Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 03, pp. 27223-27227, March, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

THE POTENTIALS OF USING PLANT-DERIVED BOTANICALS AS BIO-ACTIVE PESTICIDES IN NIGERIA

*Longe, O. O.

Department of Crop, Soil and Environmental Sciences, Ekiti State University, Ado Ekiti, Nigeria

ARTICLE INFO

Article History:
Received 18th December, 2015
Received in revised form
20th January, 2016
Accepted 28th February, 2016
Published online 16th March, 2016

Key words:
Plant-derived botanicals,
Bio-active pesticides,
Insect pests.

ABSTRACT

Several reviews have shown that plant-derived pesticides have great potential for the natural control of pests, particularly in tropical countries like Nigeria. Many of these plant species, apart from being readily available, cheap and eco-friendly, possess one or more useful properties such as repellency, antifeedant, fast knock down, flushing action, bio-degradability, broad-spectrum of activity and ability to reduce insect resistance. These are unlike synthetic chemical pesticides that have high persistence in the soil after use, high cost of application, environmental pollution, toxic residues in food, high lethal effects on non-target organisms and direct toxicity to users. There has been a steady increase in recent times, in the use of plant-based products as a cheaper and ecologically safer means of controlling pests, especially in the tropics. In South Nigeria, rural farmers mix chilli pepper and wood ash of *Parkia biglobosa* (African locust bean), *Corymbia citrodora*. or *Azadirachta indica,* to control *Podagrica* sp.on okra plants, *Abelmoschus esculentus*. The natives in this area also use the mixture of *Chromolaena odorata* L. (siam weed) and *Ocimum gratissimum* L. *(basil)* leaf extracts to repel termites and soldier ants around their houses. Similarly, an admixture of water from fermented cassava (*Manihot esculentus* Crantz) tubers and bitter leaf (*Vernonia amygdelina* L.) has shown potency against tailor ants infesting local pear fruits and leaves. In storage pest control, a lot of work has been done to investigate the efficacy of powder, oil and juice extract of many botanical plants on the survival of various insect pests, such as *C. maculatus* and *S. zeamais*, with 100% control.

Citation: Longe, 2016. "The potentials of using plant-derived botanicals as bio-active pesticides in Nigeria", *International Journal of Current Research,* 8, (03), 27223-27227.

INTRODUCTION

The utilization of plant materials to protect field crops and stored commodities against insect attack has a long history. Prior to World War II, botanical pesticides were commonly used throughout the world to protect crops from pests and most especially insect pests. Many of the plant species concerned have also been used in traditional medicine by local communities. Leaves, roots, twigs and flowers have been admixed, as protectants, with various commodities in different parts of the world, particularly India, China and Africa. However, just before the war, a highly effective synthetic insecticide named, dichlorodiphenyltrichloroethane (DDT) an organochlorine insecticide was introduced which changed the trend of pest control worldwide. Other synthetic insecticides soon followed, which then quickly displaced botanicals in the market and greatly slowed the research trend and development of natural botanical compounds.

Corresponding author: Longe, O.O.
Department of Crop, Soil and Environmental Sciences, Ekiti State University, Ado Ekiti, Nigeria

Unfortunately, these synthetic insecticides target a nervous system common to human and other animals, and can be toxic to fish and the environment. Furthermore, many of them persist for long periods and cause residual problems in food, water and the environment and, bio-concentrate in the tissues of invertebrates and vertebrates and, eventually move up the trophic level thereby capable of causing toxicity related problems at each trophic level (Coats, 1994). Some synthetic pesticides have also been suspected to be carcinogenic and toxic to mammals even at low doses. Environmental pollution, pest resurgence, pest resistance to pesticides, lethal effect to non-target organisms in the agro-ecosystem and direct toxicity to users have all been attendant consequences of the development and use of synthetic pesticides (Prakash *et al.,* 2008). Awareness of the potential health and environmental hazards of many synthetic pesticides and the observation of more and more resistance of pests to synthetic pesticides have once more stimulated interest in plant derived pesticides (Isman, 2006).

An overview of the use of botanicals for pests control by farmers

A survey of plants used as pesticides was recently conducted in some villages, in which several farmers were interviewed individually. Different species of plants were found being used by the farmers as grain storage protectants, and the most common being among them being Chromoleana odorata (Siam weed), Azadirachta indica (neem) and Capsicum annum (Chilli pepper). Insecticidal activity against insects other than those of stored grain pests were also reported. The survey found that while over a quarter of the farmers used plant protectants in some form or the other. Poor quality tobacco leaves, those unfit for sale, were used by some of the farmers to protect their stored grain. It is clear that there is a dearth of information concerning actual use of plants by farmers. There are, without doubt, very many plants used as grain protectants by rural communities, which have yet to be identified. If local production of plant protectants is to be encouraged then it is essential that farm practices are recorded and more information acquired. However, it may prove to be impractical to record treatment application rates and methods because these may vary considerably. Very little information has been acquired which describes how farmers apply plant protectants; this applies to the three studies mentioned above. This is because farmers are either unable to describe the procedures with sufficient accuracy or their accounts vary considerably from one farmer to another.

Thus research programmes which pursue optimal methods of using plant protectants on grain must strive to develop the most cost-effective procedures for application as well as identifying active components. Where plants are used as storage protectants they are almost always applied to control insect pests. In storage pest control, a lot of work has been done to investigate the efficacy of powder of C. *frutescens* (Chill pepper) on the survival of insect pest including S. *zeamais* and C. *maculatus*. Adedire and Ajayi (1996) recorded 100% mortality of S. zeamais treated with C. *frutescens* 28 days after treatment on maize grains. Similarly, Asawalam *et al*. (2007) reported C. *frutescens* to have shown 75% mortality of S. *zeamais* 33 days after treatment. The results indicated that C. *frutescens* effectively protected maize grains against weevil attack. It exhibited fumigant mode of action since it has a characteristic pungent smell and pepperish in nature. A. cepa and P. *guineense* were tested and found to be effective in controlling insect pests of stored grains. Adedire and Ajayi (1996) reported 48.75% adult mortality of S. zeamais treated with A. cepa 28 days post treatment and 100% mortality when treated with P. *guineense* after 3 days post treatment. Abdullahi and Muhammad (2004) assessed the toxic potentials of some plants powders on survival and development of C. *maculatus* and recorded 100% mortality 8 days after treatment when P. *guineense* (West African pepper) was used at the rate of 1 g/ 50 g cowpea seeds. Asawalam *et al*. (2007) also recorded 79% (highest) mortality of S. zeamais treated with P. *guineense* on maize grains. Okonkwo and Okoye (1996) reported that P. *guineense* contains piperine and chavicine, which are insecticidal, while Lale (1992) included piperidine and alkaloids as the major active components in P. *guineense* seeds. An investigation was conducted to compare the products of A. sativum and C. citratus in the control of C. *maculatus* on stored cowpea grains by Oparaeke and Dike (1996). They found that both of the plant powders showed effectiveness by exhibiting 100% mortality 7 days after treatment. Danjumma *et al*. (2009) also found that A. sativum is effective in killing adult S .zeamais and recorded 96.67% mortality at the rate of 2.0 g/ 50 g maize grains. The mode of action of these two plant powders may be due to fumigant and anti-feedant effects. A. sativum powder contains allicin as the major constituent. Leaf powder of N. tabacum was also found to be effective in killing adult insect pests. Asawalam *et al*. (2007) reported 71% mortality of S. zeamais treated with this plant powder on maize grains. It was also reported that 2.0 g of N. tabacum applied in 50 g of maize grains resulted in 100.00% mortality of S. zeamais (Danjumma *et al.,* 2009). N. tabacum was reported to possess contact, stomach and respiratory poisoning properties attributed to the active constituent nicotine (Stoll, 1988). Terpenes isolated from Rutales have been shown as effective against stored grain pest (Omar *et al.,* 2007 Contact, fumigant and antifeedant effects of a range of essential oil constituents (Cinnamaldehyde, and - pinene) against Maize weevil (Sitophilus zeamais) and the red flour beetle (Tribolium castaneum) have been demonstrated (Huang and Ho, 1998; Huang *et al.,* 1998). Various methodologies have been used to determine the effectiveness of plant materials and their extracts. Almost all trials were laboratory-based and of short duration and therefore do not necessarily reflect responses which would be observed under real farm conditions; laboratory experiments cannot account for variables such as fluctuating ambient climatic conditions, the effects of store design and structure and the multitude of pest specie. Although laboratory investigations can provide useful indicators regarding efficacy of plant products it is essential that trials are also carried out in the field, on farms.

Advantages of Biopesticides over synthetics chemicals

Plant-derived pesticides have many advantages when compared with synthetics pesticides. In addition to the above listed efficacies, here are some specific advantages of botanicals;

- Botanical pesticides generally possess low mammalian toxicity thereby creating little or no health hazards to humans, livestock and the environment.
- Some are edible and used as food or medicinal purposes
- There is practically no risk of developing pest resistance to plant-derived pesticides if prepared in natural forms as they are made up of a mixture of active principles.
- There are no adverse effects on plant growth, seed viability and cooking quality of the grains after use..
- They are less hazardous to non-target organisms
- Botanical have no incidence of pest resistance to treatment
- They are bio-degradable
- They are less expensive (most especially in their crude form) and easily available because of their natural occurrence
- Farmers can easily and cheaply grow and produce these plant materials for their use unlike synthetics which its cost is generally on the high side.

Lists of sample plants with Pesticidal properties

Scientific Name	Common Name	Family Name	Part(s) Used
Acorus calamus L	Sweet flag	Acoraceae	Rhizomes
Ageratum conyzoides	Goat weed	Asteraceae	Leaves
Alium cepa	Onion	Amaryllidaceae	Bulbs
Allium sativum L	Garlic	Amaryllidaceae	Bulbs
Anacardium occidentale L.	Cashew	Anacardiaceae	Nut Shell Oil
Annona muricata	Soursop	Annonaceae	Leaves/Seed
Artemisia vulgaris L.	Wormwood	Asteraceae	Leaves
Azadirachta indica	Neem	Meliaceae	Seeds/leaves
Citrus sinensis L	Orange	Rutaceae	Seeds
Capsicum frutenscens L	Chilli	Solanaceae	Fruits
Corymbia citrodora F	Lemon scented gum	Myrtaceae	Flowers/leaves
Cymbopogon citratus S	Lemon grass	Poaceae	Stem
Jatropha curcas L	Physic nut	Euphobiaceae	Stem peels/leaves
Monodora myristica	Nutmeg	Annonaceae	Leaves
Nicotiana tabacum L	Tobacco	Solanaceae	Leaves
Piper guineense L	West African pepper	Piperaceae	Seeds

Some demerits and major challenges on the use of Biopesticides

- The challenges in Nigeria on formulation of botanical pesticides revolve around policy and environment; which touches on structures and regulations (Olaifa, 2009). The Universities and Research Institutes need better attention than the government presently gives. Nigeria scientists cannot stay in Nigeria and develop practical usage of botanical pesticides, due government policies and bureaucracies; yet such Nigerians can go to places like Cameroon and Uganda develop them (Coulibaly *et al.,* 2002; Kawuki *et al.,* 2005).
- The developed nations of the world are not really interested in botanical pesticides because they know that they do not have the raw materials for them. They do not want to to create another OPEC type of situation where they will be held to ransom for the supply of the needed raw materials for their production.

Other challenges include:

- The use of some natural compounds in the protection of grains requires them to be applied in high concentrations, which often exceeds the threshold of acceptable flavor to the consumer (Nazer *et al.,* 2005).
- The discovery process for botanical pesticides is more cumbersome as compared to their synthetic counterparts,
- Sheer negligence due to influx of synthetic pesticides.;
- Raw material may not be readily available.
- Problem of quality control, potency variations, standardization of extraction methods, shelf-life and specific bio-efficacy all of which combined to pose more treat on the effective adoption of botanicals as a competent pest control measure.

Formulation studies and potentials for commercial production of Bio-active pesticides

Formulation Studies: Nigeria has a lot of potentials for the formulation of bio-active botanical pesticides. Like many African countries, Nigeria has longstanding indigenous knowledge and local practices of using plants and plant extracts for mitigating pests (Olaifa, 2009). Nigeria has a good number of scientists spread over 100 universities and several agricultural research institutes; that if properly mobilized, are capable of making a turnaround in the development of botanical pesticides. Nigeria can develop her own pesticide industry based on bio-active plants, to take advantage of her economic and technological advantage. There is the need to train our young entomologists and biochemists in the specialized area of pesticide toxicology, for the formulation of bio-active pesticides.

Potential for commercial Production

Only products from four plant species have found widespread use as insecticides. Rotenone is a compound produced by *Derris* and *Lonchocarpus* species and was widely used during the early part of the century in England as an insecticide. *Derris elliptica* and *D. malaccensis* occur quite commonly in East Africa and China where the roots have been used as fish poison. Rotenone has substituted for pyrethrins in mosquito coils but its production has declined because of the much cheaper synthetic analogues, which are available (FAO., 1999). The second plant product is pyrethrum which has been produced commercially for more than 150 years. Although precise production figures are not available these have been estimated at 15 000-25 000 tonnes per annum (Kis-Tamás, 1990). More than 90 percent of the world's production comes from five countries: Kenya, Tanzania, Equador, Rwanda and Japan. Small quantities are utilised locally, particularly for mosquito control, but most are exported, in the form of dried flower heads containing 0.9 percent active ingredient or a concentrated extract containing 20 percent, to the United States of America, Europe and Australia. Pyrethrins are not used for grain protection. Neem is the only other plant, which has been the subject of significant commercialisation. In the Indian sub-content, neem extracts have been sold for very long periods of time by small-scale producers who serving relatively small markets. In recent years, as neem has increased in popularity the number of commercial suppliers of neem-based products in India has mushroomed (FAO., 1999). As a pesticide neem has restricted use because of its limited shelf life. Several western companies have begun to market neem products. Another plant that has been exploited commercially is *Acorus calamus*. A preparation containing 70 percent β -asarone, is marketed by Alrich of Germany From the evidence available to date the most promising bio-active plant materials for consideration as future grain protectants are *Azadirachta*, *Acorus, Chenopodium, Eucalyptus, Mentha, Ocimum, Piper* and *Tetradenia* together with vegetable oils from various sources. Before any bio-active plant pesticide can be commercialized, even for local production and consumption, it must be shown to be safe to use. Standardised laboratory tests need to be undertaken, examining the residual effects of these materials over six to twelve months duration against key insect species. These include *A. obtectus* and *C. maculatus* on pulses, *Sitophilus spp.* and *P. truncatus* on maize, and *Sitophilus* spp., *R. dominica* and Lepidopteran species on rice and wheat. The residual effects of the materials on the commodities could then be critically evaluated and compared for both repellent/antifeedant action and also contact adult mortality and reduction in F1 production. Feasibility studies on the local availability of appropriate extraction and application techniques will also be necessary.

DISCUSSION

Toxicity of bio-pesticides, either through fumigation or through direct contact, is usually the major action of plant powders against adult insects in the laboratory tests (Rajapakse, 2006). 0.5g of *A. indica* seed powder admixed with 20g maize grains caused 100% mortality in adult S. oryzae within three days (Ivbijaro, 1983). A powder of *C. sinensis* peels was found to be effective on the mortality of *Z. subfasciatus* (Dawit and Bekelle, 2010). They recorded 67% mortality of *Z. subfasciatus* when the beans were treated with 15g of sun dried powder of orange peel, and also there was a significant reduction in progeny mergence of the insect. This mode of action could be attributed to stomach poison since the weevils feed directly on the grains (Adedire and Ajayi, 1996). The effect of leaf powder of *J. curcas* on the mortality of *C. maculatus* was assessed by Umar (2008) and a percentage mortality of 8.4% for seeds treated with the leaf powder at the rate of 2.0g/ 20g of cowpea seeds was recorded which could be due to presence of hydrogen cyanide and curcin (toxalbumin) (Duke, 1985).

In terms of Repellency, Parugrug and Roxas (2008) worked on the insecticidal action of five plants against maize weevil, S. zeamais and found that at 24 hours of exposure, ratings of 7.00 (High Repellency) were recorded in powdered *A. indica* and carbaryl, whereas *Cymbopogon citratus* (lemon grass) had repellency rating of 5.80 (Moderate Repellency) at the same hour. S. sinensis peel powder was also found to be effective in repelling *Z. subfasciatus* on (*phaseolus vulgaris*) haricot bean seeds (Dawit and Bekelle, 2010). If the plant powders reduce adult longevity and fitness, the number of eggs laid will often be lower as well. Moreover, the mechanical effect of large quantities of powders themselves could have an effect on oviposition (Rajapakse, 2006). Plant powders often reduce the emergence of adult beetles from the seed (Rajapakse, 2006). Some of these plant powders were found to have effect on adult emergence of insect pests attacking stored grains such as cowpea and maize. Abdullahi and Muhammad (2004) recorded 40.9% adult emergence of *C. maculatus on cowpea treated with P. guineense, while Asawalam and Emosairue (2006) and Asawalam et al*. (2007) recorded 10.0% and 5.0% adult emergence of *S. zeamais* on maize treated with the same plant powder respectively. *C. frutescens* and N. tabacum were also reported to affect adult emergence of *S. zeamais* on maize grains revealing 10.0% and 12.0% emergence respectively (Asawalam *et al.,* 2007).

Conclusion

Many synthetic insecticides have been found effective against stored product pests but proved to be hazardous to men and domestic animals. In addition, the risk of developing insect resistance and the high cost-benefit ratio of synthetic insecticide have posed enough evidence for the urgent need to find alternative insecticides. There should be more concentrated efforts on the search for active natural products from plants as alternatives to conventional insecticides since most researches have proved that plant materials and local traditional methods are much safer than chemical insecticides. The above listed constraints are very surmountable if the needed commitment is given both individually and collectively. Hence, there is urgent need to go into researches on some of these mentioned botanicals, to facilitate further proves and invariably adoptions for both internal use and extension. There is the need for Nigeria to develop her own botanical pesticide industry and train the young entomologists and biochemists in the specialized area of pesticide toxicology, for the formulation of bio-active pesticides.

REFERENCES

Abdullahi, Y. M. and Muhammad, S. 2004. Assessment of the toxic potentials of some Plant powders on survival and Development of *Callosobruchus maculatus*. *African Journal of Biotechnology*, 3(1): 60 – 62

Adedire, C. O. and Ajayi, T. S. 1996. Assessment of the insecticidal Properties of Some Plant Extracts as Grain Protectants against the Maize weevil, *Sitophilus zeamais* Motschulsky. *Nigerian Journal of Entomology*, 13: 93 – 101

Asawalam, E. F. and Emosairue, S. O. 2006. Comparative efficacy of *Piper guineense* (Schum and Thonn) and Pirimiphos methyl as Poison against *Sitophilus zeamais* (Motsch.. *Electronic Journal of Environmental, Agricultural and Food Chemistry*, 5(5): 1536 – 1545.

Asawalam, E. F., Emosairue, S. O., Ekeleme, F. and Wokocha, R. C. 2007. Insecticidal Effects of Powdered Parts of Eight Nigerian Plant species Against Maize weevil, *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae. *Electronic Journal of Environmental, Agricultural and Food Chemistry*, 6(11): 2526 – 2533

Bell, C. H. and Wilson, S. M. 1995. Phosphine tolerance and resistance in *Trogoderma granarium* Everts (Coleoptera: Dermestidae. *Journal of Stored Product Research*, 31: 199 – 205.

Chaudhry, M. Q. 1995. Molecular biological approaches in studying the genes that confer phosphine-resistance in insects. *Journal of Cellular Biochemistry*, 21(Suppl.): 215.

Coulibaly, O., Mbila, D., Sonwa, D.J., Adesina,A. and Bakala, J., 2002. Responding to economic crisis in Sub-Saharan Africa: new farmer-developed pest management strategies in cocoa-based plantations in Southern Cameroon. Integrated Pest Management Review 7: 165-172.

Danjumma, B. J., Majeed, Q., Manga, S. B., Yahaya, A., Dike, M. C. and Bamaiyi, L. 2009. Effect of Some Plant Powders in the Control of Sitophilus zeamais Motsch (Coleoptera: Curculionidae) Infestation on Maize Grains. *American-Eurasian Journal of Scientific Research*, 4(4): 313 – 316.

Dawit, K. Z. and Bekelle, J. 2010. Evaluation of Orange Peel Citrus sinensis (L.) as a Source of Repellent, Toxicant and Protectant against *Zabrotes subfasciatus* (Coleoptera: Bruchidae. C.N.C.S. Makelle University, 2(1): 61 – 75.

Duke, J. A. 1985. Handbook of Medicinal Herbs. Florida, USA, CRC Press Inc, 677pp. FAO., 1999. The use of spices and medicinals as bioactive protectants for grains, by Peter G., Caroline M., Melanie D., Alex F., Jenny E. and Irene G. FAO Agricultural Services Bulletin No. 137.

Ivbijaro, M. F. 1983. Toxicity of Neem Seed, Azadirachta indica A. Juss, to Sitophilus oryzae (L.) in Stored Maize. Protection Ecology, 5: 353 – 357.

Jilani, G., Khan, M. J. and Ghiasuddin, A. L. 1988. Studies on insecticidal activity of some indigenous plant materials against the pulse weevil, *Callosobruchus analis* F. Pakistan Kis-Tamas**,** A**.** 1990. *Study on the production possibilities of botanical pesticides in developing African countries.* UNIDO, Vienna, Austria.

Olaifa, J.I. 2009. Formulation of bio-active plants for plant and animal production in Nigeria: Realities and challenges. Keynote address at Humbolt Kellog/5th SAAT Annual Conference on Formulation of Medicinal Plants in Plants and Animal production in Nigeria. Monday 20th-21st April, 2009. Federal University of Technology, Akure.

Rajapakse, R.H.S. 2006. Effect of five botanicals as protectants of greengram against the pulse beetle *Callosobruchus maculatus.* Fujii K., ed. Bruchids and Legumes*: Economics, Ecology and Coevolution, 85-90. Kluwer Academic Publishers*, the Netherlands.

Selase, G., A. and Getu, E. 2009. Evaluation of botanical plants against Zabrotes subfasciatus (Boheman) (Coleoptera: Bruchidae) in stored haricot beans under laboratory condition. *African Journal of Agricultural Research*, 4(10): 1073 – 1079.

****