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Study on the impact of Imidacloprid and Dimethoate on soil respiration

Abstract

The intensive use of pesticides and insecticides has become a regular practice in order to meet the rising food demands of a fast-expanding human population. Although these chemicals are always used against specific targets (pests/insects etc.) of plants and animals, they also encounter non-target (harmless/useful) plants and animals and thus negatively influence the surroundings. In the present study, the individual and combined impact of Imidacloprid and Dimethoate on soil respiration was studied. The results clearly indicate the diminishing impact of both Imidacloprid and Dimethoate on carbon dioxide evolution from the studied soil samples.

Keywords: Imidacloprid, Dimethoate, soil respiration, carbon dioxide, combined effect

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Sweta Subarna,[1] Neha Baxla,[1] Shalini,[1] Rohit Srivastava,[1] Manoj Kumar,[2] Rakesh Ranjan,[2] Manoranjan Prasad Sinha[1]

[1]Department of Zoology, Ranchi University, India
[2]Department of Zoology, St. Xavier's College, Ranchi, India

Correspondence: Manoj Kumar, Department of Zoology, St. Xavier's College, Ranchi – 834001, Jharkhand, India, Tel +91 9608855511 Email dr17m@gmail.com

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Abbreviations: CNS, central nervous system; SOM, soil organic matter, CO_2, carbon dioxide; EC, effective concentration

Introduction

The intensive use of pesticides and insecticides has become a regular practice in order to meet the rising food demands of a fast-expanding human population. Although these chemicals are always used against specific targets (pests/insects etc.) of plants and animals, they also encounter non-target (harmless/useful) plants and animals and thus negatively impact the surroundings.[1] Given that these chemicals are subject to a variety of degradation processes and have the potential to persist in the soil, understanding their fate and behavior in the soil ecosystem is crucial.[2] Soil respiration is the term used to describe the emission of CO_2 by soil organisms. A crucial ecological process known as soil respiration releases carbon from the soil in the form of CO_2, which is then taken up by the plants from the atmosphere and transformed into organic compounds during photosynthesis.[3] Soil respiration reflects the capacity of soil to support soil life including crops, soil animals, and microorganisms. It describes the level of microbial activity, Soil Organic Matter (SOM) content and its decomposition.[4] The current study is focused on studying the effects of two pesticides, Dimethoate and Imidacloprid, on soil respiration. Imidacloprid is an insecticide designed to imitate nicotine, which is present naturally in many plants. Imidacloprid is used to control pests, termites, and certain soil insects, among other things. Dimethoate is an organophosphate pesticide and Acaricide that is frequently used. Dimethoate is an acetylcholinesterase inhibitor, meaning it inhibits the cholinesterase enzyme, which is required for the proper functioning of the central nervous system.

Material and methods

The pesticides were obtained commercially – Dimethoate (30% EC) and Imidacloprid (17.8% SL) were used to treat the soil according to the recommended agricultural dose.[5]

CO_2 evolution study

The CO2 evolution from the soil was measured using the methods of Witkamp[6] and Mishra and Dash[7]. The soil was stored in cylindrical jars. A known strength of the KOH solution was maintained in a beaker within the jar, which was sealed airtight. The control was performed without treatment. After a specific amount of time, a barium chloride solution was added to the beaker containing KOH, resulting in a white precipitate of BaCO3. Using phenolphthalein as an indicator, the leftover KOH was titrated with equal strength of HCL. The data were represented in mg of CO2 evolved per kg of soil per hour.

$$CO_2\ evolved\ from\ the\ soil\ in\ mg\ /\ kg\ /\ hr = \frac{v \times 2.2}{Hr \times kg}$$

Where v= difference between the volume of HCL consumed in control and experimental setups, Hr = time in an hour

Results

The results of the experiment stated under the materials and methods section are presented in Table 1 and graphically represented in Figure 1. The results clearly indicate the diminishing impact of both Imidacloprid and Dimethoate on carbon dioxide evolution from the studied soil samples. The carbon dioxide evolution was studied for 105 days. A significant decrease in CO_2 evolution was observed in both Imidacloprid and Dimethoate-treated soil. The combined impacts of both Imidacloprid and Dimethoate was also studied, and the results showed that carbon dioxide evolution was significantly reduced in the soil treated with both pesticide.

Table 1 The effects of Dimethoate and Imidacloprid on the evolution of carbon dioxide are shown in this table

DAYS	CONTROL	Imidacloprid	Dimethoate	Combined
0	0.1701	0.1705	0.17	0.1697
15	0.1803	0.126	0.103	0.0934
30	0.187	0.154	0.117	0.0956
45	0.2103	0.176	0.154	0.1422
60	0.2266	0.1965	0.175	0.1565
75	0.23	0.1968	0.177	0.1433
90	0.2104	0.193	0.184	0.1334
105	0.195	0.2044	0.1966	0.1755

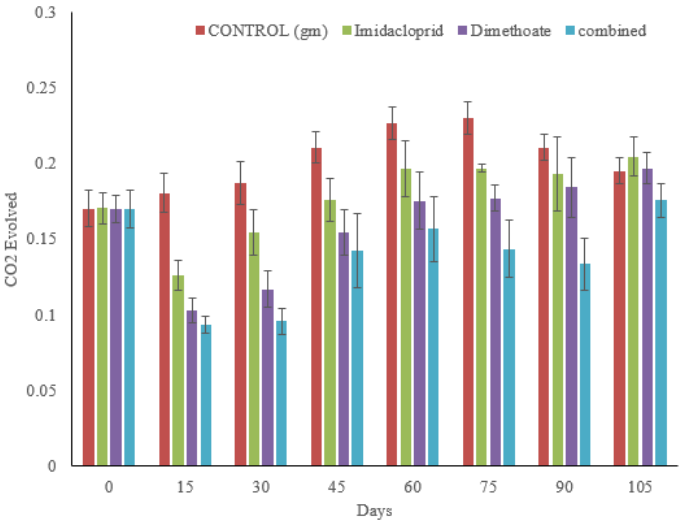

Figure 1 The figure is shown a comparison between the impacts of Imidacloprid and Dimethoate on the carbon dioxide evolution of soil.

Discussion

Soil respiration (carbon dioxide evolution) is a measurement of the amount of CO2 emitted by soil. CO2 is emitted as a result of soil bacteria decomposing organic matter (SOM). It is an essential indicator of soil health since it monitors microbial activity as well as SOM content and breakdown. It also represents the state of a soil's physical and chemical environment.[8] In the present study the individual and combined impact of Imidacloprid and Dimethoate on soil respiration was studied. The results clearly indicate the diminishing impact of both Imidacloprid and Dimethoate on carbon dioxide evolution from the studied soil samples. Karpun *et al.*[9] reported that the application of Chlorpyrifos, Phosalone, Dimethoate, Cyhalothrin and Kresoxim-methyl lead to a decrease in soil microbial respiration.[9] The decrease in soil respiration after treatment with Imidacloprid and Dimethoate clearly indicates that the pesticides have negatively impacted the soil microorganisms, which are non-target organisms. In this study, it was further observed that both pesticides had an increased negative impact on soil respiration than alone themselves.

Conclusion

In the present study, the individual and combined impact of Imidacloprid and Dimethoate on soil respiration was studied. The results clearly indicate the diminishing impact of both Imidacloprid and Dimethoate on carbon dioxide evolution from the studied soil samples.

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Conflicts of interest

There is no conflict of interest.

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