Universal Journal of Environmental Research and Technology
 eISSN 2249 0256
Available Online at: **www.environmentaljournal.org**
Volume 3, Issue 2: 326-330

Open Access **Short Communication**

Impact of Pesticides and Biopesticides on Soil Microbial Biomass Carbon

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Abstract:

Soil microorganisms have a primary role in the environment through degradation of plant and animal residues. The activities of microorganisms in soil are thus essential to the global cycling of nutrients. As these pesticides are designed to be biologically active their continuous use might affect soil microflora which may lead to impairment in soil fertility. The effect of five pesticides (Cypermethrin, Malathion, Victor, Monocil and Tafgor) and five biopesticides (Folicon, *Paeciliomyces lilacinus*, *Bacillus subtilis*, *Pseudomonas florescens* and *Beauveria bassiana*) on soil microbial biomass carbon was assessed under laboratory conditions. Pesticide treatment resulted in short lived transient toxic effect on soil microbial biomass carbon. The microbial biomass carbon content of soil increased with time in biopesticide treated soil which has a good role in agriculture production. In case of Victor treated soil, a drastic decrease in microbial biomass carbon was observed as compared to other pesticides used. Biomass carbon increased with the biopesticides treatment and the increase was found to be maximum with *Paeciliomyces lilacinus*.

Keywords: Biopesticides, Cypermethrin, Folicon, Microbial Biomass, Microorganisms, *Paeciliomyces lilacinus,* Pesticides

1.0 Introduction:

Pesticides are the important agrochemicals used for prevention of crops from pests. Their use has been largely increased in last few decades. The application of pesticides starts from the pre sowing stage. Different treatments include soil application, seed treatment, foliar spray, etc. Repeated applications of pesticides contaminate the soil. Soil is the most important site of biological interactions. The indiscriminate use of pesticides disturbs the soil environment by affecting flora and fauna including microflora of soil, and also the physico-chemical properties of soil like pH, salinity, alkalinity leading to infertility of soil (Sarnaik*et al* ., 2006). When pesticides are applied, the possibilities exist that these chemicals may exert certain effects on non-target organisms, including soil microorganisms (Simon-Sylvestre and Fournier, 1979). The microbial biomass plays an important role in the soil ecosystem where they fulfill a crucial role in nutrient cycling and decomposition (De-Lorenzo *et al* ., 2001).

Microorganisms are the primary soil decomposers driving key ecosystem processes such as organic matter decomposition, nutrient cycling and, thereby, plant productivity (Pandey and Singh, 2004; Devare*et al.*, 2007). Thus, agricultural practices affecting soil microorganisms are of particular interest. Modern agriculture worldwide uses a variety of pesticides including insecticides, nematicides, herbicides and fungicides to optimize crop production (Lo ´ pez*et al.*, 2002; Cycon*et al.*, 2006). However, continuous application of pesticides may result in soil pollution threatening processes driven by soil microorganisms and, thereby, affecting soil fertility (Lo pez*et al.*, 2002; Cycon*et al.*, 2006). Studies investigating effects of pesticides on soil microorganisms reported conflicting results (Devare*et al.*, 2007). Non-target effects of pesticides on soil microorganisms were shown to depend on soil abiotic factors (Monkiedje and Spiteller, 2002), however, interacting effects between pesticides and biotic factors received little attention.

Pesticides in the soil affect the non-target and beneficial microorganisms (Bhuyan*et al.*, 1992) and their activities which are essential for maintaining soil fertility (Schuster and Schroder, 1990). Microbial biomass in soil is considered to be an important feature of soil quality (Doran and

Parkin, 1994). Soil microbial biomass measurements has been reported to give an early indication of long-term changes in soil organic matter content, long before such changes could be measured by conventional techniques (Hart and Brookes , 1996). Microorganisms form a vital part of the soil food web, therefore microbial biomass is considered to be a measure of potential microbiological and ecosystem functioning (Rath*et al.*, 1998). However for proper understanding of ecosystem functioning and determining soil disturbances because of various agricultural management practices, microbial activities must also be determined (Nannipieri*et al* ., 2003) along with microbial biomass. Soil respiration which is considered as one of the measures of microbial activity in soil has been reported as a criteria for evaluating pesticide toxicity (Jones and Ananyeva, 2001).

Over years, chemical pesticides had made a great contribution to the fight against pests and diseases. However, their widespread and long-term use resulted in insecticide resistance and biomagnifications of insecticides, which in turn resulted in restrictions on their export. Problems, like soil and water contamination and dramatic increase of the harmful residues in many primary and derived agricultural products arose, which endangered both the general environment and human health. Microbial and biochemical parameters of soil are choice indicators of soil quality evaluations (Winding *et al*., 2005) because of their early responses to soil disturbances than those of the physical and chemical parameters. The present endeavour was therefore initiated to evaluate the effect of pesticides and biopesticides on soil microbial biomass carbon in soil at controlled laboratory conditions.

2.0 Materials and Methods:

2.1 Soil sampling: Top soil (up to 5 cm depth) samples were collected with no prior pesticide treatment. The soil samples were sieved through a 2.0 mm mesh size to remove stones and plant debris.

2.2 Pesticides: The pesticides used in this study were obtained from a local agricultural dealer store in Jaipur, India. The pesticides used were Cypermethrin, Malathion, Victor, Monocil and Tafgor.

2.3 Biopesticides: The biopesticides used in this study were obtained from Dharma Biotech Company, Hyderabad, India. The biopesticides used were Folicon (neem based), *Paeciliomyces lilacinus, Bacillus subtilis, Pseudomonas florescens and Beauveria bassiana*

2.4 Determination of Soil Biomass Carbon: Chloroform fumigation incubation method by Jenkinson and Powlson (1976) was used for the determination of soil biomass carbon. Soil samples were collected and ground to pass through 0.5 mm sieve. One gram of each soil sample was weighed into 250 ml Erlenmeyer flasks and 10 ml of $K_2Cr_2O_7$ solution was dissolved into each flask and swirled gently to disperse soil. Twenty millilitres of concentrated H_2SO_4 was rapidly added using automatic pipette and swirled gently until the soil and reagents were mixed, then the mixture was swirled more vigorously for one minute, the flasks were then rotated and allowed to stand in a sheet of asbestos for about 30 min. One hundred milliliters of distilled water was added to each flask, then 3 - 4 drops of indicator (DiPhenylAmine) was added and filterated with 0.5 N ferrous sulphate solution to the end point with brilliant green color. Microbial biomass C percent was calculated by measuring the difference in extractable organic C between the fumigated and unfumigated soils.

3.0 Results and Discussion:

The pesticides treatment had toxic effect on percentage microbial biomass carbon of the treated soil (Table 1 and Figure 1). Soil samples treated with victor had the lowest percentage organic matter content of 0.032 of all the pesticides treated soil. Monocil treated soil had the highest microbial biomass carbon content of 1.8 after the treatment. All the pesticides used showed reduction in the soil biomass carbon when compared to the control.

Table 1: Impact of Pesticides on soil microbial biomass carbon (%C) without fumigation (WOF) and with fumigation (WF)

Sample	**WOF**	**WF**	**% C**
Blank with soil	34	18.7	3.2
Victor	18.7	14.3	0.032
Cypermethrin	29	14.9	0.5
Malathion	28	14.8	0.4
Tafgor	17.8	7	0.17
Monocil	12	5	1.8

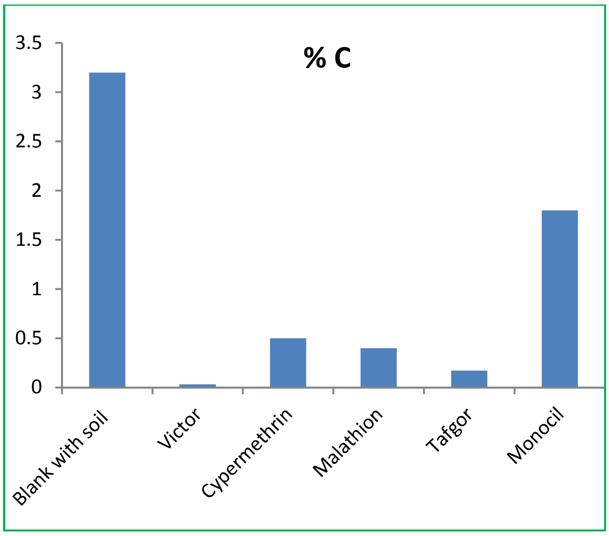

Fig 1: Effect of pesticides on Soil microbial biomass carbon (%C)

Ayansina and Oso (2006) reported that soil treatment with atrazine resulted in significant changes in percentage organic matter measurements. Ali (1990) had shown that the fate of pesticides in soils is greatly affected by the presence of organic matter in the soil by aiding their disappearance. The biopesticides treatment showed enhanced effect on percentage microbial biomass carbon of the treated soil when compared to control (Table 2 and Figure 2). Soil samples treated with *Paeciliomyces lilacinus* had the highest percentage microbial biomass carbon content of 1.46 among all the other biopesticides tested. *Bacillus subtilis* treated soil had the lowest percentage microbial biomass carbon content of 0.98. All the biopesticides used showed significant increase in the microbial biomass carbon when compared to the control.

Table2: Impact of of Biopesticides on soil microbial biomass carbon (%C) without fumigation (WOF) and with fumigation (WF)

Sample	WOF	WF	% C
Blank with soil	15	9.2	0.41
Folicon	12	8.8	1.02
Paeciliomyceslilacinus	9	9.2	1.46
Bacillus subtilis	8.8	10.7	0.98
Pseudomonas fluorescens	10.1	9	1.31
Beauveriabassiana	8	10.5	1.14

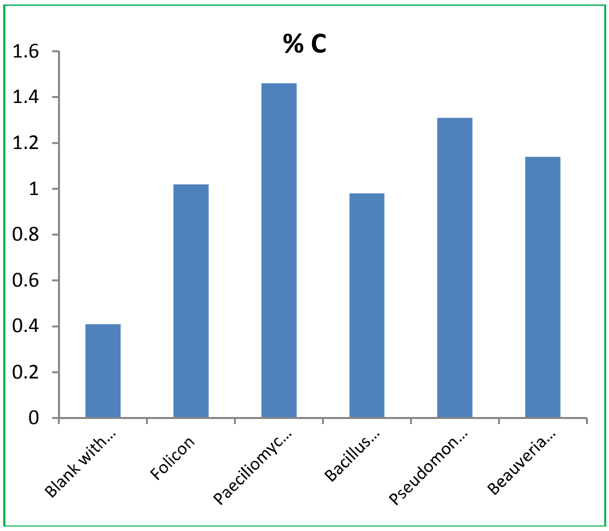

Fig 2: Effect of Biopesticides on Soil microbial biomass carbon

There are also other reports on the activity of different pesticides in relation to biomass carbon. Perucci and Sacrponi (1994, 1996), for example, found that the effect of rimsulfuron and imazethapyr on biomass carbon depended on soil moisture. Similar findings were reported also by Wardle and Parkinson (1991), as well as by Rath *et al*. (1998), in experiments investigating 2.4-D and glyphosate. Startton and Stewart (2002) recorded harmful effects of glyphosate on soil biomass and respiration in Canadian coniferous forests. Finally, Radivojević *et al*. (2008) observed transitory effects of atrazine on soil biomass-C.

Fraser *et al.* (1994) reported a 10-26% increase in microbial biomass under organic management. Microbial biomass carbon in the organically treated soil was significantly higher than other treatments. Leita *et al.,* (1999) indicated that soils treated with FYM and composts showed a significant increase in total organic carbon and biomass carbon in response to the increasing amounts of organic carbon added. A positive effect of organic fertilizers on the microbial biomass nitrogen and the carbon content in the soil was also observed and reported by Cerny *et al.,* (2008). Stimulation of microbial biomass and activities by organic carbon inputs has been well documented in various organic substrates (Tu *et al* ., 2005).

In the present study, impact of five pesticides and biopesticides on soil microbial biomass carbon was observed. It is observed that microbial biomass carbon increased with application of biopesticides and reduced with the pesticides application which is also supported by other researchers. Also, this reduction in percentage microbial biomass carbon after the application of pesticides to soil and increase in percentage microbial biomass carbon after the application of biopesticides to the soil was observed during continuous application from the second to the sixth week of treatment. To the best of our knowledge, this is the first report to study the impact of biopesticides on soil microbial biomass carbon.

4.0 Conclusion:

Although the use of pesticides has been proven beneficial for crops but decrease the overall fertility of the soil and has also polluted the environment. In turn, botanical pesticides, biofungicides and biobactericides have not only found to be increasing the fertility of soil, but also are eco-friendly, non-hazardous and beneficial for crops. As from the above study, we have concluded that biopesticide treatment showed higher microbial biomass carbon in the soil as compared to the pesticide treatment, hence promises to have a superior role and can be recommended for use in agriculture by farmers.

5.0 Acknowledgement:

The authors are grateful to the Department of Science and Technology, Govt. of Rajasthan, India for financial assistance for the study for their relentless support during thetenure of the work.

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