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ASSESSMENT OF THE EFFECTS OF PESTICIDES ON SOIL MICROARTHROPODS IN A FARM LAND IN UNIVERSITY OF PORT HARCOURT, NIGERIA

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ABSTRACT
A study on the assessment of the effect of pesticide on soil microarthropod was carried out in a farmland at the University of Port Harcourt, Nigeria for three months. Two sites were employed - pesticide treated site and control site. Soil samples were collected from each site at the depths of 0 – 10.0cm and 10.0 – 20.0cm with the aid of soil augar. Microarthropods were extracted using the modified Berlese-Tullgren funnel extractor. A total of 101 soil microarthropods classified as Collembola, Oribatida, Gamisida were collected at both depths which were further identified to species level. At depth 10 – 20cm the Gamasida and Collembola groups were completely absent at all concentration (ie 0.15, 0.3, 0.375, 0.6) except at 1.45 limit. Control site at depth 0 - 10cm recorded Oribatida, Gamisida, and Collembola as 14(40.0%), 4(14.3%) and 2(33.3%). Soil pH, soil temperature, and soil moisture content had an average of 4.60, 26.3^{0}c, and 15.72m^3 respectively at the treated site and 27^{0}c, 5.01 and 18.2 at the control site. The statistical analysis showed that there was a significant difference between the numbers of microarthropods collected at the different depths in treated sites. Significant difference also exists within the different concentrations (P≤0.05). Soil pH, depth and pesticide concentrations are important factors in the density of micro-arthropods present in the soil. To avoid distortion and destruction of the ecosystem, agriculturist must have a clear understanding of the pesticide they wish to apply.

Key words: Collembola, Pesticide, Microarthropods, Oribatid

INTRODUCTION
Micro-arthropods community is a negative feedback in food chain as some of the soil micro-arthropods found in leaf litters are very efficient in turning the food (they consume) into biomass. As a result they support long food chain e.g. organic matter (decomposers) – mite-predatory mites – spiders – battle mouse-owl (Moore *et al*., 1998).

Micro-arthropods (acari and collembolans) have been shown to contribute to the primary productivity in nutrient poor conditions (Moldenke, 1998). In that contribution, the effect on the mobilization of nutrients promoted by micro-arthropods was measured at the micro habitat scale appropriate to the scale of the faunal activity and it was discovered that small changes in the structure of micro-arthropod assemblages can have significant effects on

the local mobilization of nutrients (Ken Gray, 1991). Soil micro-arthropods help out by distributing nutrients through the soil, and by carrying bacteria on their exoskeleton and through their digestive system. By more thoroughly mixing microbes with their food, micro-arthropods enhance organic matter decomposition (Southernton, 1984). They aid decomposition of organic matter and soil mineralization. Acari (mites) and other micro-arthropods as part of the meso fauna play a crucial role in the context of soil biodiversity, decomposition and mineralization processes (Tian and Person 1998).

Anthropgenic activities have been increasingly important in shaping the organization of biotic communities (Swift, 1979). There are persistent concerns and accumulating evidence of the losses in biodiversity of living organisms (Pimm *et al*., 1995; MEA, 2005) due to the increasing consumption levels of chemical compounds (pesticides, petroleum, and other hydrocarbon) in recent time which in turn has led to high deposition and accumulation of pesticides into the environment (soil ecosystem). Pesticides have been observed to have several direct and indirect effects, reduction in population densities/abundance and species richness, migration of soil microbar arthropods, reductive and respiratory effects, alteration of life history and shorter life cycles and growth reduction among the different species and sexes of soil micro-arthropods.

The wide spread of agricultural use of pesticide results in these chemicals entering soil and water ecosystem. Soil arthropod are vital link in the food chain as decomposer and without these organisms, nature would have no way of recycling organic materials on its own (Trombetti and Williams, 1999). They are abundant in nature and can be found in air, aquatic medium and the land above 10cm depth in the soil. The process of decomposition is controlled largely by soil arthropods in conjunction with soil invertebrates like protozoa, nematodes and insects which also contributes to the soil community by mixing, loosening and aerating the soil (Evans, 1984). The populations of beneficial soil micro-arthropods (mites and collembolans) were reduced tremendously in soils where these pesticides were used for farming (Wood, 1966). These pesticides as reported have been found to reduce the population densities and richness of micro-arthropods through slow elimination or killing of micro-arthropods migration to lower depths and reduced agility and functioning of the micro-arthropods (Iloba and Ekrakene, 2009).

Soil micro-arthropods have the ability of being excellent indicator species (Frouz, 1999). This is because of their relatively short life term and limited tolerance to change in environmental conditions. They are used as biological indicators. Moldenke (1998) reported that in the United States soil mites and collembolans have been used as indicator species to evaluate the effects of forest practices and to determine what and how long it takes for soil microbes to recover. Soil quality can be evaluated using a large number of indicators (chemical, physical, biological) depending on the scale and the objective of the evaluation. Different authors have proposed new methods for soil quality, assessment, based on the soil micro fauna where some of these methods are based on the global evaluation of micro-arthropod (Parisi, 2001). Pesticides applied in soil at planting persist during the development of plant roots.

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Therefore, a portion of the pesticide likely interacts with microorganisms in the soil and rhizosphere. There are a number of studies that, in general, implicate the involvement of adapted soil microbial populations in accelerated pesticide degradation (Anderson, 1998). Therefore, understanding the mechanisms underlying the community structure of soil, animals is a pressing challenge in a world that is facing increasing rate of biodiversity loss and ecosystem degradation (Swift, 1979).

MATERIALS AND METHODS

Study Area

The study was carried out at the research field in the Department of Crop and Soil Science in University of Port Harcourt, Rivers State, Nigeria. It is situated on the southern part of Nigeria and lies approximately 4^0 43' North and $6^0$5' East of the equator. The collection of samples was done in the morning between 8.00am to 11.30am. The plot was divided into six (6) by 16cm x 22cm and labeled sub plots A, B, C, D, E and control Sub plots A, B, C, D, E, represented field areas treated with five different concentrations of DD FORCE (active ingredient DDVP 1000EC) a wide spectrum of organosphosphate pesticide (1 litre) in 400 litres of water. Protective clothing, hand gloves and goggles were worn during application.

The concentrations were 0.3ml, 0.45ml, 0.6ml, 0.15ml, 0.375ml respectively and control represented the untreated site. Sample collection was done using a soil augar that was about 5cm, 10cm, 15cm, 20cm, 25cm calibration and the samples were placed in white cellophane bags and labelled according to their depths. The samples were then taken to the laboratory for extraction using the Berlese-Tullegren funnel extractor into the extraction bottles containing 70% alcohol each.

Measurement of Parameters

Soil pH and soil moisture content were the parameters monitored and measured.

Soil pH: 20g of soil from each site was placed in a 50ml beaker containing 20ml of distilled water which was allowed to stand for 30minutes. The mixture was stirred occasionally with a glass rode. The electrode of each pH meter was then inserted into settled suspension from each site and the reading was recorded. The pH of the soil was acidic.

Soil moisture content: 50g of soil sample each taken from within the range of designated 10cm from sites were weighed and placed in the oven for 24 hours till constant weight were obtained.

Initial weight of samples recorded

Final weight of samples recorded

Loss in weight = initial weight – final weight

Soil moisture content 10% = $\frac{loss\ in\ weight}{oven\ dried} \times 100$

Soil temperature: Temperature reading was collected between 9 – 10am in the morning hour using a thermometer. This was done by digging a little hole of 10cm depth and placing the thermometer into it which was then covered and the reading was taken after 5 minutes in degree Celsius.

Laboratory Extraction of Micro-Arthropods

A modified Berlese – Tullgren funnel extractor apparatus was used to extract the micro-arthropods and this apparatus is made up of fourteen (14) extraction units.

Samples were placed on the sieve mesh at the top of each funnel, the extraction funnel is connected to a source of electric power, with each of the unit having 60 watts electric bulb and a metal plate cover sheet. The extraction of micro arthropods is mainly by the use of light ray and heat generated from the electric bulb which causes migration of soil micro arthropods to region of low temperature and low light intensity in the funnel which eventually drops into the labeled collection vials containing 70% alcohol for the preservation of extracts (micro arthropods). Extraction process lasted for seven days.

Materials used for this project work include; (a) Berlese – Tullgren funnel extractor (b) white cellophane bags (c) meter rule (d) Bucket soil augar (e)Extraction bottles (f) Measuring tape (g) Electric bulbs (h) pH meter (i)Alcohol (70%) (j) Petri-dish (k) Protection hand gloves (l) Nose mask (m)Monocular microscope (n) Glass slides (o) Masking tape (p) Binocular dissecting microscope (q) DD force pesticide (r) Knap sack (s) Weighing balance (t) Themometer

Sorting and Preservation

At the end of the seven days of extraction period, the micro arthropods were collected into the Petri dish and sorted out. This was done using a binocular dissecting microscope and a stereomicroscope. Similar specimens were separated using forceps and placed in glass specimen bottles containing 70% alcohol.

Identification of Samples

This was done in the Department of Animal and Environmental Biology, University of Port Harcourt by the use of identification keys, type-specimen and previous works, (an interactive key to mites and other soil microarthropods).

RESULTS

During the period of study, the results obtained indicated species richness and abundance variation in each site. The result as represented on the table below depicted the species diversity and abundance of the micro arthropods found at the polluted and control sites. The number of species found in the two sites were 16 species of mites and 2 collembola. Results for treated sites made up of five (5) different concentrations were as follows: for 0.15ml concentration (conc.), 3 *Oribatid* spp (*Archegozetes magnus*, *Parallonothrus* spp, *Scheloribates* spp), and 1 *Gamisida* spp (*Prodinichidae* 1 spp) and 1 *Collembola* spp (*Cryptophagus* sp) were recorded. For 0.3ml conc. Oribatida and Gamisida recorded 1 Oribatida species (*Galumna* spp), in the treated site and 2 *Gamasida* spp (*Parasitidae* spp, *Rhodacardae* spp). For 0.375ml conc. 4 Oribatid species (*Galumma* spp, *Belbidae* spp, *Scheloribates* spp, Moliecurlia inexpecta) and 1 *gamisida* spp (Rhodacaridae) were recorded. For 0.45ml conc., 4 Oribatid species (*Galumna* 1 spp, *Scheloribates* spp, Cephalidae 1 spp, *Epilomannia* sp,) Gamisida, 4 species (*Asca* spp, Uropodidae, 1 spp, Rheodacaridae 1 spp, Parasitidae 1 sp) and *collembola*, 2 species (*Cryptophagus* spp, *Morulina* spp) were recorded. For 0.6ml conc., 1 *oribatid* spp (*Scheloribates* spp) was recorded (Table 1).

At depth 0 – 10.0cm Oribatida recorded 20 at the treated site while 14 Oribatida was recorded at the control site. Gamisida recorded 2 at the treated site and 4 at the control site. Collembolan recorded 1 at the treated site and 2 at the control site. Collembolan recorded 1 at the treated site and 2 at the control site (Table 7). At 10.1 – 20.0cm Oribatida recorded 36 at the treated site and 6 at the control site. Gamisida recorded 10 at the treated site and 3 at the control site. Collembolan recorded 1 at the treated site and 2 at the control site (Table 2

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Table 1: Species Richness/representatives of soil-microanthropods encountered throughout the study

Collembolas	**Oribatidas**	**Gamisida**
Cryptophagus sp *Morulina* sp	*Schelorbates sp,* *Galuma sp,* *Mulierculia inexpecta,* *Achegozetes Magnus,* *Epilomannia sp,* *Paralonothrus sp,* *Notrus ifiensis,* *Belbidae sp,* *Prodinichidae sp.* *Sephalidae sp.*	Rhodacardae sp, *Uropodidae,* *Pararasitidae,* *Trachyuropodidae,* *Asca sp.*

Table 2: Showing Species Abundance at Different Concentrations in the two sites at all depths.

Depth		**(Control)**			**(Treated)**		
	Micro arthropods	**0.00**	**0.15 (Con A)**	**0.3 (Con B)**	**0.375 (Con C)**	**0.45 (Con D)**	**0.6 (Con E)**
0 – 10cm	Oribatida	14	5	4	4	4	-
	Gamisida	4	-	-	-	6	-
	Collembola	2	-	-	-	-	-
10.0 – 20.0cm	Oribatida	6	11	2	10	8	2
	Gamisida	3	1	3	1	6	-
	Collembola	2	0	-	-	2	-

Table 3: Abundance of Microarthopods in relation to depth at Treated and Control Site

Treated Site

Microarthopods	depth 0-10cm	depth 10-20cm	% difference
Oribatida	20	36	28.60%
Gamisida	2	10	80.00%
Collembola	1	1	52.20%

Control Site

Microarthopods	depth 0-10cm	depth 10-20cm	% difference
Oribatida	14	6	40.00%
Gamisida	14	3	14.30%
Collembola	2	2	33.30%

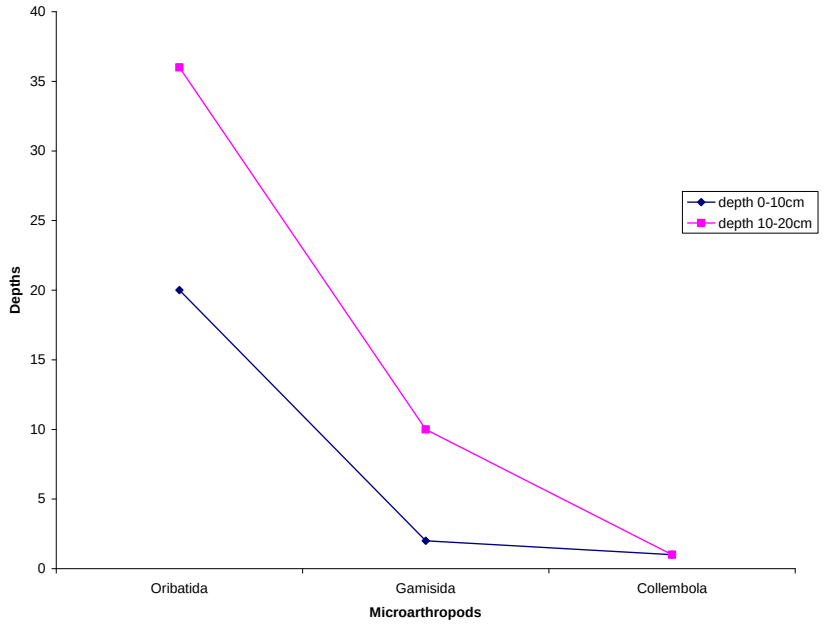

Fig. 1: Graphical representation of Abundance of Microarthopods in relation to depth at Treated Site.

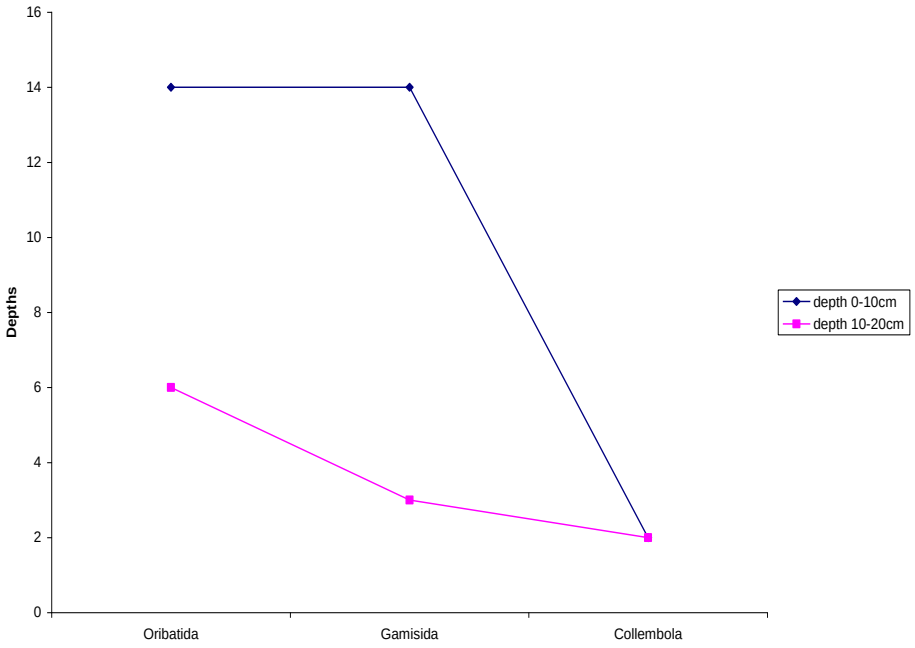

Fig. 2: Graphical representation of Abundance of Microarthopods in relation to depth at Control Site

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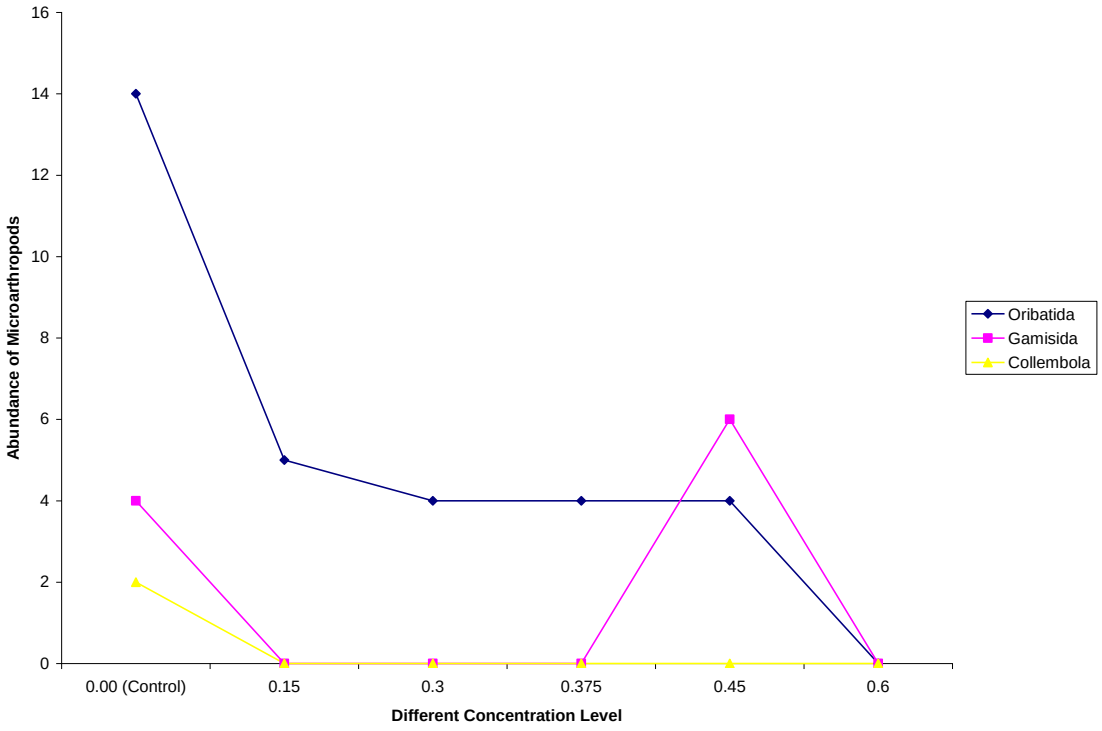

Fig. 3: Graphical representation of Species Abundance at different concentration at 0.0 – 10.0cm depth.

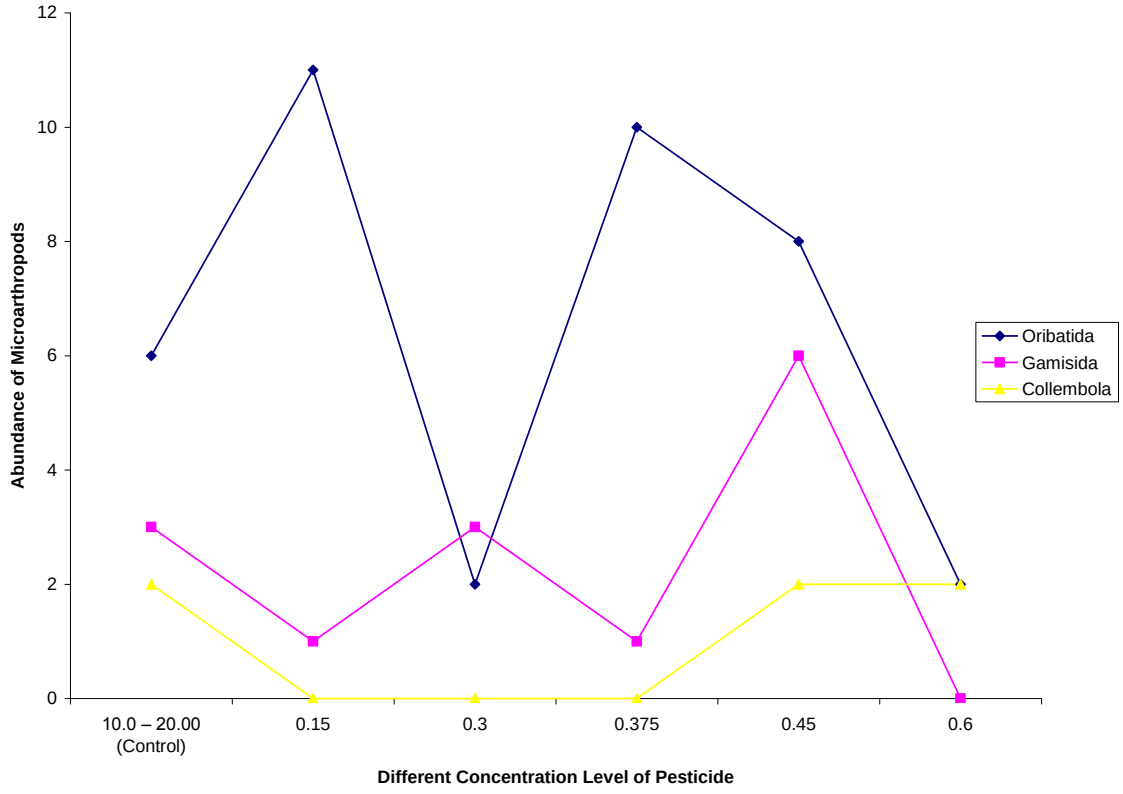

Fig. 4: Graphical representation of Species Abundance at different concentration at 10.0 – 20.0cm depth.

DISCUSSION

The response of the microarthropod to the various degree of pesticide application was influence by depth. There was a preference for the 10 – 20cm depth over the 0 – 10cm depth. This is an agreement with the work of Wallwork, 1970 where he observed ecological preferences in microarthropods. The vertical distribution of soil microarthropd observed in relation to soil depths in the two sites indicated that, there was an inverse distribution or negative relationship to depths at the control site while a direct distribution or a positive relationship to depths, slight migration or a lower depth was recorded at the treated site. Although, statistically, there was no significant difference ($p < 0.05$) at the control site, the reduction in number of soil microarthropods was significantly high in treated site with high concentration of the pesticide which recorded no value for number of microarthropods. This implies that as concentration increases death occurred due to toxic environment created. This led to downward migration of soil arthropods which is in agreement with the previous studies carried out by Iloba and Ekrakene, (2009).

The members of Collembola exhibited the weakest ability of being able to withstand the application of the pesticide as they were observed to have drastically reduce as concentration of pesticide increased. This drastic reduction in these groups of soil fauna could be as a result of their soft body which possibly offered least protection against the toxicity of the pesticide.

The toxic effect on this pesticide has the ability to create harsh environment that could cause death of the soil fauna thereby preventing them from responding to the extraction method of light rays which may be responsible for low number of microarthropods sampled. This observation agrees with that of Frouz (1999) Jones and Hopkins (1998) and Reed (1997). Although their particular monthly record differed considerably from this work, the application of pesticide affected the environmental condition which adversely affected the number of micro arthropod present in treated sites.

In terms of tolerance it is apparent that the Oribatidae (*scheloribates* sp, *Galumna* spp, *Archegozetes magnus*, *Epilornanna* sp, Belbidae sp, Cephalidae sp, *Molierculia inexpecta*, *Parallonothrus* spp had the ability to withstand the stress caused by the pesticide.

The soil pH, soil moisture content and soil temperature did not vary significantly among the different areas treated with different concentrations of the DD force pesticide and the control. Though these parameters did not vary significantly, field observation revealed a steady increase in soil moisture as the period coincided with rainy season. Perhaps, the effect depends strongly on the represented species, their individual susceptibility, and their abundance, as well as the climatic conditions (Behan and Neuton, 1999). Soil moisture content is one of the decisive factors affecting the life of Oribatids communities. Oribatid mites generally prefer habitat with elevated humidity and are susceptibility to droughts (Behan-Pelletier and Neuton, 1999, Gregocs and Hufnagel, 2009). They are abundant within the tip layers of soil and humus (Behan-Pelletier and Neuton, 1999). Increased mite numbers, particularly Oribatid density in the rainy season had also been observed by Badejo and Akinwole(2006) and Treba et al. (1999). Soil mites distribution appears to be

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pH related. Many species prefer low p1-I sites, others were found in much acidic soil pH 4.2-4.8.Some species tolerate a wider range (pH 3.5-5.6) but many favour alkaline conditions (Rusek and Marshall 2000). This decrease in soil moisture content shown in table 3 for the treated site was observed to lead to decrease in soil fauna sampled. This observation is similar to that made by Badejo (1982) when he asserted that there was a decrease in the density of soil arthropods with decrease in soil moisture. Increased soil water has the ability to dilute the pesticide thereby reducing its toxic effect on both the soil fauna and environment.

In the study, the soil pH of the treated site was reduced which tends to be more acidic. This may have accounted for the complete relegation of micro-arthropods at the 0.10cm depth compared to their number at the 20cm depth (Table 3). Observed differences in the effect of tested chemicals on soil micro-arthropods can be caused by sclerotization of the cuticle, different niche and localization within the soil.

The findings of this experiment have clearly revealed that the number of soil arthropod in soil treated pesticides follows a natural cycle and the ease with which this is achieved is predicted among other factors on the persistent nature of the pesticide, the level of application and availability of diluting agent on the pesticide. It is recommended therefore that agriculturist and farmers should have a clear understanding of the nature of the pesticide they wish to apply and must endeavor to apply such according to the prescription and in the appropriate quantity to avoid distortion and destruction of the ecosystem.

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