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Evaluation of the acute effects of Daksh, DD-force, Imiforce, Sharp shooter and Rocket pesticides on biological soil ants (*Formicidae latreille*)

Suleiman USMAN[1]*, Umar Osu UJIH[2]

ABSTRACT

The population of ants noted to have reach 20 billion on the planet. The use of pesticides in farms and gardens led to many complex environmental contaminants, which have affected the population of ants and other biological organisms. This study aimed to evaluate the acute effects of some pesticides on soil ants. Except for DD-Force (70%), and Daksh (85%), there was a complete (100%) mortality rate at the full concentrated dose of Imi-Force, Rocket and Sharp-Shooter applied to the population of ants. However, compared with that of Daksh, the mortality rate associated with DD-Force was essentially low, although it remained the same at 4 minutes. A high mortality rate (100%) was noted with Imi-Force, Rocket and Sharp-Shooter, but a slow mortality rate was noted with Sharp-Shooter as compared with Imi-Force and Rocket. Also, there was a decreased effect for Imi-Force (70%) at 500 ml/L compared with Rocket (80%) and Sharp-Shooter (80%). This shows that the population of soil ants and their biodiversity are likely to be affected with the use of Daksh, DD-Force, Imi-Force, Rocket, and Sharp shooter, if not sustainably used. Symptoms such as erratic swimming, shivering, knocking back, loss of reflex, and paralysis are likely to increase the mortality rate of ants. This study suggested that pesticides such as Daksh, DD-Force, Imi-Force, Rocket, and Sharp should be used for shooter marketing in some African and Asian countries, especially in areas dominated by important biological organisms such as ants and relatives.

Keywords: Ants, Pesticide, Acute effect, DD-force, Imi-force, Rocket, Daksh, Sharp-shooter

1. INTRODUCTION

The soil ecosystem is a medium that accommodates diverse invertebrate organisms with a range of essential benefits for agricultural production (Barrios, 2007). The proper functioning of the self-organized internested system formed by ants and termites influences the soil ecosystem at sustainable rates (Brain and Brain, 1978). The population of ants on the planet is estimated to reach 20 billion (Bargum, 2024). They are excellent architects and dig underground nests that are composed of two

fundamental components: a vertical axis, and a horizontal chamber (Yang *et al.,* 2022). The shape, size, quantity and storage system within vertical and horizontal chambers, depend largely on the environment and the population of ants in any given area (Khuong *et al.,* 2016). However, underground colony nests are believed to contain empty soil voids produced in the soil, and are located within the profile section (Brain and Brain, 1978). Bardgett (2005) reported that soil macrofauna, such as ants, termites and earthworms (soil engineers), play vital roles in soil modification and soil transformation. They are extensively studied because of their biodiversity in soil media (Brussaard, 2012). The effects of ants on soil dynamics and soil ecosystem functions can be studied through their biogenic structures, which are related to changes in soil properties. These changes in soil properties created niche opportunities for diverse organisms, and regulated many soil functions related to soil quality and biochemical processes (Usman *et al.,* 2016). The pesticides used in agricultural soils caused environmental health problems to other organisms (Usman *et al.,* 2024). These environmental health problems include the morphological, behavioural and physiological changes that affect the reproductive, nervous, respiratory and osmoregulatory organs of soil organisms (Braga *et al.,* 2020). They also contaminate the soil and water by introducing a harmful impact on various soil systems (Braga *et al.,* 2020; Usman *et al.,* 2024). Depending upon the chemical nature of pesticides and soil properties, biological organs undergo a series of chemical pathways, transport, adsorption, and desorption processes (Lai, 2017).

Agricultural intensification and an indiscriminate use of pesticides, often affect soil biological organisms, soil properties, and soil functional services (Usman *et al.,* 2024). The estimated cost of $38 billion was recorded for pesticides purchased, annually. Most of these pesticides are used for control of pest and disease in agriculture (Usman, 2020). Unfortunately, these pesticides used, are nonspecific, and can kill organisms that are beneficial to soil and environment (Usman, 2020). This concern has been one of the major debated factors that led to the FAO/WHO joint meeting on pesticide residue (JMPR) and the FAO/WHO joint meeting on pesticide specification (JMPS). One of the aims of these two meetings was to find ways to protect biological organisms, the human population, especially children, and the environment in which they live (FAO, 2018).

Pesticides are chemicals or biological agents (such as viruses, bacteria, antimicrobials, or disinfectants) that deter, incapacitate, kill, or otherwise discourage pests (Mohammad *et al.,* 2018). According to the United States Environmental Protection Agency (US-EPA, 2017), the use of pesticides is so common that the term is treated as synonymous with the protection of plant products. In general, pesticides are also used for non-agricultural purposes. Pesticide is a general concept that includes herbicide, insecticide, molluscicide, piscicide, avicide, insect growth regulator, nematicide, termiticide, rodenticide, predacide, bactericide, insect repellent, animal repellent, antimicrobial, fungicide, disinfectant and sanitizer (Carolyn, 2013). Insecticides are the most lethal and pose a risk to nontarget organisms (Goedhart and Inchausti, 2010; Usman *et al.,* 2017). Pesticides have benefits to crops, and also drawbacks because of the potential toxicity to humans and other biological species (Sharma *et al.,* 2019). Studies on residue analysis related to the impact of toxicity on biological organisms have been conducted at various levels (Sharma *et al.,* 2019). Some of these studies include studies on pesticide residue levels in soil, water, kales and tomatoes (Ngolo *et al.,* 2019); pesticide residues in various environmental and biological matrices (Rajput *et al.,* 2021); and analyses of pesticides in soils with a special emphasis on rigorous quality control (Rösch *et al.,* 2023). The pesticide substances when applied to land, air, and water, can enter aquatic systems and biological surroundings (Ngolo *et al.,* 2019). This application of pesticides causes aquatic pollution and environmental biological hazards (Marks-Perreau *et al.,* 2023). Therefore, to ensure the sustainable use of pesticide in agriculture, and pesticide policies for biological organisms (Möhring *et al.,* 2020); there is an urgent need to conduct research on the impact of common pesticides used by farmers in sub-Saharan Africa.

Pesticides are designed to disrupt key biochemical processes associated with the nervous and reproductive systems of target pests (Medina-Pastor and Triacchini, 2020). In many cases, these processes are similar among different organisms, whether they are pests or humans (Leo *et al.,* 2016). For example, organophosphate and carbamate insecticide poison insects by inhibiting the enzyme acetylcholinesterase (Mohamed *et al.,* 2021). This insecticide poison can be toxic to biological organisms, human, and soil environments (Usman *et al.,* 2017). Another pesticide poison that can leads to adverse health effects, is via endocrine disruption (Min *et al.,* 2007). At small doses, these pesticides are able block hormones or trigger inappropriate hormonal activity, in contrast at high doses, they may interfere leads to sterility, lowered sperm counts, and cancer of the reproductive organs (United Nations, 2018). Acute pesticide poisoning can cause a range of symptoms in adults and children, depending on the type of pesticide (McKinley *et al.,* 2008). For example, the use of organ phosphorus compounds was noted to produce effects such as neurobehavioral, gastrointestinal, and respiratory (Usman *et al.,* 2024). In some cases, acute pesticide poisoning can result in death, either rapidly or over the course of weeks, depending on the characteristics of the product and type of exposure (FAO, 2019). National and international concerns about their various biological effects have remained a focus in recent years (Yao, 2020). Other effects related to human diseases have been also linked to high levels of exposure to pesticides; these include brain (neuroblastoma) cancers, soft tissue sarcomas, colorectal and testis carcinomas, hormonal imbalances leading to infertility, breast pain, menstrual disturbances, adrenal gland exhaustion and early

menopause, among others (van Wendel de Joode *et al.*, 2020). This paper aimed to evaluate the acute impact of Daksh, DD-Force, Imi-Force, Sharp Shooter and Rocket pesticides on soil biological ants via specific laboratory visual examinations.

2. MATERIALS AND METHODS

Site and sample collection

Samples of biological ants were collected from the Warwade Irrigation Dam site in the Dutse Region, Nigeria. The area located within the latitudes of 11.76° and 13°N and longitudes of 9.34° and 10°E, respectively. The average annual rainfall ranges from 743 mm to 800 mm, and the monthly temperature ranges from 30°C to 45°C. The soil of the site was described according to Soil Survey Staff (2022) as Vertisols because of the Fluvic and Takyric materials. Physically, the nature and condition of the site can be characterized as bare by dwarf shrubs and fewer grasses (Table 1). The common crops in the area are rice, wheat, maize, and varieties of horticultural plants such as tomato and onion, largely cultivated under irrigation.

Table 1. Biophysical surface characteristics of the ants' nest colony sites

Ant collection point (sample)	Vegetation type field assessment (m)	Dominant soil type (USDA)	Soil texture (USDA)	Agricultural land use (visual)
1	Shrubs (0.3– 0.9)	Vertisols	Clay loam	Mixed-cropping
2	Shrubs (0.5–1.1)	Vertisols	Clay loam	Mono-cropping
3	Grasses (0.4–1.1 m)	Vertisols	Loam	Mixed-cropping
4	Grasses (0.2–1.6 m)	Vertisols	Clay	Mono-cropping
5	Grasses (0.3–0.8 m)	Vertisols	Loam	Mono-cropping
6	Grasses (0.7–0.9 m)	Vertisols	Clay loam	Mono-cropping
7	Shrubs (0.6–0.9 m)	Vertisols	Loam	Mixed-cropping
8	Shrubs (0.7–1.2 m)	Vertisols	Loam	Mono-cropping
9	Shrubs (0.4–1.8 m)	Vertisols	Clay	Mono-cropping
10	Shrubs (0.4–1.2 m)	Vertisols	Clay	Mono-cropping

This study included chemical pesticides, a stopwatch, a plastic container, a plastic bottle, a digital camera scanner and pure water. The pesticides used were purchased from the sales outlets of Dutse and Kano. These pesticides are Daksh, DD-force, Imiforce, Sharp Shooter and Rocket (Table 2).

Table 2. Information about the common pesticides used for the evaluation (after Usman, 2020)

Pesticide/market trade name	Chemical composition	Common name	Active ingredient	Mode of entry	Function/action
DD Force (Liquid form)	Organophosphate	Dichlorvos	dichlorvos (DDVP: 2, 2 dichlorovinyl dimethyl phosphate)	Stomach poisons	Through digestive track and nerves poison
Imi-force (Liquid form)	Organophosphate	Chloronicotinyl	Chloronicotinyl 200 g/	Systematic through the plant tissue	Physical poison
Daksh (Liquid form)	Systematic	Indoxacarb	Dimethyl Dichlorovinyl Phosphate (DDVP)	Stomach intoxicant	Respiratory poisons
Sharp Shooter (Liquid form)	Profonofos 40%, cypermethrin 4%, emulsifier 10%, solvent 46%.	Sharp Shooter	Profonofos, cypermethrin, emulsifier, solvent	Broad spectrum	Broad spectrum
Rocket (Liquid form)	Non systematic	Profonofos, cypermethrin	Profonofos and pyrethroid cypermethrin	Stomach poison	Stomach action

Approximately one hundred and sixty (160) healthy biological ants were collected at the growing stage from 10 different location points at the study site (Table 1), and their biological kingdom is shown in Figure 1 (Bardgett, 2005). The description of these ant populations could be related to the general theoretical ecology of other ant groups living in sub-Saharan African ecosystems (Usman *et al.*, 2016). They are small insects that can carry more than 25 times their body weight (FAO, 2005). Ant brains conform to the general design of insect brains, similar to human brains, which reflect their vertebrate, mammalian and primate origins (Charies, 2003). The ants' queen and colony can live for up to 30 years; however, the mobile ants can live for one to three years (Bargum 2024). They feed on leaves, fruit, sugary, food, aphids and dead creatures, among others (Coleman *et al.*, 1992). They also help in the biological decomposition of dead organic matter and add significant value to soil functions (FAO, 2011).

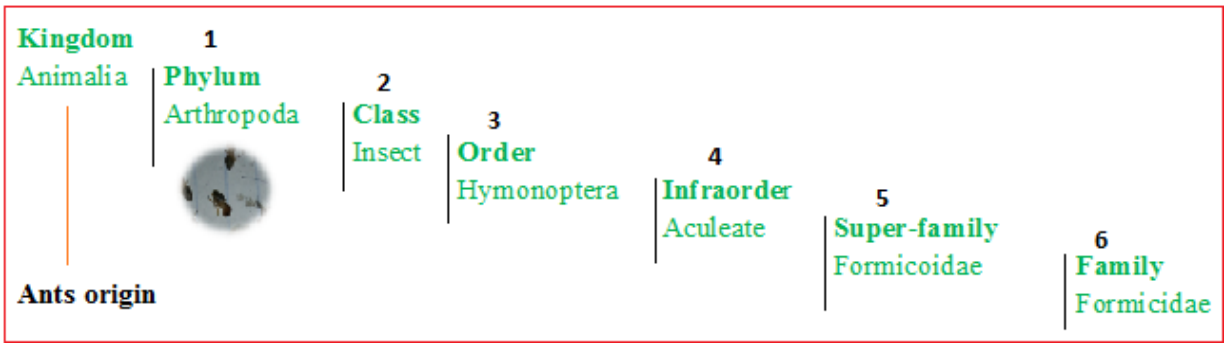

Figure 1. Representation of the biological classification components of ants

Laboratory analysis and procedure involved

Five (5) different samples of pesticides (DD-Force, Imi-Force, Daksh, Rocket and Sharp-Shooter) were organized into four additional (4) concentrated treatments. However, for each treatment, the mortality rate was observed at 2 minutes, 4 minutes, 6 minutes and 10 minutes. The procedure involved the use of a sequential dilution process in which a specific dose of pesticide solution was prepared by adding 500 ml of pesticide to different liters of water (H_2O). The stock solution was preserved at standard temperature, and the samples were divided into four (4) different concentrations on repeated trials:

a. The solution was concentrated without dilution (pure chemical used).
b. The solution was diluted in 1 liter of water (i.e. 1 liter of H_2O used).
c. The solution was diluted in 1.5 liters (i.e. 1.5 liters of H_2O added used).
d. The solution was diluted in 2 liters of water (i.e. 2 liters of H_2O added used).

An acute toxicity assessment was conducted to determine the toxicity level of the pesticide, and the mortality rate was visualized by the naked eye. This procedure followed a similar simple procedure for the determination of organochlorine pesticides in soil using gas chromatography-tandem mass spectrometry (Rashid *et al.*, 2010). The biological ants were distributed randomly among treatments. The mortality rate of the ants in each experimental bottle, were monitored and recorded for 2 minutes, 4 minutes, 6 minutes and 10 minutes. In addition, the behavioural changes were also monitored and recorded based on 'yes' and 'no'. These behavioural changes include erratic swimming, air gulping, and loss of reflex, discolouration and paralysis. Careful observation through visual assessment was used during the visual assessment. At each set of times used, the percentage mortality rates, and the behavioural changes of the ant population toward a specific pesticide formulation, were recorded within 2 minutes. The chemical scoring and evaluation system followed the same principles as those described by O'Bryan and Ross (1988).

Statistical analysis

All data was subjected to analysis of variance (ANOVA) where average mean, standard deviation and square of the mean were analysed.

3. RESULTS & DISCUSSION

Mortality rate

Tables 3 to 7 provide basic information regarding the mortality rate of the biological ant population at various concentrations of pesticides for DD-Force, Imi-Force, Daksh, Rocket and Sharp-Shooter.

Table 3. The percentage cumulative mortality rate of ants exposed to DD Force

Concentration	DD-Force: Time			
	2 minutes (%)	4 minutes (%)	6 minutes (%)	10 minutes (%)
Pure chemical	70	100	-	-
500 mL/1 litter	30	90	100	-
500 mL/1.5 litter	20	70	100	-
150 mL/2 litters	10	30	90	100

Table 4. The percentage cumulative mortality rate of ants exposed to Daksh

Concentration	Daksh: Time			
	2 minutes (%)	4 minutes (%)	6 minutes (%)	10 minutes (%)
Pure chemical	85	100	-	-
500 mL/1 liter	20	100	-	
500 mL/1.5 liters	20	80	100	-
150 mL/2 liters	0	70	90	100

Table 5. The percentage cumulative mortality rate of ants exposed to the Imi-force

Concentration	Imi-Force: Time			
	2 minutes (%)	4 minutes (%)	6 minutes (%)	10 minutes (%)
Pure chemical	100	-	-	-
500 mL/1 liter	70	80	100	
500 mL/1.5 liters	50	60	90	100
150 mL/2 liters	40	50	70	100

Table 6. The percentage cumulative mortality rate of ants exposed to Rockets

Concentration	Rocket: Time			
	2 minutes (%)	4 minutes (%)	6 minutes (%)	10 minutes (%)
Pure chemical	100	-	-	-
500 mL/1 liter	80	100	-	-
500 mL/1.5 liters	50	100	-	-
150 mL/2 liters	20	90	100	-

Table 7. The percentage cumulative mortality rate of ants exposed to Sharp-Shooters

Concentration	Sharp-shooter: Time			
	2 minutes (%)	4 minutes (%)	6 minutes (%)	10 minutes (%)
Pure chemical	99	-	-	-
500 mL/1 liter	80	100		
500 mL/1.5 liters	55	92	100	-
150 mL/2 liters	26	45	87	100

The results show that the concentrations of pesticides probably affect the ants because of toxicity level, and this might also have adverse effect on biodiversity in the study area (Tables 3–7). Compared to the pure chemical and other treatments, there is a slight decrease in mortality rate of the ants. Except for DD-Force (70%) and Daksh (85%), there was a complete (100%) mortality rate at the full concentrated dose of Imi-Force, Rocket and Sharp-Shooter. However, compared with Daksh, DD-Force was essentially low, with an extension of 2 minutes before the mortality rate reached 100%; however, it appeared to be the same at 4 minutes (Figure 2).

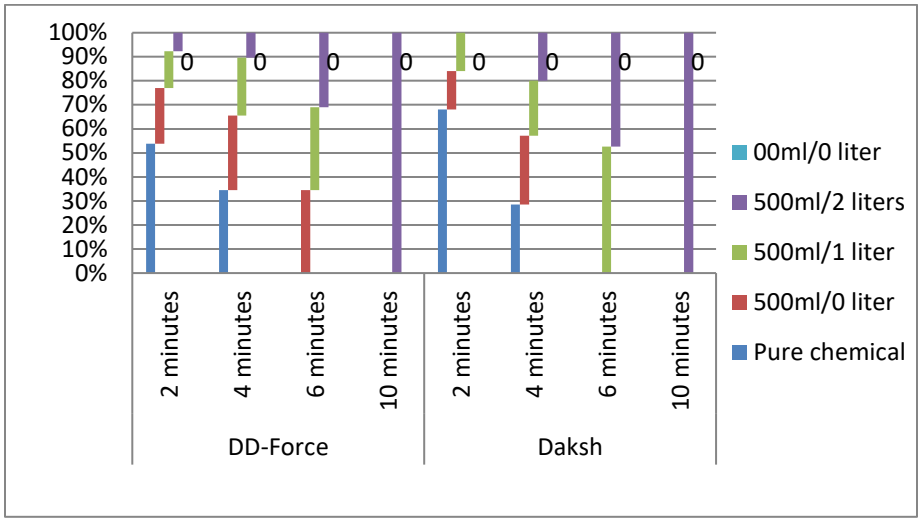

Figure 2. Percentage mortality rate with DD Force and Daksh

A high mortality rate (100%) was noted at 2 minutes with Imi-Force, Rocket and Sharp-Shooter; however, a slow rate was consistently noted with Sharp-Shooter as compared to Imi-Force and Rocket (Figure 3, 4, 5). Additionally, there was a slow mortality rate with Imi-Force (70%) at 500 ml/1 liter as compared to Rocket (80%) and Sharp-Shooter (80%). This is probably because of cutback of the concentrated energetic (active) ingredients in the formulation of Imi-Force. This was noted as a common attribute to all other treatments related to Imi-Force, and appeared to last between 6 and10 minutes (Table 5).

There are contradiction effects on mortality rate between DD-Force and Imi-Force at 2 minutes, 4 minutes and 6 minutes (Figure 6). This contradiction was inconsistent according to opinions of the majority of farmers and pesticide dealers in the study area. Farmers rated DD-Force and Imi-Force as the same based on their mode of action, although this opinion can be true only through further analysis (Usman *et al.*, 2024).

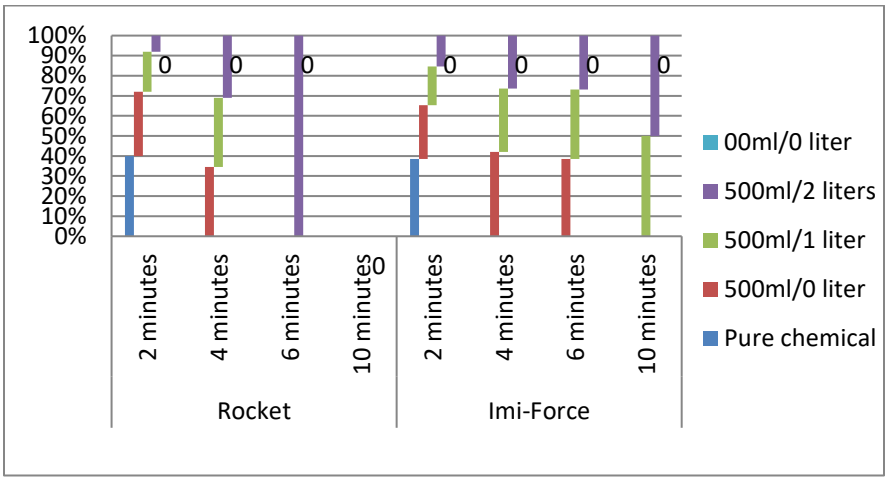

Figure 3. Percentage mortality rate with Rocket and Imi-Force

The average mortality rate was found to be high with Imi-Force but lower with Rocket (Table 8). There was also a high mortality rate with DD-Force compared to Imi-Force. Sharp-shooter and Daksh appeared to have the same effect, although the effects were lower than those of Imi-Force and DD-Force. The percentage mortality rate at 1 to 10 minutes, appeared to be identical for Daksh, Sharp-Shooter and Rocket (SD = 44), but disagreed with DD-Force and Imi-Force (SD = 43, 41). The deviation mean square also shows the apparent percentage mortality rate proximity for Daksh, Sharp-Shooter and Rocket (Table 8). Therefore, the effect of Imi-Force on ant population is probably higher as compared to DD-Force, and other treatments.

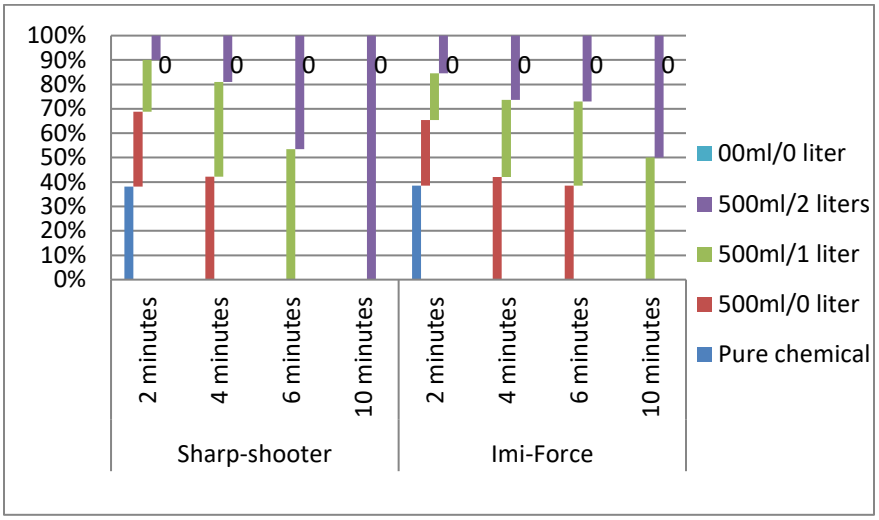

Figure 4. Percentage mortality rate with the sharp shooter and Imi Force

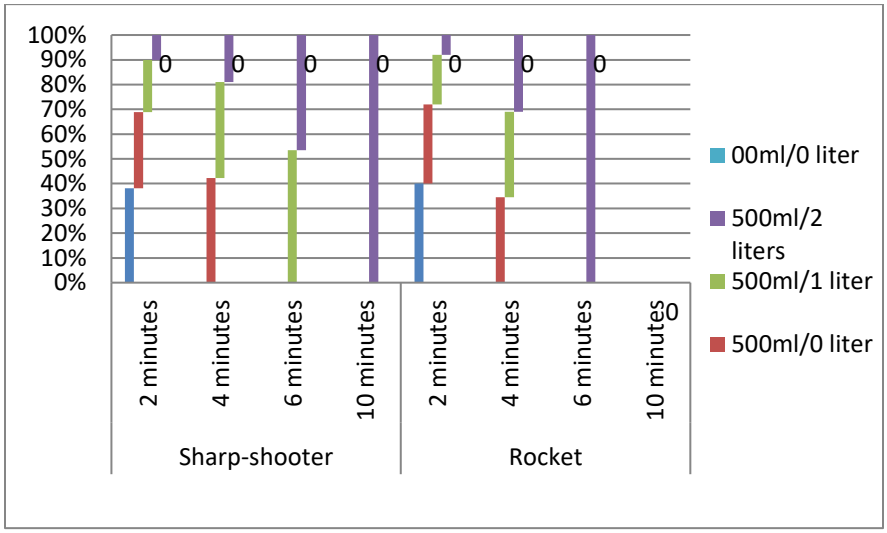

Figure 5. Percentage mortality rate associated with sharp shooters and rockets

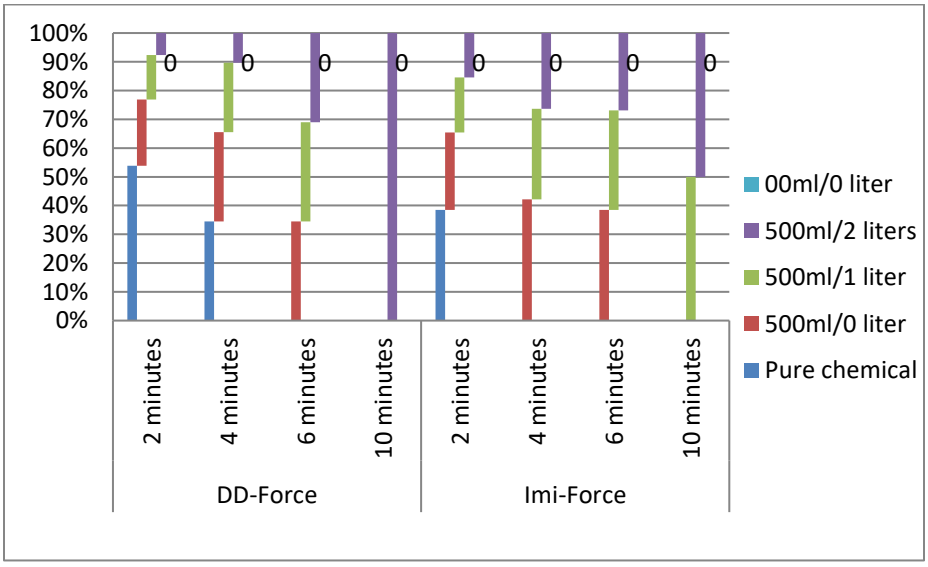

Figure 6. Percentage mortality rate associated with sharp boots and rockets

Table 8. Average mortality rate, standard deviation and sum of the means squared

Pesticide	Average mortality rate (%)	Standard deviation (%)	Dev. SQ (%)
Daksh	38.25	44.81761	38163.75
DD-Force	40.50	43.22219	35495.00
Imi-Force	47.89	41.44326	30915.79
Sharp-shooter	39.20	44.26428	37227.20
Rocket	32.00	44.08126	36920.00

Ant population behavioral changes after contact with pesticides

Table 9 explained the behavioral changes in the population of ants as they have exposed to various pesticides' treatments. There are an exhibited erratic swimming of ants with Imi-Force and Rocket; however, this appeared to be absent with Daksh, DD-Force and Sharp-Shooter. The behavioral changes described how ants are not comfortable with the energetic ingredients contained in the Imi-Force, and Rocket. Visually, Nockback, including shivering and quivering, was observed with Daksh, DD-Force, Imi-Force and Sharp-Shooter devices. This probably explains the level of toxicity of these groups of pesticides to the ant population in the soil ecosystem. There is also an indication of a sensible level of poisonous ingredients, which are not healthy to the overall biological organisms about these pesticides (Usman *et al.,* 2017). There was a loss of reflex or response with DD-Force, Imi-Force and Sharp shooters. This loss of reflex, is probably affected the entire body system of the ants during the first contact with the pesticides. Also, there were discoloration and staining of the liquid molecules, which seem to be often with a Sharp Shooter and Rocket as compared to other pesticides. Likewise, there was an indication of paralyze conditions, which appeared to be related to all the treatments.

Table 9. Ant behavioral changes toward a specific pesticide

Pesticide	Behavioral changes toward specific pesticide at 2 minutes of application					
	Erratic swimming	Nock back	Loss of reflex	Discolouration	Molting	Paralyze
Daksh	No	Yes	No	No	No	Yes
DD-Force	No	Yes	Yes	No	No	Yes
Imi-Force	Yes	Yes	Yes	No	No	Yes
Sharp-shooter	No	Yes	Yes	Yes	No	No
Rocket	Yes	No	No	Yes	Yes	Yes

Discussion

Initially, the biological ant population sampled (160 samples) was in excellent genetic condition. However, they may travel in search of food and feeds to places where pesticides are sprayed indiscriminately and become contaminated (Usman *et al.,* 2024). However, it is optimistic that they live in an environment where risk of pesticide contamination is low except for an accident. Depending on the level of toxicity and type of pesticide used, there is a always high tendency for ants and other soil organisms been killed when pesticides used indiscriminately (van Wendel de Joode *et al.,* 2020). There is evidence of behavioral disorders after exposure to these pesticides, which can lead to erratic swimming, shivering, and paralysis, among others (Table 9). These can negatively affect the health of the ant population and may lead to sudden death due to either short-term (acute) or long-term (chronic) effects (Mora *et al.,* 2018). High mortality rates were recorded for all the pesticides, although these rates varied among the treatments (Tables 3–7). The mortality incidence was noted to begin with various symptoms, as reported in Table 9, and was tallied with other related studies on pesticide effects on biological organisms (González-Curbelo *et al.,* 2022), as well as pesticide studies that focused on soil, water and biological components (Chai *et al.,* 2014).

The evidence of high mortality at various treatment levels is probably associated with higher acute toxicity as noted with Imi-Force, Rocket and Sharp shooter (Figure 4, 5). This occurrence has been reported for pesticides such as benzene (Canton and Adema, 1978), phenol, cholinesterase (Chakraborty *et al.,* 2009) and some herbicides (Mayeetreyee *et al.,* 2013). According to Usman (2018), factors such as inhibition, detoxification and absorption are responsible for higher toxicity effect in soil organisms. This higher toxicity, describes how the ant population is associated with the energetic ingredients contained in the various pesticides used in this study. According to Joko *et al.* (2020) soil organisms absorbed pesticide molecules, become inhibited and contaminated. This has led to the

sudden death of a large population of ants with Imi-Force and Rocket at 500 mL/0 liter (e.g., Figure 7). Hence, the aforementioned factors were probably responsible for the different toxic reactions noted at various treatment levels (Usman *et al.,* 2017). Additionally, the concentration of the symptoms observed (Table 9), is probably related to the absorption of toxicants (energetic ingredients) diluted in water (H_2O) solution (Usman, 2020). This could be fairly explained by the mode of action of pesticides when they contact pests on both farms and gardens (Marks-Perreau *et al.,* 2023).

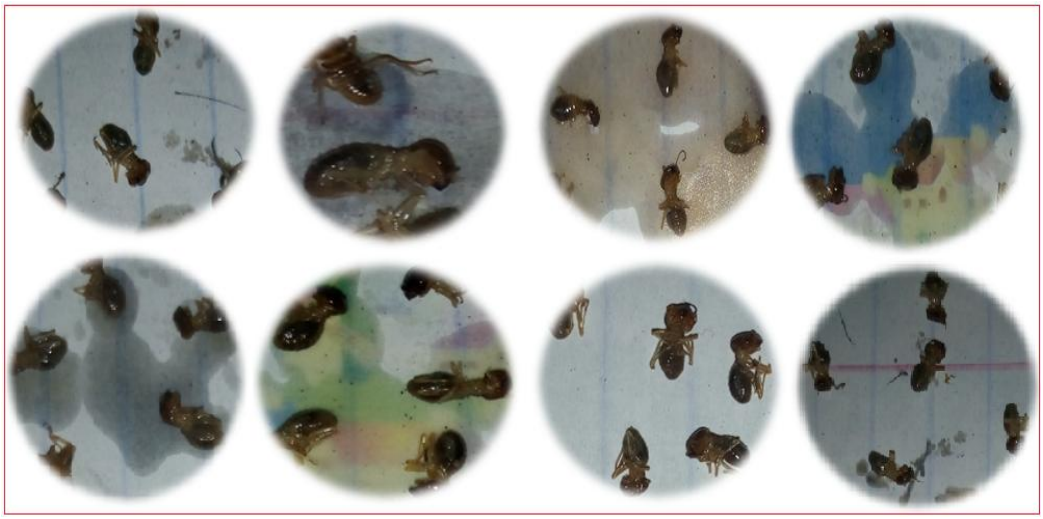

Figure 7. Digitized scanned image of the mortality of the ants after exposure to pesticides

Generally, the higher mortality rate observed as digitized in Figure 7, could be probably because of the soaring toxicity in the pesticides used (Ndungu *et al.,* 2019). This soaring toxicity level could have also increased the inhibition by the ant population, and eventually caused many deaths (Figure 7). Although, this may differ, if the same pesticides are to be prayed in an open environment, however, the probably that important soil organisms such as ants, to be affected remained a question of debate among many soil and crop scientists (Usman, 2020). Nevertheless, this study shows that the use of these pesticides by farmers needs to be handled with care. According to Mondal (2020) any high concentrations of pesticides can affect the behavioral conditions of ants, and might lead to a swift death. This pattern appeared to be a normal situation for acute, and subacute toxicity tests, but the concentration effect on biological organisms can be hazardous if not use sustainably (Larsen *et al.,* 2017). Ephratic (changeable/variable) swimming observed with ants in this study can be attributed to disturbances in the metabolic state resulting in the depletion of energy. The observed loss of the reflex can be attributed to the depletion of energy, as it could be an indication of impaired carbohydrate metabolism (Anderson et al., 1988). This could most likely be because the ant population was not comfortable with pesticide toxicants and thus entered a state of coma, paralysis, and death instantly (Tables 3–7), as similarly noted by Mayeetreyee *et al.* (2013).

4. CONCLUSION

This study evaluated the acute impact of Daksh, DD-Force, Imi-Force, Sharp Shooter and Rocket pesticides on soil biological ants via specific laboratory visual examinations. Most of the obvious mortality rate took place within a short period of time (2 to 6 minutes), and can be probably attributed to concentration of toxicity in the pesticides formulation. A substantial increase in the mortality rate occurred immediately after contact with the pesticides. There are several behavioral signs, which appeared before death, including erratic swimming, shivering, knocking back, loss of reflex, and paralysis. The evidence of these behavioral disorders, demonstrated that the sustainable use of Daksh, DD-Force, Imi-Force, Sharp Shooter and Rocket, must be ensured among the farmers in the study area. This study suggested that regular verification and analysis of pesticide residues by government agencies, from time to time is necessary. Trainings and skills acquisition on how pesticides should be handled, managed, and used, are required in every locality. Pesticides dealers and farmers should be guided on health issues, risk and environmental consequences related to working with pesticides.

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Dr. Suleiman Usman designed the study and conducted the practical analyses. Dr. Usman reviewed the work, edited and improved the quality. Dr. Umar Osuh Ujih provided some technical supports during the analysis.

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Conflict of interest
The authors declare that they have no conflicts of interest, competing financial interests or personal relationships that could have influenced the work reported in this paper.

Ethical approval
This work is mainly on the use of agrochemical pesticide on soil and does not involve any information on humans or animals; thus, an ethical statement is not applicable to the context of the manuscript.

Informed consent
Not applicable.

Data availability
The data supporting the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

1. Anderson T, Forlin L, Hardig J, Larsson A. Physiological disturbances in fish living in coastal water polluted with bleached kraft pulp mill effluents. Canadian Journal of Fisheries and Aquatic Science, 1988; 45: 1525-1536.
2. Bardgett RD. The biology of soil: A community and ecosystem approach. Oxford University Press, Oxford, New York. 2005; 242.
3. Bargum K. The book of ant records: amazing facts and feats. Theme: 'Ant biology, cool facts, entomology, social behavior.'. Orca Book Publishers, Lexile 860 L. 2004; 48.
4. Barrios E. Soil biota, ecosystem services and land productivity. Ecological Economics, 2007; 64(2): 269–285.
5. Brain MV, Brain M. Production ecology of ants and termites. Cambridge University Press, Cambridge, UK, Vol. 1978; 13.
6. Brussaard L. Ecosystem services provided by the soil biota. In: Soil ecology and ecosystem services. Wall, D.H., Bardgett, R.D., Behan-Pelletier, V., Herrick, J.E., Jones, T.H., Ritz, K., Six, J., Strong, D.R., van der Putten, W.H. (Eds). Oxford University Press. 2012; 45-58.
7. Braga ARC, de Rosso VV, Harayashiki CAY, Jimenez PC, Castro ÍB. Global Health Risks from Pesticide Use in Brazil. Nature Food, 2020; 1(6): 312-314.
8. Chai LK, Elie F, Jinang C (2014) Determination of 24 pesticides residues in mineral and peat soils by modified QuEChERS method and gas chromatography. Int. J. Environ Anal Chem, 2014; 94:519–530. doi: 10.1080/03067319.2013.871713.
9. Canton JH, Adema DMM. Reproducibility of short- term and reproduction toxicity experiments with *D. magna* and comparison of the sensitivity of *D. magna, D. pulex* and *D. culculata* in short-term experiment. Hydrobiologia. 1978;59: 135-140.
10. Carolyn R. National Pesticide Applicator Certification Core Manual. National Association of State Departments of Agriculture Research Foundation, Washington, DC. 2013.
11. Chakraborty S, Mukherjee S, Roychoudhury S, Siddique S, Lahiri T, Ray MR. Chronic exposures to cholinesterase inhibiting pesticides adversely affect respiratory health of agricultural workers in India. Journal of Occupational Health, 2009; 51: 488–497.
12. Coleman DC, Crossley-Jr DA. Microbial and faunal interactions and effects on litter nitrogen and decomposition in agroecosystems. Ecological Monographs, 1992; 62: 569-591.
13. Cowgill UM, Millazzo DP. The sensitivity of *Ceriodaphnia dubia* and *Daphnia magna* to seven chemicals utilizing the three

brood test. Archives Environmental Contamination and Toxicology, 1991; 20: 211-213.
14. Charies M. The life and times of the ant. Houghton Mifflin Boston, MA 2003.
15. FAO. The importance of soil organic matter: key to drought resistant soil and sustained food production. FAO Soils Bulletin, No. 80. Food and Agricultural Organization of United Nation, Rome, Italy. 2005; 11-47 & 65pp. https://openknowledge.fao.org/
16. FAO. Biodiversity for Food and Agriculture Contributing to food security and sustainability in a changing world. Food and Agricultural Organization, Rome, Italy. 2011; 66pp. https://www.fao.org/fileadmin/templates/biodiversity_paia/PAR-FAO-book_lr.pdf
17. FAO-WHO. Food and Agriculture Organization of United Nations (FAO), The World Health Organization (WHO), Global Situation of Pesticide Management in Agriculture and Public Health, Report of a 2018 WHO–FAO survey, online publication, 2018.
18. FAO-WHO. Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO), Global Situation of Pesticide Management in Agriculture and Public Health. FAO, Rome, Italy 2019.
19. González-Curbelo MA, Angélica D, Varela-Martínez A, Riaño-Herrera DA. Pesticide-Residue Analysis in Soils by the QuEChERS Method: A Review. Molecules 2022; 27(13): 4323. doi: 10.3390/molecules27134323.
20. Goedhart PW, Inchausti P. Persistent negative effects of pesticides on biodiversity and biological control potential on European farmland. Basic and Applied Ecology, 2010; 11 (2): 97-105. doi: 10.1016/j.baae.2009.12.001.
21. Joko T, Dewanti NAY, Dangiran HL. Pesticide Poisoning and the Use of Personal Protective Equipment (PPE) in Indonesian Farmers. Journal of Environmental and Public Health 2020; 1-7.
22. Khuong A, Gautrais J, Perna A, Sbai C, Camba M, Kuntz P, Jost C, Theraulaz G. Stigmergic construction and topochemical information shape ant nest architecture. Proc. Natl. Acad. Sci. USA 2016; 113: 1303–1308.
23. Lai W. Pesticide use and Health outcomes: Evidence from Agricultural Water Pollution in China. Journal of Envir. Econ. and Mannt, 2017; 86: 93-120.
24. Larsen AE, Gaines SD, Deschênes O. Agricultural Pesticide Use and Adverse Birth Outcomes in the San Joaquin Valley of California. Nature communications, 2017; 8(1): 1-9.
25. Leo ML, Hamir N, Rathore S. Handbook of Pesticides: Methods of Pesticide Residues Analysis. CRS Press, 2016; 628.
26. Mohammad N, Abidin EZ, How V, Praveena SM, Hashim Z. Pesticide Management Approach Towards Protecting the Safety and Health of Farmers in Southeast Asia. Reviews on Environmental Health, 2018; 33(2): 123-134.
27. Mohamed AH, Noorhisham NA, Yahaya N, Mohamad S, Kamaruzzaman S, Osman H, Aboul-Enein H. Sampling and sample preparation techniques for the analysis of organophosphorus pesticides in soil matrices. Crit. Rev. Anal. Chem, 2021; 1: 1–22.
28. Marks-Perreau P, Emma Soulé E, Keichinger O, Bedos C, Prevost L, Van Dijk P, Bockstaller C. An indicator to assess risks on water and air of pesticide spraying in crop fields. https://doi.org/10.1016/j.scitotenv.2023.161000.
29. Mayeetreyee B, Pasayat M, Samal A, Kujur M, Kumar J, Maharana M, Patel AK. Effect of Four Herbicides on Soil Organic Carbon, Microbial Biomass-C, Enzyme Activity and Microbial Populations in Agricultural Soil. Inter. J. of Research in Envir. Sci. and Tech, 2013; 3(4): 100-112.
30. Medina-Pastor P, Triacchini G. The 2018 European Union Report on Pesticide Residues in Food. EFSA Journal, 2020; 18:4.
31. Min H, Ye Y, Chen Z, Wu W, Yufeng D. Effects of butachlor on microbial populations and enzyme activities in paddy soil. J. Environ. Sci. Pesti. Food Contaminants Agri. Wastes, 2007; 36(5): 581-595.
32. Mondal P. Modern Sample Preparation Techniques for Pesticide Residues Analysis in Soil. Soil Analysis: Recent Trends and Applications, 2020; 163–185.
33. Mora AM, Córdoba L, Cano JC, Hernandez-Bonilla D, Pardo L, Schnaas L, Smith DR, Menezes-Filho JA, Mergler D, Lindh CH, Eskenazi B, de Joode B, van W. Prenatal Mancozeb Exposure, Excess Manganese, and Neurodevelopment at 1 Year of Age in the Infants' Environmental Health (ISA) study. Environmental Health Perspectives 2018; 126 (5), 1–9.
34. Möhring N, Ingold K, Kudsk P, Martin-Laurent F, Niggli U, Siegrist M, Studer P, Walter A, Finger R. pathways for Advancing Pesticide Policies. Nature Food 2020; 1(9): 535-540.
35. Ngolo P, Nawiri M, Machocho A, Oyieke H. Pesticide Residue Levels in Soil, Water, Kales and Tomatoes in EwasoNarok Wetland, Laipikia, County, Kenya. Journal of Scientific Research and Reports, 2019; 24(5): 5-24.
36. Ndungu AW, Yan X, Makokha VA, Githaiga KB, Wang J. Occurrence and Risk Assessment of Heavy Metals and Organochlorine Pesticides in Surface Soils', Central Kenya. Journal of Environmental Health Science and Engineering, 2019; 17, 63–73.
37. O'Bryan TR, Ross RH. Chemical scoring system for hazard and exposure identification. J. Toxicol Environ Health, 1988; 25(1): 199–34. doi: 10.1080/15287398809531193. PMID: 3418742.
38. Rajput S., Sharma R., Kumari A., Kaur R., Sharma G., Arora S. and Kaur R. Pesticide residues in various environmental and

biological matrices: Distribution, extraction, and analytical procedures. Environ. Dev. Sustain. 2021; 24:6032–6052. doi: 10.1007/s10668-021-01722-4.

39. Rashid A, Nawaz S, Barker H, Ahmad I. Ashraf M. Development of a simple extraction and clean-up procedure for determination of organochlorine pesticides in soil using gas chromatography-tandem mass spectrometry. J. Chromatogr A., 2010; 1217:2933–2939. doi: 10.1016/j.chroma.2010.02.060.
40. Rösch A, Wettstein EF, Wächter D, Reininger V, Meuli RG. A multiresidue method for trace analysis of pesticides in soils with special emphasis on rigorous quality control. Analytical and Bioanalytical Chemistry, 2023; 415: 6009–6025. Available via: orcid.org/0000-0001-9971-31041
41. Sharma A, Kumar V, Shahzad B, Tanveer M. Worldwide Pesticide Usage and its Impacts on Ecosystem. SN Applied Sciences, 2019; 1(11).
42. Soil Survey Staff. Key to Soil Taxonomy. 13th ed, United State Department of Agriculture and National Resources Conservation Services. 2022; 410.
43. United Nations. Understanding the Impacts of Pesticides on Children: A discussion paper. United Nations Children's Fund (UNICEF) 2018.
44. US-EPA. Basic Information about Pesticide Ingredients. Url: https://www.epa.gov/ingredients-used-pesticides-products/basic-information-about-pesticide-ingredients#active, 2017.
45. Usman S. Pesticide in Soil and Plant: An Overview. ABU Press, Zaria, Nigeria, 2020.
46. Usman S, Muhammad Y, Chiroman AM. Roles of soil biota and biodiversity in soil environment – A concise communication. Eurasian Journal Soil Science, 2016; 5(4): 255–265.
47. Usman, S, Kundiri AM, Nzamouhe M. Effects of Organophosphate Herbicides on Biological Organisms in Soil Medium – A Mini Review. Journal of Ecology and Toxicology, 2017; 1, 1:102.
48. Usman S. Soil Challenges by Pesticide: An Illustrated Concept for Environmental Awareness. Journal of Ecology and Toxicology, 2018; 2 (1):109.
49. Usman S, Jayeoba JO, Amana SM. Pesticides and soil environment: An age-linked concept. Bulgarian Journal of Soil Science, 2024; 9(1): 83–103.
50. van Wendel de Joode B, Mora AM, Lindh CH, Hernández-Bonilla D, Córdoba L, Wesseling C, Hoppin JA, Mergler D. Pesticide Exposure and Neurodevelopment in Children Aged 6–9 Years from Talamanca, Costa Rica. Cortex, 2016; 137–150.
51. Yang G, Zhou W, Qu W, Yao W, Zhu P, Xu J. A review of ant nests and their implications for architecture. Buildings, 2022; 12(12): 2225. doi: 10.3390/buildings12122225.
52. Yao BO. Industry Efforts to Combat Fraudulent Pesticides in West Africa. Africa Agriculture Status Report 2020, Nairobi, Alliance for a Green Revolution in Africa 2020.