

Effect of Some Insecticides on Soil Fauna

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Received 26 February 2016; Accepted 31 March 2016; Published online 15 April 2016

Abstract Laboratory tests were carried out to study the effect of soil application of four granular insecticides namely, rynaxypyr 0.4% G @ 40g a.i. / ha, fipronil 0.3%G @ 75g a.i. / ha, carbofuran 3%G@ 1.0kg a.i./ha, cartap hydrochloride 4%G@1.0kg a.i. /ha, and sprayable formulation of chlorpyriphos (20%EC) @ 500g a.i./ha on soil fauna. Following application, earthworm population reduced up to 15 days in rynaxypyr 4G but up to 30 days in all other treatments. Rynaxypyr 0.4G was safe to collembolans and soil oribatid mites, whereas, chlorpyriphos was safe to the oribatid mites only. All other insecticides reduced the population of collembolans and oribatid mites up to 7 days. The effect of treatments on other meso-fauna (pseudoscorpions, minute staphylinids) was non-significant.

Keywords Soil arthropods, Earthworms, Insecticides.

Introduction

Soil fauna comprised of many organisms like, mites,

collembolans, proturans, diplurans, symphylans, pseudo-scorpions, fly larvae, grubs, beetles, annelids, centipedes, millipedes plays vital role in organic matter decomposition, nutrient recycling and maintenance of soil health. These animals are broadly classified into macro-, meso- and micro-fauna, of which two meso-fauna namely, collembolans and mites are the most abundant reaching densities up to 100,000 individuals per square meter [1]. Among the macro-fauna, earthworms play most important role in maintaining soil fertility and soil structure, which perhaps is greater than any other soil fauna. Moreover, soil fauna passively transport bacteria, fungi and protozoa in the gut or on the cuticle across region of soil that are impenetrable to the microbiota. By this way, soil fauna act as catalyst by bringing decomposers into contact with substrates. However, their population is affected by cultivation practices, especially the agrochemicals used for crop production. Insecticides reach the soil directly by deliberate application of soil insecticides. An appreciable proportion of insecticides applied to crops contaminate the soil indirectly by drifting or by runoff from plant canopy. Estimation of effect of insecticides on the population of soil fauna is of great importance, as their presence is vital for maintenance of soil fertility / soil health [2]. With this background, laboratory tests were undertaken to study the effect of some granular and sprayable formulations of insecticides, commonly applied to soil, on soil fauna.

Materials and Methods

Effect of four granular insecticides namely, rynaxypyr 0.4% G @ 40g a. i. / ha, fipronil 0.3% G @ 75g a. i.

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/ ha, carbofuran 3% G and cartap hydrochloride 4% G, both @ 1.0 kg a.i. / ha, and chlorpyrifos 20% EC @ 500g a. i./ ha on earthworm and other soil meso-fauna was tested in the Department of Agril. Entomology, BCKV, Mohanpur, Nadia, West Bengal.

Effect on earthworms

Twenty number of laboratory reared individuals of the earthworm (*Perionyxexcavatus*) were released in each of the trays (30 × 45 cm) filled with well rotten cow dung mixed soil (1 part of cow dung in 3 parts of soil) up to a depth of 6 inches. Required quantities of granular insecticides were sprinkled over the soil on the next day; the top layer was stirred gently with a glass rod and sprayed with water @ 30 ml / tray. In case of chlorpyrifos 20% EC, the required quantity of insecticide was mixed in 30ml of water and sprayed over the soil. Watering was done frequently to maintain soil moisture. Earth worm population was counted after 7, 15, 22 and 30 days after treatment.

Effect on soil meso-fauna

Top soil (up to six inches depth) rich in organic matter was collected from University farm at Mohanpur, which harboured high population of meso-fauna as revealed from prior observations. The collected soil was mixed thoroughly and placed in trays measuring 30 × 45 cm @ 5kg / tray. The trays were then kept in

the laboratory for one week to acclimatize the meso-fauna present there with laboratory condition. Water was sprayed regularly over the soil to maintain proper soil moisture. After oneweek, required quantities of granular insecticides were aprinkled over the soil. The treated soil was then stirred gently with a glass rod to mix the insecticide with soil and sprayed with 30 ml of water/ tray. Measured quantity of chlorpyrifos was mixed with the same amount of water and sprayed over the soil on tray. Watering was continued till the end of experiment. Soil samples, 250g each, were taken from each of the trays immediately before and 7, 15 and 30 days after treatment, and were placed in Berlese funnel for extraction of arthropod fauna present there. Data obtained were analyzed for test of significance following CRD after square root transformation.

Results and Discussion

Effect on earthworms

All the insecticidal treatments except rynaxypyr 0.4% G significantly reduced earthworm population than the untreated control up to 30 days after treatment, which were at par among them in respect of post-treatment earth worm population (Table 1). Rynaxypyr 0.4% G significantly reduced earth worm population than untreated control up to 15 days of treatment (16.33 and 18.33 / tray), thereafter became on a par with the latter. It was observed that, rynaxypyr 0.4%G resulted in slight increase in earthworm population (21.67 and

Table 1. Number of earthworms in different treatments. * Number of earthworms released / tray : 20, ** Square root transformed values.

Treatments	7 DAT	15 DAT	22 DAT	30 DAT
Rynaxypyr 0.4% G @ 40 g a.i. / ha	16.33 (4.09)**	18.33 (4.33)	21.67 (4.67)	22.67 (4.79)
Fipronil 0.3%G 75g a.i. / ha	@ 15.33 (3.98)	15.67 (4.02)	14.33 (3.84)	12.00 (3.53)
Carbofuran 3% G 1.0kg a.i. / ha	@ 16.33 (4.10)	17.67 (4.26)	16.67 (4.13)	16.33 (4.10)
Cartap hydrochloride 4% G 1.0kg a.i. / ha	@ 14.67 (3.89)	13.67 (3.76)	11.67 (3.47)	12.67 (3.61)
Chlorpyrifos 20% Ec 500g a.i. / ha	@ 13.33 (3.72)	14.33 (3.85)	15.67 (4.02)	15.33 (3.98)
Control	20.33 (4.56)	25.33 (5.08)	26.00 (5.14)	26.00 (5.14)
CD (p=0.05)	0.45	0.57	0.86	0.73

Table 2. Number of arthropod meso-fauna extracted from 250g soil in different treatments. * Square root transformed values.

Treatments	P T	Collembolans			Oribatid mites			Other minute arthropods				
		7 DAT	15 DAT	30 DAT	7 DAT	15 DAT	30 DAT	P T	7 DAT	15 DAT	30 DAT	
Rynaxypyr 0.4G @ 40g a.i. / ha	2.67 (1.61)*	3.00 (1.82)	1.67 (1.35)	1.00 (1.10)	5.33 (2.35)	5.33 (2.35)	5.00 (2.32)	4.67 (2.27)	0.67 (1.00)	1.00 (1.17)	0.33 (0.88)	0.67 (1.00)
Fipronil 0.3G @ 75g a.i. / ha	1.33 (1.27)	0.00 (0.71)	0.33 (0.88)	0.33 (0.88)	6.33 (2.46)	1.00 (1.17)	2.33 (1.64)	5.00 (2.29)	0.33 (0.88)	0.33 (0.88)	0.00 (0.71)	0.33 (0.88)
Carbofuran 3G @ 1.0 kg a.i. / ha	1.00 (1.17)	0.00 (0.71)	0.33 (0.88)	0.67 (1.00)	4.00 (2.00)	1.33 (1.29)	2.00 (1.47)	2.33 (1.60)	0.00 (0.71)	0.33 (0.88)	0.33 (0.88)	0.00 (0.71)
Cartap hydrochloride 4G @ 1.0kg a.i. / ha	2.33 (1.57)	1.00 (1.00)	0.67 (1.00)	0.67 (0.88)	6.67 (2.58)	3.00 (1.82)	4.33 (2.16)	2.67 (1.77)	0.33 (0.88)	0.67 (1.00)	0.00 (0.71)	0.33 (0.88)
Chlorpyriphose 20% EC @ 500g a. i. / ha	1.33 (1.27)	0.00 (0.71)	0.00 (0.71)	0.33 (0.88)	6.00 (2.46)	5.00 (2.28)	3.00 (1.72)	2.17 (1.46)	0.00 (0.71)	0.67 (1.00)	0.67 (1.00)	0.00 (0.71)
Control	1.33 (1.27)	1.67 (1.35)	1.67 (1.35)	1.00 (1.00)	8.67 (2.94)	9.00 (3.04)	5.67 (2.35)	8.33 (2.66)	0.00 (0.71)	1.33 (1.29)	0.00 (0.71)	0.00 (0.71)
CD (p=0.05)	NS	NS	NS	NS	NS	1.08	NS	NS	NS	NS	NS	NS

22.67/ tray) than the original level from 22 days onwards, which was significantly higher than carbofuran 3% G in both the observations (11.67 and 12.67 / tray), and fipronil 0.3% G (12.00 / tray) and cartap hydrochloride 4%G (15.33 / tray) at 30 days after treatment.

Effect on arthropod meso-fauna

Among the arthropod meso-fauna obtained from the soil, soil oribatid mites were the most abundant, followed by collembolans (Table 2). Few individuals of minute staphylinid beetles and their grubs, and pseudo-scorpions were also obtained.

Effect on Collembolans

The pre-treatment populations of collembolans extracted from 250g soil in different treatments varied from 1.00—2.67 and all the treatments were statistically at par. After 7 days of treatment, collembolan population declined totally in fipronil 0.3%G, carbofuran 3%G and chlorpyriphos 20%EC. Rynaxypyr 0.4%G registered slight increase in collembolan population (3.00/250g soil) which was significantly higher than that recorded in all other treatments including untreated control. After 15th day onwards, however, collembolan population declined in rynaxypyr 0.4% G treated trays to reach the same level with untreated control. Collembolans further

appeared in the extracted samples after 15 days in fipronil and carbofuran and after 30 days in chlorpyriphos. Cartap hydrochloride 4%G did not significantly reduce the number of collembolans than the untreated control. All the insecticidal treatments became on a par with untreated control from 22nd day onwards in respect of number of collembolans.

Effect on oribatid mites

Among the insecticides, fipronil 0.3%G, carbofuran 3%G and cartap hydrochloride 4%G significantly reduced the population of soil oribatid mites after 7 days of treatment, after which all the insecticides were statistically at par with untreated control. Mite population remained almost unchanged in rynaxypyr 0.4%G, whereas, in case of fipronil 0.3%G mite population reached to almost original level after 30 days of treatment.

Effect on other minute arthropods

Population of other minute arthropods extracted per 250g soil in different treatments was very low (0.00—1.33) and no significant difference was recorded between the insecticidal treatments and untreated control.

Earthworms are not very susceptible to pesticides at normal dosage [3]. Moreover, the effect can

be minimized by restricting its movement, increasing mucous secretion level by concentrating pesticides and heavy metals in their tissues [4, 5]. During the present investigation, all the insecticides reduced the population of earthworms, though the adverse effect of rynaxypyr 0.4%G was not prolonged and new juveniles appeared after the first week. Fipronil 0.3% G was found to be relatively more toxic than chlorpyrifos 20%EC, which was not in agreement with Mostert et al. [6] who found chlorpyrifos as highly toxic to earthworms while, fipronil was safe to them. The results further showed exceptional safety of rynaxypyr 0.4%G to the arthropod soil meso-fauna namely, collembolans and oribatid mites. Chlorpyrifos 20% EC was safe to the oribatid mites, whereas, cartap hydrochlorides was safe to the collembolans. Earlier, Stark [7] reported chlorpyrifos as highly toxic to collembolans. Rynaxypyr acts on the ryanodine receptors of muscles and is very specific to lepidopteran larvae. Low toxicity of this insecticide to the earthworms and other meso-fauna may be attributed to differences in ryanodine receptors in different species. Similarly cartap hydrochloride shows selectivity against lepi-

dopteran caterpillars mainly, though it reduced the population of earthworms and oribatid mites.

References

1. Hopkin SP (1997) *Biology of the Springtails (Insecta, Collembola)*. Oxford Univ Press, Oxford, UK.
2. Vig K, Singh DK, Sharma PK (2006) Endosulfan and quinolphos residues and toxicity to soil microarthropods after repeated applications in a field investigation. *J Environ Sci : Health, Part-B, Pesticides, Food Contam and Agric Wastes* 41 : 681—692.
3. Jairajpuri MS (1993) *Earthworms and Vermiculture : An Introduction*. Earthworm Resources and Vermiculture. Zoological Survey of India, Kolkata, India.
4. Kale RD, Krishnamoorthy RV (1979) Pesticidal effects of Sevin (1-naphthyl-n-methyl carbamate) on the survival and abundance of the earthworm *Pentoscocolex corethrurus*. *Proc Ind Acad Sci* 88 B : 391—396.
5. Edwards CA, Lofty JR (1977) *Biology of earthworms*. 2nd edn Springer, US.
6. Mostert MA, Schoeman AS, Merwe-M-Van-Ser (2000) The toxicity of five insecticides to earthworms of the *Pheretima* group using an artificial soil test. *Pest Manag Sci* 56 : 1093—1097.
7. Stark JD (1992) Comparison of the impact of a neem seed kernel extract formulation Margosan-O and chlorpyrifos on non-target invertebrates inhabiting turf grass. *Pesticide Sci* 56 : 293—299.