

The Efficacy of Plant Oils as Green Pesticides in the Management of Field and Storage Pests.

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ABSTRACT:

Non-chemical materials that can be employed in the management of pests are referred to as green pesticides and include plant extracts, hormones, toxins of organic origin, microbials, entomophagous nematodes, secondary metabolites from micro-organisms, pheromones and genes used to transform crops to express resistance to pests as well as biodegradable synthetic and semi-synthetic products. Fixed plant oils extracted mechanically or chemically from the seeds of Neem, Castor oil, Moringa and Jatropha plants showed broad spectrum pesticidal activity against several insects and other members of the phylum Arthropoda. These fixed plant oils were thereafter transformed separately into emulsifiable concentrates by dissolving in organic solvents at the ratios of 95:5; 90:10; 80:20 and 75:25 oil/solvent respectively and thereafter, mixed with water at various concentrations to form their respective spray liquids. The three products namely the fixed plant oil, the emulsifiable concentrate and the spray liquid were pesticidal against a broad spectrum of insects and other arthropods and are characterized by ease of preparation, quick action, broad spectrum activity, absence of odour, long shelf life etc.

Key Words: Efficacy, Plant, Oils, Green, Pesticides

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INTRODUCTION:

Natural pesticides, both of microbial and plant origin, are yet to have impact in the market place in spite of, widespread public concern for the long-term health and environmental effects of synthetic pesticides, particularly in Europe and North America.

Bioinsecticides, dominated by *Bacillus thuringiensis*-based products and botanical insecticides, dominated by pyrethrum-based products, each commands little more than one percent of the global insecticide market (Isman, 2000). According to Isman and Machial (2006), green pesticide refers to all types of nature-oriented and beneficial pest

control materials that can contribute to reduce the pest population and increase food production. These types of pesticides are safe, eco-friendly and are more compatible with the environmental components than synthetic pesticides. This broad definition of green pesticides will include materials such as plant extracts, hormones, pheromones, toxins of organic origin, microbials, entomophagous nematodes, plant derived pesticides, secondary metabolites from micro-organisms, pheromones and genes used to transform crops to express resistance to pests as well as biodegradable synthetic and semi-synthetic products (Koul *et al.*, 2003; Koul, 2005; Dhaliwal and Koul, 2007; Koul, 2008).

Plant or vegetable oils are usually extracted mechanically or chemically from flowers, fruits, seeds or roots and are classed as fixed or fatty oils because they leave greasy spots on a filter paper and do not possess any appreciable vapour pressure. Hence, they are liquids at ordinary temperatures (Lale, 2002).

Many researchers have reported the effectiveness of fixed oils from the seeds of groundnut, palm kernel, coconut, neem etc. in protecting stored legumes from damage by bruchid and storage fungi (Hall and Harman, 1991; Huis van, 1991; Lale, 1995). Similarly, many fixed oils in

admixture with grains have been reported as effective protectants against some stored insect pests of cereals (Don-Pedro, 1989a; Kumar and Okoronkwo, 1991). Other workers have proven that coating legume seeds with oils extracted from plants is effective in bruchid damage control (Singh *et al.*, 1978; Pandey *et al.*, 1981; Messina and Renwick, 1983; Pereira, 1983; Zehrer, 1983; Jadhav and Jadhav, 1984; Naik and Numbre, 1984; Ivbijaro, 1984; Ivbijaro *et al.*, 1985; Rajapakse and van Emden, 1997). These oils are often available in village shops and are purchased by farmers in countries like Nigeria for use as seed protectants (Compton *et al.*, 1993).

The objectives of this study were to assess the potential of fixed plant oils as green pesticides and to determine their broad spectrum activity against various types of field and storage insect pests.

MATERIALS & METHODS:

Location:

Field surveys were carried out in the research fields of Crop Protection Department, Bayero University, Kano (11° 58' N and 08° 26' E) and that of the Institute of Agricultural Research, Samaru, Zaria (11° 12' N and 07° 37' E) during both dry as well as wet season of 2011/2012 while Laboratory studies were carried out in the Entomology Research unit of the

Department of Crop Protection, Bayero University, Kano.

Source of materials.

Various fixed plant oils were obtained from their respective milled seeds using the Soxlet extraction facility at the Department of Animal Science, Bayero University, Kano. Petroleum ether was used as the extraction solvent, while the organic solvents- Petroleum ether, Xylene, Alcohol, Kerosene, Hexane were purchased from Ceeman Ventures Limited, Kano.

In this study, all organic solvents were assessed separately as diluents of the fixed plant oils at the ratios of 95:5; 90:10; 80:20 and 75:25 of oil/solvent in order to obtain the respective emulsifiable concentrate (EC). By serial dilutions, these were then mixed separately with water to produce various concentrations of spray liquids which were then sprayed on a wide range of both field as well as storage insects, arachnids, etc. The identities of insects collected were confirmed at the insect museum, Department of Crop Protection, Ahmadu Bello University, Zaria. The standard concentration level established during this study was 1.0 (% i.e. 5 ml of the EC was used to prepare a 50 cl spray liquid).

RESULTS AND DISCUSSION:

All the fixed plant oils and their derived emulsifiable concentrates as well as the spray liquids assessed in this study showed insecticidal properties against all the arthropods that were subjected to spraying or topical application.

Observations are as presented in Tables 1, 2, and 3. The efficacy of fixed plant oils as insecticides have been attributed to ovicidal effects of the oils, with adult emergence completely prevented while oviposition as well as adult longevity were reduced. Khalequzzman *et al.*, (2007) The mode of action of fixed plant oils as well as the derived emulsifiable concentrates and spray liquids could be by asphyxiation (physical action) whereby oil droplets act as physical barrier to respiration due to their clogging air passages (spiracles) on the insect body. This observation was also noted by Credland (1992) as well as Bryan and Cloyd (2001). Asphyxiation is a condition of severely deficient supply of oxygen to the body of living things that arises from being unable to breathe normally. This condition causes generalized hypoxia which primarily affects the tissues and organs and circumstances that can induce this condition include the constriction or obstruction of airways, or simple blockage from the presence of foreign materials or from being in environments where oxygen is not readily accessible (<http://en.wikipedia.org/wiki/Asphyxia>).

Insects generally respire by means of tracheal tubes which open to the outside as paired spiracles on each of the thoracic and abdominal segments. The most potent poisons act by preventing the combination of oxygen with haemoglobin during cellular respiration. This process, which is very fast tends to be the primary mode of action of all plant or vegetable oils

generally and being a physical action as well as a necessity of life, there is no exception to it and hence the broad spectrum activity nature of these oil materials. However, there could be

secondary action of the chemical constituents of these oil materials responsible for other modes of action such as toxicity and repellence by constituents (Don-Pedro, 1989b; 1990).

Table 1: List of plants oils assessed as green pesticides.

Common name	Scientific name	Plant habit	Family
Neem	<i>Azadirachta indica</i>	Tree	Meliaceae
Castor	<i>Ricinus communis</i>	Shrub	Euphorbiaceae
Physic plant	<i>Jatropha curcas</i>	Shrub	Euphorbiaceae
Thevetia	<i>Thevetia neriifolia</i>	Shrub	Apocynaceae
Water-melon	<i>Citrullus lanatus</i>	Herb	Cruciferae
Umbrella tree	<i>Terminalia catappa</i>	Tree	Verbenaceae
Melina	<i>Gmelina arborea</i>	Tree	Verbenaceae

Table 2: Some field insect pests of crops sprayed with plant oils, derived emulsifiable concentrates and spray liquids

Pest	Stage	Family	Order
<i>Aphis fabae</i>	Adult	Aphididae	Homoptera
<i>Clavigralla tomentosicollis</i>	Adult	Coreidae	Hemiptera
<i>Podagrica</i> sp	Adult	Pentatomidae	Hemiptera
Click beetle	Adult	Elateridae	Coleoptera
Blister beetle	Adult	Meloidae	Coleoptera
Thrips	Adult	Thripidae	Thysanoptera
<i>Microtermes</i> sp.	Adult	Rhinotermitidae	Isoptera
<i>Periplanata americana</i>	Adult	Blattidae	Orthoptera
Cricket	Adult	Gryllidae	Orthoptera
Mosquito	Adult	Culicidae	Diptera
Wasps	Adult	Vespidae	Hymenoptera
Cutworms	Larva	Noctuidae	Lepidoptera
<i>Helicoverpa armigera</i>	Larva	Noctuidae	Lepidoptera
<i>Apis mellifera</i>	Adult	Apidae	Hymenoptera
<i>Schistocerca gregaria</i>	Adult	Acrididae	Orthoptera
<i>Anoplocnemis curvipes</i>	Adult	Coriidae	Hemiptera

Table 3: Some storage pests sprayed with plant oils, derived emulsifiable concentrates and spray liquids.

Pest	Stage	Family	Order
<i>Callosobruchus maculatus</i>	Larva	Chrysomellidae	Coleoptera
<i>Sitophilus zeamais</i>	Adult	Curculionidae	Coleoptera
<i>Tribolium castaneum</i>	Adult	Tenebrionidae	Coleoptera
<i>Sitotroga cereallela</i>	Adult	Gelechiidae	Lepidoptera

CONCLUSION:

This study has confirmed the pesticidal properties of fixed plant oils as well as the potency of its derived emulsifiable concentrates and spray liquids. The study has also established the broad spectrum activity of fixed plant oils as well as the derived emulsifiable concentrates and spray liquids on insects generally as well as other arthropods, based on asphyxiation (physical action) as the mode of action.

RECOMMENDATIONS:

There is the immediate need for independent confirmation of these findings by other researchers across various research centres and institutions in the countries as well as outside. There is also the need for soil scientists to come in to ascertain the suitability of the meal cakes obtained as by-products of oil extraction from seeds as organic fertilizers while agronomists need to determine the optimum levels of this new class of fertilizers.

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