Status of Exposure of Bio-Systems to Restricted Aluminium Phosphide Pesticide in Kano State, Nigeria

Adejumo Isaac Oluseun1*, Ologhobo Anthony Durojaiye2, Adedeji Israel Ajibade3, Ogunjimi Sunday Idowu4

1Department of Animal Science, Landmark University, P.M.B. 1001, Omu-Aran, Kwara State, Nigeria
2Department of Animal Science, University of Ibadan, Ibadan, Nigeria
3Department of Agricultural Economics and Extension, Landmark University, Omu-Aran, Nigeria
4Department of Agricultural Economics and Extension, Federal University, Oye-Ekiti, Nigeria
*Corresponding Author: Email: smogisaac@gmail.com

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Abstract. Insect pests are one of the major organisms that are responsible for reduction in quality, germination potential and quantity of maize grains as well as seeds in storage. The aim of this study was to assess the types, sources of chemicals used to preserve maize in Nigeria as well as to ascertain the technical know-how of handling these chemicals among maize merchants. The study was conducted in Kano State of Nigeria. Four local government areas which are Kura, Rogo, Garun-Malan, and Rano were selected at random from the state and from the each local government areas, two villages were selected at random. Fifty respondents were chosen at random from the two villages to make a total of 200 respondents in all. Information on the most commonly used maize preservative chemicals were obtained through structured questionnaires. The result of the survey indicated that the mean age ranged between 46-49%, modal age (38-56%), respondents with no formal education (19-40%), those with primary school education, quaranic education, secondary school and tertiary education ranged between 37-42%, 0-13%, 7-16%, and 10-20% respectively. Majority of the respondents are male (77-88%). The most commonly used maize storage pesticide was aluminium phosphide (42-52%). Lack of formal education among maize farmers/merchants is majorly responsible for misuse of pesticides in the study areas.

Keywords: bio-system, exposure, Nigeria, pesticide, survey

1. INTRODUCTION

Maize grain losses in particular have been said to contribute to food insecurity and low farm income. The effect of post-harvest losses as one of the critical constraints to food security among farmers across Africa cannot be over-emphasised (Owusu, 2001; Owusu et al., 2007). Insect pests are one of the major organisms that are responsible for reduction in quality, germination potential and quantity of maize grains/seeds in storage (Olakojo and Akinlosotu, 2004). Larger grain borers (Prostephanus truncatus), grain weevils (Sitophilus spp.), and Angoumois grain moth (Sitotroga cerealella) are the most important stored cereal pests in Africa are (Phiri and Otieno, 2008; Abate et al., 2000). Between 40 and 100% losses of agricultural produce had been reported without chemical treatment at household levels in Malawi (Denning et al., 2009) while about 45% of the total production of rice and cocoa were lost without the use of pesticides (Tijani, 2006). As a mean of safeguarding agricultural produce from such enormous losses the use of pesticides becomes a necessary step towards ensuring food security. Synthetic pesticides have been reported to provide effective control when used correctly. The major chemical classes of pesticide in existence are organochlorines, carbamates, pyrethroids, and organophosphates (Ogah and Coker, 2012). The use of pesticides will not only keep off the pests but also assist to keep the quality of the produce. The use of agrochemicals has been observed as a mainstay of agriculture across the globe as a result of the benefits it offers (Olabode et al., 2011). The benefits include reduction of drudgery, timely and efficient weed control, effective pest control and enhancement of the shelf life of agricultural produce. Pesticides are also used in public health as well as in other areas for the control of pests and disease vectors (Ogah and Coker, 2012). However, use of pesticides often leads to residue in foods. When used, pesticides could contaminate the environment and accumulate in the food chain (Ogah and Coker, 2012), thereby posing a potential threat to human health as well as the
Adejumo et al.
Status of Exposure of Bio-Systems to Restricted Aluminium Phosphide Pesticide in Kano State, Nigeria

environment when not properly used (Kishi, 2005). In developing countries, more than 3 million people have suffered severe acute pesticide poisoning (Larson, 2003, WHO, 2001), warranting the increasing concern about misuse of pesticides in such countries. Despite this increasing concern, few studies have been carried out on the subject to investigate pesticide sustainability (Oluwole and Cheke, 2009) as well as the potential effects this could have on non-target organisms.

2. MATERIALS AND METHODS

2.1. Data sources and sampling techniques

The study was conducted in Kano State of Nigeria. The state was purposively selected due to the prevalence farming households in the state. Kano is a major centre for the production and export of agricultural products. Agriculture is one of the most important pillars of the State’s economy with about 75% of the total working population engaged directly or indirectly in this activity. The principal food crops cultivated in abundance are Millet, Cowpeas, Sorghum, Maize and Rice for local consumption while Groundnuts and Cotton are produced for export and industrial purposes (http://en.wikipedia.org/wiki/Kano_State). It is known to have 44 local government areas. Four local government areas were randomly selected, after which two villages were randomly chosen from each local government areas. The local government areas where the study was conducted are: Kura, Rogo, Garun-Mallam, and Rano. From the two villages selected, a total of 50 households were chosen. The total sample size was 200 households. The study was conducted in four Local Government Areas in the state. The survey was carried out with the use of a structured questionnaire, though its administration process was participatory in nature. The questionnaires were designed in English but the interview was conducted in Hausa due to the majority of the respondents in Hausa due to the high rate of illiteracy among the sampled respondents. Willingness of the majority of the respondents and the involvement of Hausa-speaking enumerators facilitated the success of the study. Each interview took about 20 minutes. The structured questionnaires were designed to collect information on demographic information, commonly used maize storage chemicals, frequency of use, level of education, attitude to chemical labels and challenges to the use of storage chemicals. In order to avoid being bias in response to the question being asked, the questionnaires used were design to avoid leading questions. For example, ‘what do you do with chemically-treated grains?’ was asked in order to find out whether the respondent sells, consumes or feeds chemically-treated grains to animals immediately.

2.2. Methods of data analysis

Descriptive statistics including frequency, charts and percentages was used to analyse the data obtained.

3. RESULTS AND DISCUSSIONS

Tables 1 and 2 show demographic information of respondents in the study areas and commonly used maize storage pesticides in the study areas respectively. Figures 1, 2, and 3 show frequency of use of maize storage pesticides in the study areas, proportions of respondents’ consultation of changed agents before using pesticides and mode of storage of pesticide-treated maize grains respectively.

3.1. Rano Local Government Area of Kano State

The mean and modal ages of the respondents interviewed in Rano Local Government Area of Kano State were 49 and 48 years. The majority (77%) of the respondents were male. 30 percent of the respondents had no former education, 37% had primary school education, 2% had secondary school education, while 7% and 17% had quaranic and tertiary education (Table 1). The most commonly used was maize storage chemical was aluminium phosphide (48%), followed by actellic dust (18%), Devec EC (1%) was the least used (Table 2). The average number of AIP tablets used was 2 per 100 kg of maize grains. 71 percent of the storage of the respondents was frequent users of storage chemicals, 9% were occasional users, while 11% used none (Figure 1).

3.2. Garun-Mallam Local Government Area of Kano State

Of all the respondents (maize farmers and traders) in the study area, 88% were male. The mean and modal ages for the respondents were 46 and 38 years respectively, 19 percent had no former education, 39% had primary school education, 13% had quranic education, 9% had secondary school education, while 20% had tertiary education (Table 1). The most commonly used was maize storage chemical was aluminium phosphide (42%), followed by store force (13%), while the least used was Rambo Rambo (3%) (Table 2). The average number of AIP tablets used was 2 per 100 kg of maize grains. 80 percent were used maize storage chemicals while 9% used none, 71% were frequent users while 9% were occasional users (Figure 1).
Table 1: Demographic information of respondents in Kano State, Nigeria

<table>
<thead>
<tr>
<th>Local Government Area</th>
<th>Mean Age</th>
<th>Modal Age</th>
<th>No Formal Education (%)</th>
<th>Primary school education (%)</th>
<th>Secondary school education (%)</th>
<th>Quranic education (%)</th>
<th>Tertiary education (%)</th>
<th>Male (%)</th>
<th>Female (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kura</td>
<td>48.00</td>
<td>56.00</td>
<td>22.00</td>
<td>42.00</td>
<td>16.00</td>
<td>9.00</td>
<td>11.00</td>
<td>88.00</td>
<td>12.00</td>
</tr>
<tr>
<td>Rogo</td>
<td>47.00</td>
<td>46.00</td>
<td>40.00</td>
<td>40.00</td>
<td>10.00</td>
<td>0.00</td>
<td>10.00</td>
<td>87.00</td>
<td>13.00</td>
</tr>
<tr>
<td>Garun-Mallam</td>
<td>46.00</td>
<td>38.00</td>
<td>19.00</td>
<td>39.00</td>
<td>9.00</td>
<td>13.00</td>
<td>20.00</td>
<td>88.00</td>
<td>12.00</td>
</tr>
<tr>
<td>Rano</td>
<td>49.00</td>
<td>48.00</td>
<td>30.00</td>
<td>37.00</td>
<td>7.00</td>
<td>9.00</td>
<td>17.00</td>
<td>77.00</td>
<td>23.00</td>
</tr>
</tbody>
</table>

Table 2: Commonly used maize storage pesticides in Kano State, Nigeria

<table>
<thead>
<tr>
<th>Storage pesticide</th>
<th>Rano</th>
<th>Garun-Mallam</th>
<th>Kura</th>
<th>Rogo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum phosphide (%)</td>
<td>48</td>
<td>42</td>
<td>52</td>
<td>44</td>
</tr>
<tr>
<td>Pirimiphos methyl (%)</td>
<td>18</td>
<td>15</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Pirimiphos methyl 25%EC (%)</td>
<td>8</td>
<td>13</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Dichlorvos (%)</td>
<td>9</td>
<td>8</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Aldrin (%)</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Mefonoxam (%)</td>
<td>6</td>
<td>8</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Permethrin (%)</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Devee* (%)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Nil (%)</td>
<td>9</td>
<td>12</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Unidentified (%)</td>
<td>0</td>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Average tablet of AIP used/100 kg of grains</td>
<td>2.00</td>
<td>2.00</td>
<td>3.00</td>
<td>2.00</td>
</tr>
</tbody>
</table>

*active ingredient not identified

3.3 Kura Local Government Area of Kano State

88 percent of the farmers and traders interviewed were male. The mean and modal ages for the respondents were 48 and 56 years respectively. 22 percent of the respondents had no former education, 42% had primary school education, 9% had quranic education while 16% and 11% had secondary school and tertiary education respectively (Table 1). 63 percent of the respondents who had no formal education, primary or quranic education had difficulty in reading and understanding the instructions on the storage chemical containers. Of all the maize storage chemicals used by the respondents in the study area, the most commonly used was aluminium phosphide (52%), followed by store force (14%), while the least used was apron star (3%). 5 percent of the respondents did not know the name of the storage chemical they use, while 11% used none (Table 2). The average number of AIP tablets used was 3 per 100 kg of maize grains. In terms of frequency of use, 60% were frequent users of storage chemicals while 20% were occasional users (Figure 1).

3.4. Rogo Local Government Area of Kano State

The majority (87%) of the farmers and traders interviewed in Rogo Local Government Area were male. The mean and modal ages for the respondents were 47 and 46 years respectively. Of all the respondents 40 percent of the respondents had no former education, 40% had primary school education, while 10% of the respondents had secondary school and tertiary education each (Table 1). 80 percent of the respondents could not read and understand the chemical labels on the container due to no formal education or primary education. aluminium phosphide (44%) was the most commonly used maize storage chemicals used by the respondents in the study area, followed by store force (11%), and DDVP (11%). 6 percent of the respondents did not know the name of the storage chemical they use (Table 2). The average number of AIP tablets used was 2 per 100 kg of maize
grains. Of the 84% user of maize storage chemicals in the study area, 60% were frequent users of storage chemicals while 24% were occasional users (Figure 1).

3.5. Discussion

The results of the study revealed that larger percentage of the maize farmers and traders in the study areas were male, with little or no formal education. Misuse of pesticides in the study areas seems to be inevitable, since agricultural use of pesticides is left in the hands of illiterates. The result of this study emphasizes the point made by Okoedo-Okojie and Onomolease (2009) who earlier reported that education has a significant role to play on the promotion, transfer, and adoption of knowledge that boost agriculture. However, misuse of pesticides is not limited to only pesticide applicators, as respondents indicated adulteration of chemicals as one major constraint to their use of pesticides.

The result of the study showed that some of the respondents did not even know the name of the storage chemicals they used, some (4%) sold the chemically-treated grains immediately or whenever they needed money to buy farm inputs, while some fed them to cattle and horses. Vast majority of the farmers and traders (82%) indicated that they stored chemically treated grains in perforated sacks in their residential houses, where children and other innocent family members could be exposed to pesticide hazards. The result of this study is similar to the findings of Adejumo et al. (2014). This confirms that pesticide application and regulation policy in the study areas are poorly implemented. Majority of the respondents (78%) indicated that they did not obtain instruction regarding the use of pesticide from agricultural change agents.

Aluminium phosphide (AlP) is a colourless and flammable pesticide (Turkey and Togar, 2013). It is considered toxic in various organs like heart, liver and kidney of mammals (Okolie et al., 2004). Aluminium phosphide is an inorganic compound with the empirical formula AlP. Its trade names include fumtoxin, L-fume, phostoxin, justoxin, forcetoxin, gastoxin, quik-fume. The basic manufacturers include Bernardo Chemical Ltd., Inc, Degesch America, Inc., Inventa Corporation, Midland Fumigant, Inc., and Pestcon Systems, Inc. The recommended maximum
residual limit of phosphine is given as 0.1mg/kg for animal feed (FAO/WHO, 1993; Bradshaw et al., 2006).

Aluminum phosphide is stable when protected from moisture, but the pure aluminum phosphide is not stable. Aluminum phosphide readily releases phosphine gas (the material with the pesticidal properties) upon contact with moisture from the air, water or acids (EPA, 1998). AIP is known to produce phosphine gas when it reacts with water or acid. Phosphine gas is a highly toxic gas, a mitochondrial poison that could interfere with oxidative phosphorylation and protein synthesis (Goswami et al., 1994). AIP has been reported to produce chromosome damage in agricultural workers (Turker et al., 2003; Perez et al., 2009). Lack of formal education affect the proper use of maize storage pesticides in the study areas, hence, maize merchants, consumers and livestock are likely to be exposed to food/feed poisoning through the sale of improperly treated maize grains. Having the understanding the most commonly used pesticide is fumigant, the environment may also be contaminated as a result of improper use of the pesticides in the study areas. The suggested high rate of death attributed to food poisoning in Nigeria may be due to the improper use of storage pesticides in Nigeria. (Njoku, 2008; Akunyili, 2010). Bogle et al. (2006) reported that 93 cases of AIP exposure were reported to the National Poisons Information Service (London) between January 1997 and June 2003, 8 of which was AIP ingestion, 57 phosphine gas inhalation, and 14 where the exposure route was unknown, resulting in 17 of the cases being asymptomatic, 33 had respiratory symptoms, while 27 had gastrointestinal symptoms. There was one death reported.

4. CONCLUSION

Education plays important roles in sustainable and improved agricultural production. Hence, proper education of farmers in Nigeria should not be taken with levity otherwise, the lives of the young and adults are not safe as they could be exposed to food poisoning without their consent, based on the amount of AIP used per 100 kg of grains as well as the mode of usage (inside in perforated sacks in residential buildings). Also, proper awareness of the dangers of the misuse of pesticides in Nigeria as well as other developing countries should be taken more serious, because non-target bio-systems are unduly exposed to restricted pesticides due to lack of proper education and awareness.

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Adejumo Isaac O. is a Ph.D candidate in Animal Nutrition and Feed Toxicology, Department of Animal Science, University of Ibadan, Nigeria. He is a lecturer in the Department of Animal Science, Landmark University, Omu-Aran, Kwara State, Nigeria. He is a registered animal scientist, as well as a member of other professional bodies.

Professor A.D. Ologhobo is a professor of Agricultural Biochemistry, Animal Nutrition and Feed Toxicology. He is currently the Head of Department, Department of Animal Science, University of Ibadan, Ibadan, Nigeria. He is a registered animal scientist and a member of several other professional bodies.

Adedeji Israel Ajibade is a production economist. He is a Ph.D candidate in the Department of Agricultural Economics, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. He is also lecturer in the Department of Agricultural Economics and Extension, Landmark University, Omu-Aran, Kwara State, Nigeria.

Dr Ogunjimi Sunday Idowu is an agricultural extension and rural sociologist. He is a lecturer in the Department of Agricultural Economics and Extension, Federal University Oye-Ekiti, Ekiti State, Nigeria. He is an author of many academic articles in local and international journals.