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Safety of Active Ingredients in Commonly Used Pesticides in Nasarawa State, Nigeria

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ABSTRACT

The use of pesticides has become an integral part of modern farming and environmental improvement in many parts of the world. However, this practice has often resulted in environmental contamination or pollution. The adverse effects of these chemicals in Nigeria are much more aggravated by the limited knowledge among users on safe practice, toxicological and chemical properties of these substances. The general public may be affected by pesticide residues through consumption of treated food or exposure to areas treated with pesticides and their persistent magnification through food chain. Toxicity assessment is essential in determining animal sensitivity to toxicants, degree of damage to the target organs, the haematological and biochemical indices and their ameliorative measures. From the foregoing therefore, the study assesses the safety of active ingredients in commonly used pesticides in Nasarawa State, Nigeria. Multi-stage sampling technique was used for the study. One community each was purposively selected from five Local Government Areas in the state. A total of 200 copies of structured questionnaire were used to assess the commonly used pesticides in the study area. Descriptive statistical technique was used to analyse the data collected. Twenty different pesticides were identified to be in use in the study area while eleven active ingredients (AIs) were identified. These include: glyphosate (48.09%)>pyrethroid (25.12%)>vapona (8.86%)>atrazine (7.59%)>dichloride (3.86%)>triclopyr (2.53%)> (acifluorfen, nicosulfuron and butachlor (1.27)). The AIs are further grouped into 8 major pesticide classes that is: organophosphate, pyrethroid, traizine, organochlorine, pyridine, urea, aromatic acid and acetanilide. Organophosphates, pyrethroids and traizines were found in 10, 3 and 2 of the pesticides, respectively. While the remaining pesticides contain one each of aromatic acid, urea acetanilide, pyridine and lastly organochlorine. The use of pesticides is on the increase in the study area, hence safety measures must be applied to forestall consequent environmental disorders.

Keywords: Pesticides, Active ingredients, Wildlife, Environment, Non- target species

Introduction

The term pesticide encompasses herbicides, insecticides, fungicides and rodenticides (WHO, 2016), and in effect is any compound used to control a pest species. The use of pesticides for farming and domestic activities is in the increase and this has led to substantial improvement in the economic and social well being of many users in terms of increased food production and effective control of vector borne diseases (Lami and Amana, 2015). Pesticides contain both active and inert ingredients (Zacharia, 2011). While the active ingredients (AIs) are products that prevent, destroy, repel, control or mitigates a pesticide, the inert ingredients are important for product performance and usability. Active ingredients make up small proportion of the whole pesticide. However, the misuse of pesticides has often resulted in environmental contamination most especially when they leave traces of residues after each application (Kishi, 2005). Pesticide residue refers to the pesticides that may remain on or in food after they are applied to food crops (IUPAC, 1997). Residues of pesticides contaminate soils and water, remain in the crops, enter the food chain, and finally are ingested by humans with foodstuffs and water (Taylor *et al.*, 2003). The levels of these residues in foods are often stipulated by regulatory bodies in many countries. Exposure of the general population to these residues most commonly occurs through consumption of treated food sources, or being in close contact to areas treated with pesticides such as farms or lawns around houses. Persistence of these chemicals can be magnified through the food chain and have been detected in products ranging from meat, poultry, and fish, to vegetable oils, nuts, and various fruits and vegetables (Stephen *et al.*, 2011).

Majority of the active ingredients can be termed as Persistent Organic Pollutants (POPs). POPs are organic compounds that are ubiquitous, to a varying degree, resist photolytic, biological and chemical degradation; thus remaining in the environment for years (Ritter *et al.*, 1995). POPs are either polycyclic aromatic hydrocarbons or halogenated hydrocarbons. They are characterized by low water solubility (leading to their bioaccumulation in fatty tissues), semi-volatility (enabling them to move long distances in the atmosphere before deposition occurs), persistence, bioaccumulative, biomagnifying, bioconcentrate (that is, become more concentrated) and toxic. According to Zhang *et al.* (2007), these pollutants can be detected far from their sources of origin because of long-range transport stemming from atmospheric exchange, water currents, animal migration and other pathways. Although, both natural and anthropogenic POPs exist, some have been produced deliberately by industry for a wide variety of applications; others are formed accidentally or eventually released as a by-product of various activities (Ritter *et al.*, 1995). UNEP (2002) asserts that residues and metabolites of many POPs are very stable, with long half-lives in the environment. Residues of pesticides contaminate soils and water, remain in the crops, enter the food chain, and finally are ingested by humans with foodstuffs and water (Taylor *et al.*, 2003).

The adverse effects of pesticides in Nigeria are much more aggravated by the limited knowledge among users on safe practice, toxicological and chemical properties of these substances. Also, little is known about the long term and indirect effects of pesticides on the environment. Nonetheless, the use of these chemicals has been beneficial as they are used to eradicate insect pests, unwanted species of plants, or animals and disease vectors.

Omonona *et al.* (2015) reported that the use of pesticides in agriculture is worldwide, leaving traces to quantifiable amounts of chemicals in the environment with possible deleterious effects. This could result in ill health of wildlife which could be aggravated by stress or any other environmental toxicities and opportunistic infections (Akegbejo, 1996; Omonona and Kayode, 2011). Also, the toxicity, dosage applied, weather conditions prevailing after the application, and how long the pesticide persists in the environment could account for its adverse effects on the environment. Soil factors and weather conditions have long been recognised as the most important factors that affect its fate in the environment and consequently the activity, selectivity, and adverse effects on the environment (Monaco *et al.*, 2002).

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The populations of numerous wildlife species have undergone a precipitous decline, Omonona and Jarikre (2015) attributed this to habitat loss and over exploitation resulting from unregulated pesticide uses. Other notable disadvantages often associated with pesticide usage according to (Gold *et al.*, 2001) include blood disorders (anaemia, defective blood coagulation), brain and nerve damage, paralysis, jaundice and hepatic fibrosis, allergenic sensitization, emphysema, asthma, kidney problems, cancer, genetic disorders, birth defects, miscarriage, impotence, and infertility or sterility.

Each pesticide or pesticide class comes with a specific set of environmental concern. Such undesirable effects have led to the banning of many pesticides, while regulations have limited and/or reduced the use of others.

Methodology

Study area

Nasarawa State lies between latitudes 8°34´ and 13°85´N longitudes 8°18´ and 31°88´. It has its capital in Lafia and an estimated population of 2,523,400 (NPC, 2006). The state shares boundaries in the north with Kaduna State, in the east by Taraba and Plateau States, in the south by Kogi and Benue States and in the west by Abuja-the Federal Capital Territory.

It lies within the guinea savannah region and has tropical climate with moderate rainfall (annual mean rainfall of 1311:75 cm) (Nyagba, 1995). The state is made up of plain lands and hills and has some of the most beautiful sites and landscapes in the country. Nasarawa also has 13 local government areas and various ethnic groups within the state such as: Alago, Aho, Ake, Agatu, Bassa, Eggon, Gwandara, Hausa and Kanuri, amongst others. The major occupations of the people in Nasarawa include farming: the mainstay of its economy, with the production of varieties of cash crops throughout the year, others are fishing, dyeing, weaving, carving and blacksmithery. The land support the cultivation of foods and cash crops- maize, beniseed, millet, melon, yam, cassava, cashew, mangoes, oranges and production of animals- cattle, goats, sheep, chickens and many more. The state is also endowed with various mineral resources that offer potential for economically viable industrial and agricultural development projects which include: tin, marble, coal, semi-precious stones, barytes and aqua marine. It has a total land area of 27,137.8 sqkm (NPC, 2006).

Multi-stage sampling technique was used for the study. Five Local Government Areas (LGAs) were purposively selected in the state. The five represent 38.46% out of the 13 LGAs of Nasarawa State. One community was purposively selected from each LGA based on the population of farmers and the agricultural activities carried out in the area. Local government areas selected in the state include: Awe, Doma, Karu, Keana and Lafia with the corresponding communities: Awe, Doma, Mararaba Udege, Kadarko and Lafia. Forty farmers were randomly selected from each community making a total of 200 farmers from the five communities selected for the study. A total of 200 copies of structured questionnaire were used to assess the commonly used pesticides in the study area. Both questionnaires and interview schedule instruments were used and data collected were subjected to descriptive statistics.

Results and discussion

The result showed that out of the twenty pesticides used in the study area, 11 different AIs were identified (Table 1). They include the following in order of frequency: glyphosate (48.09%)>pyrethroid (25.12%)>vapona (8.86%)>atrazine (7.59%)>dichloride (3.86%)>triclopyr (2.53%)> (acifluorfen, nicosulfuron and butachlor (1.27)). These AIs can further be grouped into 8 major pesticide classes comprising organophosphate (OP), pyrethroids, traizine, organochlorine (OC), pyridine, urea, aromatic acid and acetanilide. While 10 pesticides contained organophosphate, three were from pyrethroid class, two from traizine class and one each from aromatic acid, urea, acetanilide, pyridine and lastly organochlorine. Out of the different pesticide formulation types used in the area, majority were herbicides (65.82%), especially glyphosate, which was the commonest AI, because weeds were the most serious threat to crop production in the study area. Glyphosate pesticides are non selective and they are known to inhibit plant growth (Hoagland and Duke, 1982), this may account for the choice and preference of its usage over the others. They belong to the phosphonoglycine group of organophosphate OP herbicides (Perez *et al*., 2011). It is the active ingredient in over 750 different herbicide formulations (Mesnage *et al*., 2015), thus making it presently the most widely used OP in the world (Perez *et al*., 2011).

Herbicides were followed in rank of importance by insecticides (33.98%). Pyrethroid pesticides which were the second highest used in the study area are synthetic analogues of pyrethrins. They have valuable insecticidal property which was recognized in the 19th century, and are active ingredients of many insect-control products intended for indoor home use (Feo *et al*., 2010). The pyrethroids have a high share of the insecticide market because their activity profile indicates high efficiency, wide spectrum, low mammalian and avian toxicity and biodegradability (Pap *et al*., 1996). They are characterised by low persistence, low volatility and rapid degradation.Unlike the OP insecticides that act on the central nervous system of exposed organisms, exposure to toxic doses of pyrethroids causes incoordination, convulsions, and paralysis (Soderlund and Bloomquist, 1989).

The traizine class (atrazine (ATZ) as the AI) ranked third and is a chloro-S-triazine compound used as a selective pre-emergence and post-emergence herbicide for the control of broad leaved weeds in a variety of agricultural crops, as well as in forestry and for non-selective weed control on non-crop areas (US-EPA, 1994). It is the one of the widely used herbicides of the triazine group.

Hence, the widespread use and easy accessibility of atrazine and its residues have contaminated not only plants, soil, water and cultivated ground, but also agricultural products (Purcell *et al.*, 2001). Various *in-vitro* studies have shown the ability of ATZ to induce genetic damage in human and animal (Ribas *et al.*, 1995). Although, ATZ is classified by the WHO as a pesticide unlikely to present acute hazard in normal use (IPCS, 1999), the toxicity associated with atrazine ranges from hormone-disrupting effects to carcinogenic effects in animals and possibly in humans. However, recent investigations have demonstrated that the presence of atrazine may cause sublethal effects such as induction of xenobiotic metabolizing systems (Kannan *et al.*, 1994) and may influence the toxicity of other xenobiotics (Nerin *et al.*, 1996).

Dichloride ranking fourth with the percentage frequency of (3.80) is of the OC class and have been identified as one of the major classes of environmental contaminants through human activities resulting in its widespread distribution throughout various terrestrial and aquatic ecosystems (Herrera *et al*., 1996). Organochlorine pesticides (OCPs) which, historically, have proven to be most resistant to degradation and had the widest production, use and release characteristics belong to persistent organic pollutants (POPs) with halogenated hydrocarbons. Their presence in the environment has caused serious concerns by the government and researchers because they are chemically stable, have high lipid solubility and toxic to humans and animals (Bouwman *et al*., 1990). This has raised toxicological concerns for both wildlife and mankind, based on historical and ongoing trends in the use of OCPs and Abdullah *et al*. (1997) recognized the necessity for continual monitoring and surveillance of these substances in natural surroundings. OCPs have been considered as 'endocrine disrupting chemicals' and carcinogenic substances (Lemaire *et al*., 2004). OC insecticides are potentially toxic, highly persistent and resistant to biodegradation and it readily accumulates in human body tissues, causing a variety of health hazards (Sankar *et al*., 2006).

Most of the AIs used for the pesticides formulation such as atrazine and dichloride have been banned because they are known to be POPs with hazardous effects on and the environment. However, these pesticides were freely available in the open markets for the farmers to purchase. This confirms that the pesticides regulation policy in the state is poorly implemented, as reported for Nigeria as a whole by Osibanjo (2001).

The restriction and ban in the use of OC pesticides because of their detrimental effect on biodiversity led to a rise as stated by Walker (2014) in the use of another group of less persistent but highly toxic organic pollutants known as organophosphates (OP). Although not reflected in current material-safety data sheets, OP has been listed recently by International Agency for Research on Cancer as a probable class 2A human carcinogen (IARC, 2015). Unfortunately, these too has either been banned or restricted in a number of countries due to its potential carcinogenicity and ability to act as an endocrine disruptor at environmentally relevant and sub-lethal levels (Thongprakaisang *et al*., 2013).

Besides the drift of pesticides to non target areas, other forms of exposure to these AIs and their residues as cited by (Mancini *et al*., 2005) could be from the division of labour practiced in the communities with the women involved in weeding, harvesting and planting while various roles played by the children involve assisting in fetching water to prepare pesticide solutions or help in purchasing pesticides from local shops, poor storage either in the room, house or in the store where foodstuffs are kept thereby exposing users and non-users, especially children, to hazards (Tijani, 2006). Packaged pesticide containers regrettable are washed and either reused by pesticide users for food or water storage, sold to interested buyers or left carelessly at application site. Unfortunately, even with thorough washing, some of these pesticide containers still retain traces of the pesticides. All these pose serious health hazards to pesticide users, their families, posing serious risks to nearby streams, animal food, child health and the entire biodiversity in general (Ajayi and Akinnifesi, 2007; Tijani, 2006).

Other active ingredients recorded in the study area even though they have low percentage frequency, if not monitored or controlled could pose serious harm to biodiversity in future.

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Table 1: Commonly used pesticides in Nasarawa State

Serial number	Pesticide trade name	Pesticide type	Pesticide class	Active ingredient	Frequency	% frequency
1	Tackle	Herbicide	Aromatic acid	Acifluorfen	1	1.27
2	Touch down	Herbicide	Organophosphate	Glyphosate	16	20.25
3	Extra force	Herbicide	Triazine	Atrazine	4	5.06
4	Primextra	Herbicide	Triazine	Atrazine	2	2.53
5	Clear weed	Herbicide	Organophosphate	Glyphosate	3	3.80
6	Force up	Herbicide	Organophosphate	Glyphosate	4	5.06
7	Guard force	Herbicide	Urea	Nicosulfuron	1	1.27
8	Weed burner	Herbicide	Organophosphate	Glyphosate	4	5.06
9	Wipe out	Herbicide	Organophosphate	Glyphosate	2	2.53
10	Buta force	Herbicide	Acetanilide	Butachlor	1	1.27
11	Ultrasate	Herbicide	Organophosphate	Glyphosate	2	2.53
12	Sarosate	Herbicide	Organophosphate	Glyphosate	2	2.53
13	Wipe off	Herbicide	Organophosphate	Glyphosate	4	5.06
14	Uproot	Herbicide	Pyridine	Triclopyr and 2,4- D ester	2	2.53
15	Bret-P-20	Herbicide	Organochlorine	Dichloride	3	3.80
16	Delsate	Herbicide	Organophosphate	Glyphosate	1	1.27
17	Baygon	Insecticide	Pyrethroid	Cyfluthrin	4	5.06
18	Raid	Insecticide	Pyrethroid	Deltamethrine	8	10.03
19	Rambo	Insecticide	Pyrethroid	Alletrin	8	10.03
20	Sheltox	Insecticide	Organophosphate	Vapona	7	8.86
Total					**79**	**100**

Source: Field survey, 2018.

Conclusion and Recommendation

Pesticides usage must be safe for the environment, animals and humans. However, many factors affect their safety. Some of these factors include: low literacy level, which makes it difficult for the user to read or follow instruction, lack of training in pesticide usage, ignorance about potential dangers of pesticides to health and environment, inappropriate mixing and application method, over application, poor regulation and easy availability of hazardous pesticides, and poor practices (lack of personal protective equipment). To curtail environmental contaminants both in the terrestrial and aquatic ecosystems, there should be continual monitoring and surveillance of these substances in natural surroundings to forestall consequent physiological, biochemical and behavioural disorders.

The increase use of glyphosate in the study area could directly or indirectly contaminate the environment thereby posing as a threat to humans, terrestrial and aquatic animals.

The following mitigating measures are therefore recommended:

Regulatory and adequate monitoring policies that can provide adequate extension and advisory services to pesticide distributors on the range of pesticide products available and their uses and handling are recommended. This may improve the quality of pesticide and customer services that are available to the farmers in the community.

Government should intensify efforts aimed at registering and controlling distribution of pesticides and banning hazardous ones. This could be achieved through strict enforcement of existing regulation and monitoring policies.

Also, government should make newer, less toxic chemical pesticides more readily available to the farmers in ready to use packages.

In addition, pesticide manufacturers should be instructed and compelled to exhibit pesticide instructions and warning labels in the language commonly understood by the farmers and other end users, and also to package products in containers that are not attractive for subsequent re-use according to the International Code of Conduct on the Distribution and Use of Pesticides.

Finally, research into best management practices, such as using vegetation buffers or timing applications to avoid exposure to non target organisms, or development of formulations that are less likely to be transported into nearby streams and rivers should be conducted.

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