vermicomposting which is very useful in crop production. The Indiscrete use of chemical fertilizers and pesticides poses a threat to soil quality, crop production and also hampered the growth of earthworms. In the present study the impact of pesticides and vermicompost in potato crops field and on *Eisenia foetida* was evaluated. The study aimed to understand the effect of chemical and biological fertilizers on the life table attributes of earthworm, *Eisenia foetida*. Laboratory adapted *Eisenia foetida* were reared on artificial soil supplemented with chemical fertilizers and vermicompost. Changes in number and biomass of *Eisenia foetida* were monitored four times in various applications of pesticides and in vermicompost. Four pesticides that are commonly used in potato crops are Chlorpyrifos, Malathion, Carbofuran and Cypermethrin. Thus, the negative impact of these pesticides on *Eisenia foetida* and Potato crops has been reported when compared to the control (Vermicompost). The effect of Pesticides was noted in following order: Chlorpyrifos > Malathion > Cabofuran > Cypermethrin. Application of Chlorpyrifos to the potato crop field harboring earthworms reduced the number of earthworms from 200 in the control group to 20 after 60 days of the application. The effect was more pronounced on the total biomass of the culture owing to the high toxicity of Chlorpyrifos. The Pesticides treatment decreased the percent survival of the earthworms by 70% and 40%, respectively. The number and biomass of Earthworm decreased on increasing the application of pesticides thus, reduces crop production. On the other hand, the vermicompost had a positive effect on the earthworm's biology.

Keywords: Pesticides, Chlorpyrifos, Malathion, Cabofuran, Cypermethrin, Organic farming, Vermicompost, *Eisenia foetida*

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Introduction

Earthworms constitute about more than 80% of the invertebrate biomass in soil and are considered as ecologically important soil fauna because of their role in metabolism, fertility and structural development of soil (Ismail, 1997). Existence of these ecologically important soil

organisms is threatened by the escalating use of insecticides in agricultural fields in recent years (Santadino *et al*., 2014; Rico *et al*., 2016; Reddy and Rao, 2008). Research on vermicomposting will provide farmers with an environment-friendly fertilizer and assist in promoting the agriculture sector towards a greener future (Huang *et al*., 2018). The use of such technology will help in cost management in agriculture which is increased in the recent years and has added to the burden of farmers in terms of chemical fertilizers and chemical pesticides. Consequently, the cost of production has increased many folds. Use of organic source of fertilizers like vermicompost could be an effective solution to the problem where it could substitute the chemical inputs in crop productivity and reduce the economic cost and on the other hand may also lead to organic produce which fetches higher price in the market. The increase in living standards around the world has created a growing demand for such organic produce using only natural pesticides and fertilizers, which are perceived to be healthier for consumers and environment friendly (Kaplan, 2016). The present study deals with the impact of pesticides and vermicompost on earthworm species, *Eisenia foetida*. A number of researches throughout the world have found that the nutrient profile in vermicompost is generally higher than traditional compost. Earthworms are highly susceptible to changes of ecological factors. Any change in the system directly affects species composition (Lammertyn *et al*., 2021). The use of vermicomposting have beneficial role on earthworms as well as crop production but the excessive use of pesticides at the same time threatened the survival of earthworms (Wang *et al*., 2012, 2016). Pesticides adversely affect beneficial soil organisms and contribute to environmental concern (Suthar *et al*., 2014; Chen *et al*., 2018). Vermicompost treated soil has better aeration, porosity, bulk density and water retention. Chemical properties such as pH, Electrical conductivity and organic matter content are also improved for better crop yield. Vermicomposts have been shown to improve plant growth significantly *E. foetida* is one of the most favourite worm species for composting and organic gardening (Garg *et al*., 2006) and is frequently used as a biological monitor for testing the effects of contaminants on soil biota (OECD 1984; Yasmin and D'Souza, 2007, 2010). Although this earthworm species is exotic to India, it is extensively cultured and used for vermin-composting in this country. The objective of this study was to compare the effect of pesticides and vermicompost on earthworm and on potato crop field.

Materials and Methods

The experiment was conducted in a Potato crop field nearby Aligarh district. *Eisenia foetida* were collected from the college laboratory which was originally cultured through the process of vermicomposting. Four pesticides Chlorpyrifos, Malathion, Carbofuran and Cypermethrin were obtained from Kisanseva Kendra. The field was divided into five sectors. Fifty individuals of the species *Eisenia foetida* was placed in each sector and measured before being placed in field. The trial was set up with five treatments in four applications of pesticides. In control experiment no pesticides were used but it was only vermicompost. Concentrations of four pesticides were prepared and were subsequently mixed with soil. Worms were exposed to different concentrations of Pesticides for 0, 30, and 45 days. Changes in number (N) and Biomass (B) of *Eisenia foetida* were monitored during various applications of pesticides. Growth effects, mortality and Biomass were evaluated on 0, 30, 45 and 60 days. Physicochemical characteristic of vermicompost was noted initially and after 60 days. Total nitrogen was determined by Flame photometer. The pH and electrical conductivity (EC) were determined using a double distilled water suspension of each waste in the ratio of 1:10 (w/v) that had been agitated mechanically for 30 min and filtered through Whatman No. 1 filter paper. Total organic carbon (TOC) was measured using the method of Nelson and Sommers (1982) dry combustion method. Total Kjeldahl nitrogen

(TKN) was determined after digesting the sample with concentrated H_2SO_4 and concentrated $HClO_4$ (9:1, v/v) according to Bremner and Mulvaney (1982) procedure. Total available phosphorus (TAP) was analyzed using the colorimetric method with molybdenum in sulphuric acid. Total Potassium (TK) was determined after digesting the sample in diacid mixture (cc HNO_3: cc $HClO_4$ = 4 : 1, v/v), by flame photometer (Elico, CL 22 D, Hyderabad, India). Matured worms were collected from the soil and weighed. After treatment, change in number and Biomass of *Eisenia foetida* were recorded. Change in Physiochemical characteristics of vermicompost was also noted. The experimental data was expressed as mean ± S.E. One way analysis of variance (ANOVA) and Least Significant Difference (LSD) was carried out using SPSS software to determine difference from control and between the treatments ($p < 0.05$). Because normality of data is a prerequisite for ANOVA, the count data were log-transformed to ensure normal distribution. When the final F test in ANOVA indicated that there were significant differences between the means of the counts of the young worm groups, the Tukey test was performed to determine exactly which group differed most significantly from the control group. The weights of the treated worms were compared to that of the control group with the help of the paired t test.

Results and Discussion

A number of studies have been conducted on the standard worm *Eisenia foetida*. Some of the responses of earthworms to sublethal concentrations of Pesticides are shown in Table1. Negative impact of Pesticides on earthworm growth has been reported.

Table 2 shows the physicochemical characteristics of vermicompost which was considered as control. There was little change in pH of vermicompost. The pH decreased from alkaline to acidic. The electrical conductivity of vermicompost decreased from 2.2 to 1.22 after 60 days. Total organic carbon declined drastically due to loss of TOC in form of CO_2 during vermicomposting. Inoculation of earthworms in decomposing organic waste material promotes biochemical degradation and their activity also promoted the colonization of decomposer communities of waste system, this is due to suitable biological and chemical environment conditions. Earthworms break and homogenize the ingested material through muscular action of their foregut and also add mucus and enzymes in ingested material, this increase the surface area for microbial action. Thus, combined action of earthworms and microorganisms bring TOC loss from the substrates in the form of CO_2. Earthworms and microorganisms use large portion of carbon as an energy source and nitrogen for building cell structure which causes decomposition of organic matter. Total Kjeldahl nitrogen increased from 0.42 to 0.68 because of mineralization of organic matter. Kaushik and Garg (2003) have observed 2.0- 3.2 fold increase in TKN in textile mill sludge vermicomposting. Losses of organic carbon might be responsible for nitrogen addition in the form of mucus.

Table 3 and 4 shows the number (N) and biomass (B) of *Eisenia foetida* during different application of Pesticides. The maximum yield of *Eisenia foetida* as well as Potato crops in field was noted in control experiment because vermicompost was used in this sector. Compared to the control sector in which no pesticides were used, the number (Fig. 1) and biomass (Fig. 2) of earthworms in other four sectors decreased significantly because pesticides were used in these four sectors. All the four pesticides have a high use in agriculture.

It suggests that pesticides had a strong depressive effect on the earthworms (Jovana *et al*., 2014). This negative impact was highest in Chlorpyrifos pesticide. Pyrethroids have lesser impact compared to Chlorpyrifos. Choo and Baker (1998) reported that endosulphan significantly reduce the weight of juvenile *Aporrectodea trapezoids*. Khan *et al*. (2007) reported a significant reduction in earthworm biomass after exposure to different concentrations of copper

Table 1: Responses of earthworm to the sublethal concentrations of Pesticides

Pesticides	Concentration of pesticide/exposure	Test conditions	Responses
Chlorpyrifos	5,20, 60 mg/kg soil 0, 30 ,45 days	pH= 6.0 ± 0.5 Moisture=50% Temp = 20°C	Adverse impact on growth and reproduction.
Malathion	80, 300,600 mg/kg soil 0,30 ,45 days	pH=6.5 Moisture=50% Temp= 21-22°C	Significant reduction in body weight decreased spermatic viability.
Carbofuran	1, 4, 16 mg/kg soil 0, 30, 45 days	pH= 5.9-6.1 Moisture=50% Temp= 20 ± 2°C	Toxicity causes reduce growth and reproduction.
Cypermethrin	5, 20, 40 mg/kg soil 0, 30, 45 days	pH=6.0 ± 0.5 Moisture=50% Temp=20°C	Significant reduction in cocoon production. Juveniles more sensitive than adults.

Table 2: Physicochemical characteristics of Vermicompost

Parameter	INITIAL (0 DAY)	FINAL (60^{th} day)
pH (1:10)	8.9 ± 0.1	7.2 ± 0.1
EC	2.2 ± 0.03	1.22 ± 0.03
TOC %	49 ± 0.23	28.1 ± 0.32
TKN%	0.42 ± 0.06	0.68 ± 0.03
TK%	0.32 ± 0.02	0.24 ± 0.04
TAP%	0.23 ± 0.04	0.42 ± 0.04

Table 3: Effects of Pesticides and vermicompost on Number (N) of Earthworms

Pesticides	Number of Earthworms after application of Pesticides				Average
	(0 days)	(30 days)	(45 days)	(60 days)	
Control	50	125	140	200	128.75
Chlorpyrifos	50	62	49	20	45.25
Malathion	50	50	54	36	47.5
Carbofuran	50	59	63	68	60
Pyrethroids	50	70	76	80	69

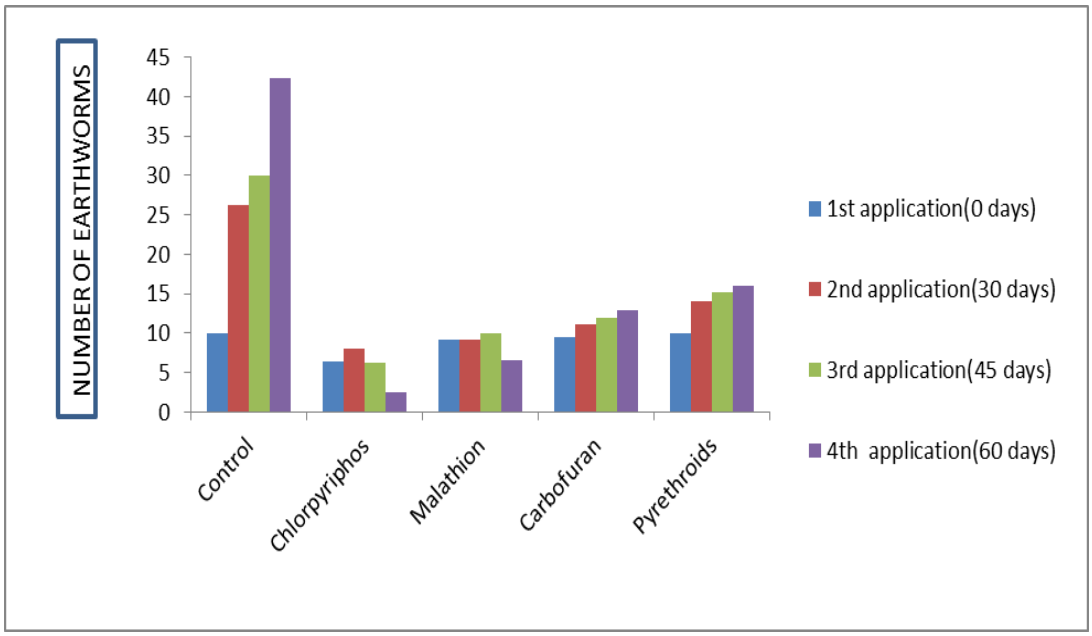

Fig. 1: Different applications of Pesticides on number of Earthworms

Table 4: Effect of Pesticides and vermicompost on Biomass of Earthworms

Pesticides	**Biomass of earthworm after application of Pesticides (mg/ml)**				**Average**
	(0 days)	(30 days)	(45 days)	(60 days)	
Control	10.00	26.20	30.00	42.30	27.12
Chlorpyrifos	6.43	7.97	6.30	2.57	5.81
Malathion	9.20	9.20	9.93	6.62	8.87
Carbofuran	9.45	11.15	11.90	12.85	11.33
Pyrethroids	10.00	14	15.2	16	13.8

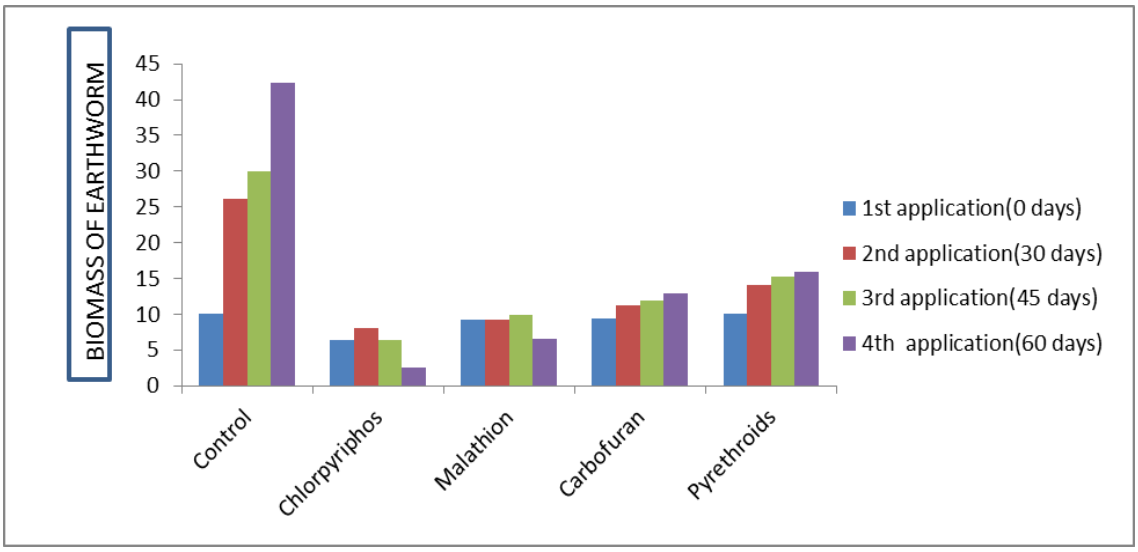

Fig. 2: Different Applications of Pesticides on Biomass of Earthworms.

chloride and concluded abnormal functioning of major physiological systems such as digestion and absorption. Booth and Halloran (2001) found growth to be significantly reduced in *Aporrectodea caliginosa* on exposure to two organophosphate pesticides, diazinon and Chlorpyrifos at 60 and 28 mg/kg doses. Bustos-Obregon and Goicochea (2002) explored the effect of exposure to commercial parathion on *Eisenia foeida* and observed decrease in body weight of treated worm. The use of pesticides not only affects the growth of *Eisenia foetida* but also have toxic effect on Potato crop field, soil, water, plants and animals (Agrawal et al, 2011, 2022). This gives rise to serious environmental concerns.

Conclusion

The obtained results suggest that organic farming i.e. vermicomposting improves crop production, saves earthworms and saves environment from these hazardous pesticides that also affects the health of farmers. The farmers must be educated to adopt vermicomposting technology for field applications to decrease their investment in conventional farming. Therefore, by adopting this technology industry, municipal corporations, and farmers will not only save money but will also contribute in saving environment.

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