



ISSUES SURROUNDING THE USE OF PLANT-DERIVED PESTICIDES (BOTANICALS) IN PEST MANAGEMENT IN NIGERIA

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ABSTRACT

The use of plant-derived pesticides against crop pests both on the field and during post-harvest is now emerging as one of the important means to be used in crop protection under an Integrated Pest Management framework following the multiple global challenges created by synthetic chemical pesticides. This paper outlines the place of botanicals in crop pest management and enumerated the constraints/limitations to their development which among others includes; raw material availability, quality control, potency variations, standardization of extraction methods, shelf-life and bioefficacy. Concerted efforts towards the development and application of known botanicals, screening of more botanicals to isolate new and novel bioactive molecules, relaxing the requirements for registration of botanicals, intensive researches on the various means of employing plant-derived pesticides in crop protection and large-scale production of plants with bioactive molecules amidst others are recommended as a way forward for Nigeria.

KEYWORDS: Plant-derived pesticides, botanicals, synthetic pyrethroids.

INTRODUCTION

Pests are one of the serious challenges facing crop production today. Although there are many ways to reduce or kill pests, every pest management method has certain drawbacks. The use of plants and plants-derived products to control pests in developing world is well known and, before the discovery of synthetic pesticides, plants or plant-derived products were the only pest managing agents available (Owen, 2004). Traditional botanical pest control methods treated the pests' habitats with leaves, stems, seed, roots or plant structures known to kill or repel the pests (Golob and Webley, 1980). Sometimes plant materials were chopped or ground into powders or liquids and applied on crops as crop protectants and, some of these traditional botanical pest control methods are still used today, especially by farmers not yet heavily influenced by modern technology. For self defense purposes, many plants generate chemicals that are toxic to pests and, since these naturally occurring pesticides are derived from plants, they are called Botanical pesticides or Botanicals. Prior to World war II, Botanical pesticides were commonly used throughout the world to protect crops from pests and most especially insects pests. 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. Because this chemical was cheaper, easier to apply and most importantly, long-lasting; other synthetic insecticides followed shortly which then quickly displaced botanicals in the market and greatly slowed the research and

development of natural botanical compounds. 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 coupled with the fact that the industry may not have enough resources to continually develop and supply the market with new products precisely when needed to replace the old have stimulated interest in plant-derived pesticides (Isman, 2006).

Plant-derived pesticides in pest management

Plant-derived pesticides have great potential for the natural control of pests, particularly in tropical countries like Nigeria. The number of plant species possessing pesticidal substances is enormous. There are over 2,000 recorded plant species with known pesticidal properties (Jacobson, 1989).

Plant-derived pesticides have many advantages when compared with synthetics. Some of these are;

- i. Botanical pesticides generally possess low mammalian toxicity thereby creating little or no health hazards and environmental pollution.
- ii. 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.
- iii. There are no adverse effects on plant growth, seed viability and cooking quality of the grains.
- iv. They are less hazardous to non-target organisms and pest resistance has not yet been reported except in synthetic pyrethroid.
- v. Botanical pesticides are less expensive (most especially in their crude form) and easily available because of their natural occurrence (Chen, *et al.*, 1995, Tripathy and Dubey, 2004, Prakash *et al.*, 2008).

In spite of relatively small previous efforts in the development of botanical pesticides, they have made large impact in the area of insecticides and, minor successes have been achieved in fungicides, herbicides, rodenticides, nematocides and molluscicides (Duke, 1990). The knowledge of pests to which a particular plant is resistant to have provided useful information for predicting what pest may be controlled by secondary metabolites derived from a particular plant species. This approach has led to the discovery of several commercial pesticides such as pyrethroid insecticides. Botanicals have been classified into insecticides, fungicides, nematocides, molluscicides, herbicides and, rodenticides. These pesticides have variable mode of action. Some act as direct toxicants, sterilant while others act as antifeedant/repellent or behavior modifiers. The discovery process for botanical pesticides is more cumbersome as compared to synthetic counterparts, but the less environmental load caused by botanical pesticides makes them an attractive alternative. The complexity, limited environmental stability and low activity of many biocides from plants, compared with synthetic pesticides are discouraging. The complexity has again made the number of options that must be considered in discovery and development of a natural product as pesticides to be larger than for a synthetic pesticide. However, advances in Chemistry and Biotechnology are increasing the speed and ease with which man can discover and develop secondary compounds of plants as pesticides. All these advances coupled with increasing need and environmental pressures are greatly increasing the interest for the production of plant-derived pesticides.

Overview of plant based products used as insecticides

Although botanical insecticides may not always match synthetic insecticides in efficacy, the natural insecticides extracted from plants in their semi-purified form have slow releasing action and are prophylactic which make them however, amenable for adoption in Integrated Pest Management (IPM) programmes. Research findings have shown that plant-based products are doing and can do well as insecticides. For example, terpenes isolated from Rutales have been shown as effective against stored grain pest (Omar *et al.*, 2007). Essential oils of Cumin (*Cuminum cyminum*), Anise (*Pimpinella anisum*), Oregano

(*Origanum syriacum* var. *bevanii*) and Eucalyptus (*Eucalyptus camaldulensis*) were effective as fumigants against the cotton aphids (*Aphis gossypii*) and Carmine spider mite (*Tetranychus cinnabarinus*) (Tuni and Sahinkaya, 1998). Contact, fumigant and antifeedant effects of a range of essential oil constituents (Cinnamaldehyde, and α -pinene) against Maize weevil (*Sitophilus zeamais*) and the red flour beetle (*Tribolium castaneum*) have been demonstrated (Huang and Ho, 1998; Huang *et al.*, 1998). In the United States, exemption from registration of some insecticides based on plant essential oils has greatly facilitated their commercial development (Quarles, 1996). Production of Botanical insecticide containing 3% toosendanin (an antifeedant limonoid from the bark of *Melia toosendan* and *Melia azederach*) as active ingredient has already commenced in China (Koul, 2008).

Overview of plant-based products tried as fungicides

Pre-harvest losses due to fungal diseases in world crop production can amount to 11.8% or even higher in developing countries (Agrios, 1997). Most of the efforts in the past few years for the effective control of plant diseases have been focused on effective eradication or prevention through the development of synthetic chemical fungicides (Bajpai *et al.*, 2004). However, increasing worry over the environmental load caused by the presently used synthetic fungicides has necessitated the search for fungicides of biological origin due to their numerous advantages over the synthetics. The body of scientific literature documenting bioactivity of plant derivatives to pests, fungi inclusive continues to expand rapidly for example; monoterpene isolated from essential oil of *Carum carvi* exhibited fungicidal activity in protecting potato tubers from rotting (Anonymous, 1994). The essential and methanol extract and derived fraction of *Metasequoia glytostroboides* showed great potential of antifungal activity against *Fusarium oxysporum*, *Fusarium solani* and *Sclerotinia sclerotiorum* (Bajpai *et al.*, 2007). α -cedrol isolated from essential oil of *Thuja orientalis* possess antifungal activity against *Alternaria alternate* (Guleria *et al.*, 2008a). Volatile oils from *Eucalyptus citriodora* showed complete inhibition of *Rhizoctonia solani* and *Helminthosporium oryzae* at 10 and 20ppm, respectively (Ramazani *et al.*, 2002). Guleria *et al.*, (2008b) reported toxicity of *Solanum xanthocarpum* leaf extract against *Alternaria brassicae*. Neem formulations have been used for controlling the damping off of brinjal and chilli (Bohra *et al.*, 2006). Aqueous leaf extracts of *Datura metel* and *Lawsonia inermis*, known for their high activity against *Phaeoisariopsis personata*, completely inhibited the germination of urediniospores of *Puccinia arachidis* in vitro. Scientific literature on the activity of plant-derived pesticides acting as herbicides, nematocides, molluscicides and rodenticides are quite encouraging.

Constraints to the development and use of plant-derived pesticides in Nigeria

1. Inadequate field-based data and demonstrations on the efficacy, application and cost-effectiveness of plant-derived pesticides in pest control. Field data are needed to determine the optimum quantity of plant product required to attain the farmers' desired result.

2. Plant-derived pesticides generally have slow pest-killing effect when compared with synthetics. This therefore calls for more frequent applications to attain the desired pest control.
3. The quality and efficacy of plant-derived pesticides varies as extraction and formulation procedures are not standardized and this again makes it difficult to allow for comparison.
4. The regulatory protocols being designed, keeping in view the synthetic chemicals, constitute a barrier to the commercialization of potentially useful botanicals mainly because of the presence of complex mixtures of active ingredients in them.
5. Available research data on the efficacy of plant-derived pesticides are generated from plant species growing under different climatic and agroecological environment without considering the effect of these variations to the efficacy of plant-products on its pest control ability.
6. Most tested plant-derived pesticides have not been officially recommended for use.
7. Lack of organized market and promotion system for plant-derived pesticides leading to the unavailability of the products in the market.
8. The perception by most, especially the progressive farmers that the use of plant-derived pesticides is conservative.

Promoting the development and use of plant-derived pesticides in Nigeria

1. Efforts should be directed towards the development and application of known botanicals.
2. The screening of more plants to isolate new and novel bioactive molecules which have pest controlling properties and/or which can serve as guides for the development of eco-friendly pesticides should be looked into.
3. Registration requirements for botanicals need to be modified to accommodate the environmentally benign botanical pesticides. A clue need to be drawn from India where botanical pesticides applicants are allowed to market their new products for upto a period of five (5) years before final registration (Isman, 2006). However, the registration of botanicals made up of a single active ingredient should be discouraged as they are no more different from synthetics which are in most cases made up of a single active ingredient with its attendant risk of promoting pest resistance.
4. Researches into the use of plant derived pesticides as synergists/binders to synthetic pesticides to enhance their biological activities as pesticides should be encouraged in Nigeria. The mixture of Sesamum oil with permethrin dust and neem oil with DDT have been documented (Prakash *et al.*, 2008).
5. Researches into the efficacy of intercropping a biologically active plant/crop with the main crop in pest control should be explored in Nigeria. It has been documented that intercropping rocket salad, *Erica sativa* with mustard crop is known to reduce the incidences of mustard aphids and intercropping of marigold with tomato is found to minimize incidences of root-knot nematodes, *Meloidogyne incognita*.

6. Efforts should also be geared toward large scale production of plants with bioactive molecules to encourage the availability of raw material for plant-based pesticide production.

CONCLUSION

The potential of using plant materials as deterrent against pest in crops, on the field and during post-harvest period, is a study that is presently gaining acceptance as a result of the indiscriminate use of chemical pesticides which have given rise to many well-known problems, including genetic resistance of pest species, toxic residues in stored products, increasing costs of application, hazards from handling and environmental pollution. However, insufficient data and demonstrations on cost-effectiveness of plant derived pesticides under farm conditions, unavailability and where available; difficulty in accessing the botanicals, slow pest killing characteristic, variation in the quality of the products due to unavailability of standards for extracting and formulating biopesticides, the perception that using plant-based pesticides is conservative amidst others, are clogs in the wheel of development and use of plant derived pesticides in Nigeria.

The use of local resources for the manufacture of plant-derived pesticides, could make a developing country like Nigeria more independent of pesticide imports and furthermore, be of potential economic value. The need direct efforts towards development and application of known botanicals, screening of more botanicals to isolate new and novel bioactive molecules, relaxing the requirements for registration of botanicals, intensive researches in various means of recruiting plant-based pesticides in crop protection and large-scale production of plants with bioactive molecules are therefore, highly recommended.

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