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Success Stories of Eco-friendly Organically Acceptable Insecticides as Natural Products Discovery

Muhammad Sarwar*, Muhammad Salman

Nuclear Institute for Food &Agriculture (NIFA), Tarnab, Peshawar, Pakistan

Abstract

This publication contains a set of facts about specific organic insecticides that can be used in organic plant protection systems and provides background information about the type of material, how it is made, how it works, and types of pests it can control. Owing to the emphasis during these days on environment and health issues, growers aresearching for ways to produce healthy cropswhile still protecting the fragile ecosystems in their ownland. These goals may seem to conflict wheninsects or other pests invading the crops. There aretimes when the growers may resort to pesticides tocontrol a pest invasion, but there are also many nonchemical alternatives. Some of these alternatives are ina category known as organic controls using organic insecticides possessing carbon atoms includingbotanicals, diatomaceous earth, kaolin clay, pesticide soap, detergents and horticulture oils. By definition, an organic insecticide is a substance that performs a biocidal action on insects due to nature of its chemical structure. Botanicalinsecticides include nicotine from tobacco, pyrethrum from chrysanthemums, derris from cabbage, rotenone from beans, sabadilla from lilies, ryania from ryania shrub, limonene from citrus peel, and neem from tropical neem tree. Most organic insecticides, other than nicotine, have low levels of toxicity in mammals and birds, and create few adverse environmental effects. Least toxic insecticides that are labelled as natural or organic products are necessarily harmless to humans or environment, many are quite safe to use and some have hazards associated with them. Organic insecticides are usually inherently less toxic in contrast to broad spectrum conventional pesticides that may affect organisms like different birds, insects and mammals. Organic insecticides generally affect only target pest and closely related organisms, often are effective in very small quantities, decompose quickly thereby resulting in lower exposures and largely avoiding pollution problems. When used as a component of integrated pest management, organic insecticides can greatly decrease use of conventional pesticides, while crop yields remain high. Preventive, cultural, mechanical, and physical methodsmust be first choice for pest control, and conditions for use of biological material must bedocumented in organic system plan. To use biopesticides effectively and safely, however, users need to know a great deal about managing pests, must carefully follow all label directions concerning any limitations, and wear protective clothing whenever using any insecticide because even those products that are nontoxic can be irritating to skin, eyes and mucous membranes.

Keywords

Organic Insecticides, Organic Farming, Diatomaceous Earth, Kaolin Clay, Soap, Oil

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1. Introduction

Large quantities of pesticides (including herbicides, insecticides and fungicides) are used around the world. Pesticides are substances or a mixture of substances, of chemical or biological origin, used by human society to mitigate or repel pests such as bacteria, nematodes, insects, mites, mollusks, birds, rodents, and other organisms that

* Corresponding author
E-mail address: drmsarwar64@yahoo.com (M. Sarwar)

affect food production or human health. These usually act by disrupting some components of the pest's life processes to kill or inactivate them. Synthetic chemical insecticides provide many benefits to food production and human health, but these also pose some hazards. Insecticide contamination of soils and waterways affects our health; environment and access to overseas markets owing to many of our international markets want to know whether their food is produced in an environmentally responsible way. In many instances, alternative methods of insect's management offer adequate levels of pest control and pose fewer hazards. One such alternative is the use of organic insecticidesthat contain microorganisms or their by-products. Organic insecticides are especially valuable because their toxicity to non-target animals and humans is extremely low. Compared to other commonly used insecticides, these are safe for both the pesticide users and consumers of treated crops (Ekstrom, 1994; Addor, 1995; Rand, 1995; Bohmart, 1997; Sarwar, 2015 a; 2015 b; 2015).

Organic farming also known as natural, ecological or common sense farming is a system of growing healthyplants by encouraging healthy soils, beneficial insects and birds. The philosophy includesthe way farmers treat the soil, design their farming and choose which plants to grow. It also includes how farmers decide which fertilizers to use and how tocontrol weeds and insect pests. Organic farmingavoids theuse of synthetically produced fertilizers, pesticides andlivestock feed additives. However, the term organicgardening has different meanings among differentindividuals, so a synthetically manufactured fertilizeror pesticide may be objectionable to one organicgardener, but acceptable to another (Balusu and Fadamiro, 2012). Phase out of the fumigant methyl bromide, restrictions on organophosphates, environmental problems with neonicotinoids and pyrethroids, pest resistance, and the exponential growth oforganic agriculture have created amarket for alternatives (Quarles, 2011 a; 2011 b). Naturally occurring microbials canbe used in organic production andhuman health risks with these are low. As anadded advantage, many pests arenot resistant to their effects. There are several natural (plant) insecticides that have been widely used, although compared with modern synthetics the plant substances are relatively weak. Insecticides possessing carbon atoms including insecticides from a plant or animal source that are on the list of organic materials review institutes are considered organics. One benefit of a plant insecticide is that many of them are biodegradable,and effective for a number of key pestsencountered in organic production,such as western flower thrips, twospotted mites, whiteflies, caterpillars, psyllids and pest beetles (Goettel et al., 2001).

2. Organic Chemical Pest Control

There is a large commercial market for effective, non-polluting organic materials that can be used in organic production. There is also a large market for low impact organic natural products to manage insect pests. Organic insecticidesare essentially nontoxic and non-pathogenic towildlife, humans and other organisms notclosely related to the target pest. The safetyoffered by organic insecticides is their greateststrength. The toxic action of these insecticides isoften specific to a single group or species ofinsects and this specificity means that mostorganic insecticides do not directly affectbeneficial insects (including predators orparasites) in treated areas. If necessary, most organic insecticides can beused in conjunction with synthetic chemicalinsecticides because in most cases the microbialproduct is not deactivated or damaged byresidues of conventional insecticides. Because their residues present no hazards tohumans or otheranimals, organic insecticidescan be applied even when a crop is almost readyfor harvest. In some cases, the pathogenic microorganismscan become established in a pest population orits habitat and provide control during subsequentpest generations or seasons.Because a single organic insecticide is toxicto only a specific species or group of insects,each application may control only a portion ofthe pests present in a field, garden, or lawn. Ifother types of pests are present in the treated area, they will survive and may continue to cause damage (Weinzierl et al., 2005; Brian et al., 2013).

3. Types of Organic Insecticides

Pesticides are any substance or mixture of substances that kill pests and this definition includes bothorganic and conventional pesticides. When focus is on organic farming, make sure that every materialschosen is an organically approved one, have organic certification and usually havea specific logo or identifier on the label. There are a number of natural materials available and some work quite well. In general, non-synthetic substances donot have much residual activity and may need to be used more frequentlythan synthetic pesticides. Individual product label can tell to farmershow often to apply the material at the plants or gardens (Silcox and Roth, 1994; Casida and Quistad, 1995). Efficacy of organic substances is summarized in the beneath text based on trials data:-

3.1. Antibiotic Insecticides

Antibiotic insecticides are produced by fermentation from actinomycetes (filamentous bacteria found in the soil that give it a sweet healthy smell) or streptomycetes (spinosad) and usually their activities are selective to individual groups. Spinosad is composed of spinosyns A and D, which issubstance, produced by aerobic fermentation of the actinomycete species *Saccharopolysoraspinosa* found in soil samples. It is a fast-acting, somewhat broad-spectrum material that acts on insect primarily through ingestion or by direct contact with a spray droplet or a newly treated surface. It affects the nervous system of the insect, causing loss of muscle control. Continuous activation of motor neurons causes insects to die of exhaustion within 1-2 days. Foliar applications of spinosad are not highly systemic in plants, although some movement into leaf tissue has been demonstrated. The addition of a penetrating surfactant increases absorption by tissues and activity on pests that mine leaves. Abamectin is an acaricide and also shows activity against some thrips, while use of spinosad shows activity against certain Lepidoptera larvae and thrips (Salgado, 1997; Thompson et al., 2000).

3.2. Insecticidal Soapsand Detergents

The liquid dishwashing soap is almostalways means detergent, which is chemicallyunlike to soap. Real soap is technically a salt,resulting from a reaction between an acid (fat)and an alkali (lye). Soap, often listed on labels as 'potassium salts of fatty acids, is insecticidal substance. Detergents, on the other hand, help to suffocateinsects, but are used more in sprays as aspreader or sticker to break surface tensionbetween the spray droplets and plant parts forbetter adherence and coverage. The differencebetween soap and detergent is often ignored, andif used as a wetting agent, perhaps it doesnotmatter whether farmers use soap or detergent.However, as an insecticide against aphids and many other sucking insects, as well as some other pests, only true soap can provide control. Insecticidal soaps evidently kill insect pests by penetrating the insect's outer coat cuticle orentering the respiratory system and causing cell damage or disruption.Avoid using of homemade soap sprays, particularly those with household detergents because these soaps have either not been tested or found to contain ingredients that actually harm plants(Imai et al., 1995; Lawrence, 2007).

3.3. Horticulture Oils

Mostly, oils are petroleum-based products that alsocontain certain fatty acids which form layers onplant parts to smother insects or provide amechanical barrier to prevent damage. There aretwo kinds of oils, growing season (summer) anddormant that refers to the time of year theapplication is made. As a general rule, some common examples of oils include for normal dormant use or summer use on vegetables, greenhouse ornamentals,flower and foliage plants, some fruits and nut trees, somefield crops, berries, grapes, olives, citrus, shade trees, field ornamentals, evergreen, some shrubs and indoor oroutdoor uses. Generally, rules for using oilsinclude wear a mask, coat the leaves, stems and ground, treat test plants first and look for damage, spray at the right time, do not mix chemicals and use at low rates. However, these treatments are sold undermany different brand and trade names, and always read the label of a product to see products formulated for use against the particular insect targeted tocontrol. Some oils control egg and immature formsof pests only;however, possible phytotoxicity onivy, ferns and houseplants may result. Oils are widely used to control the egg stage of various mites and insects by preventing the normal exchange of gases through the egg surface or interfering with the egg structure. When used against other stages of insects and mites, oils can block the respiratorysystem, causing suffocation or breakdown of the outside tissue (cuticle) of the insect or mite. Secondary toxicity mechanisms include penetrating and degrading ofarthropod tissues and fumigant effects of volatile oil components.Horticultural mineral oils are highly refined narrow distillation range oils, their phytotoxicity problems are mainly due to sunlight oxidising unsaturated hydrocarbons, and show direct toxicity by asphyxiating small insects and also behavioural effects in reducing oviposition by some lepidopterans. In most cases there is a relatively narrow window when the target is susceptible, the volume of spray used is critical as good coverage is essential, no reported cases of resistance developing in target pest species, and arerelatively non-toxic to predators and parasites (Ebbon, 2002).

3.4. Botanicals

Botanicals are insecticides derived and extracted from plants. These are broad spectrum pesticides, can be extremely effective if used properly and have low environmental persistence (Rosenthal and Berenbaum, 1991; Miller and Uetz, 1998; Copping, 2001; Sarwar, 2015 d).

3.4.1. Old Botanicals

In general, although these are broad-spectrum insecticides of moderate toxicity and persistence, they rarely bioaccumulate or cause major environmental impacts, but most are not persistent and do not bioaccumulate in animals or have significant environmental impacts. Botanicalinsecticides include nicotine from tobacco, pyrethrum from chrysanthemum, derris from cabbage, rotenone from beans, sabadilla from lilies, ryania from the ryania shrub, calotropis,and neem from the tropical neem tree. Most botanicals, other than nicotine, have low levels of toxicity in mammals and birds and create few adverse environmental effects. Pyrethrins, from dried chrysanthemum-type flowers, work well against many insects, especiallythe soft-bodied types. Rotenone, from the roots of several tropical plants, is probably the mosteffective generalpurpose natural insecticide. Used as a spray or a dust, it kills a widerange of insects, such as caterpillars, aphids and a number of beetles. Rotenone is sometimes combined with a pyrethrin under different trade names, and this is very effective against pests.

3.4.2. Newer Botanicals

In recent years, new classes of insecticides have been marketed, none of which are persistent or bioaccumulate and have few effects on mammals, but are may be very toxic to aquatic invertebrates. They include citrus, neem azadirachtin, garlic, hot pepper derivatives, and limonene from citrus peel.These plants are commonly found in all villages; about 1 kg of leaves from each plant is taken, powdered and then ground into a paste to be mixed in water.The mixture is then diluted in 5 litres of water and left undisturbed for 5 days. When required for using, about 500 ml of this concentration is diluted in 10 litres of water and sprayed over the plants. The ideal time for spraying these botanicals is during 6 am to 8.30 am and between 4 pm and 6.30 pm. Depending upon the soil, crop and other climatic factors, the concentration can be raised or lowered, and applicators can contact their nearby organic farmers who are using these products for guidelines regarding the concentration.

3.4.3. Preparation of Ginger-Garlic Extract

Another tried and a proven mixture used is ginger-garlic extract. About 1 gm of ginger and garlic each, 2gm of green chilli and 5 litres of water are taken. The garlic, ginger and green chilli are ground into a paste and mixed with water. After 10 days the mixture is filtered and used, and the prescribed quantity is about 500 ml of this solution diluted in 10 litres of water which can be sprayed over the plants.Both the above botanicals have been found effective in controlling leaf roller, thrips, mealy bugs, fruit, stem and bark borers, hairy caterpillar and aphids. Even if a farmer is not convinced about the benefits of organic inputs, he can continue to grow his crops using chemicals, but at the same time he can set aside a small portion in his field to grow the same crop using organic inputs. By doing so he can find out for himself the cost benefit ratio that itself can convince him about its efficacy.

3.4.4. Reparation of Calotropis, Moringa and Datura Extracts

One kg of calotropis leaves is crushed with mortar-pestle; add one litter of water to this paste, filter and 10 litres of water is added before spraying. The calotropis solution is active against insect pests and acts as a repellent and antifeedent. About 200 g of leaves and flowers of moringa are ground with 250 ml of water to make it into a paste. Filter it, and add water to make final volume to 10 litters. Stir well with a suitable emulsifier (soap solution).One kg of Datura leaves are cut into small pieces and then ground with 250 ml of water to make a paste. Then filter through the cotton cloth with another 250 ml of water and dilute in 5 litres of water. Datura seed can also be used and this solution is active against insect pests, diseases and mites etc. Importantly, the solutions prepared here can be mixed well with soap solution at the rate of 10 g/1 litre of extract before spraying. It is recommended that the application or spraying of all the botanical pesticides should be carried out only in the late afternoon of the day (Sarwar, 2015 e).

3.4.5. Oil and Detergent Sprays

For preparing oil and detergent sprays,recipe is, mix 1 tablespoon of dishwashingdetergent with 1 cup of cooking oil. This is the stocksolution and in the nextstep mix 1 to 1.5 teaspoons of the stocksolution with each cup of water. For a gallon of spray,this amounts to 5 to 8 tablespoons of stock solutionper gallon of water. Other recipe is, use 2 to 4 tablespoons of dishwashingdetergent and 5 tablespoons of vegetable oil pergallon of water.For using oil and detergent sprays on any plants, cut oil amount in half if foliage is very tender and stock solutions should not be stored for more than a few days.Oils can also damage plants if used when temperatures are above 80 degrees F,but ifthesoap mix is increased to more than 2 tablespoons per gallon, test may be done for phytotoxicity (damage to the plant) by treating onlya small part of the plant before spraying the entireplant. Oil products can control a wide range of soft-bodied insects, such as aphids, mites, thrips,whiteflies, mealybugs, psyllids,and to control the corn earwormby applying a mix of plant oil and Bt directly into the silk channel of the pest earworm (Agnello, 2002; Koul et al., 2008).

3.4.6. Diatomaceous Earth

Diatomaceous earth is a dusty product composed of finely groundskeletons of fossil diatoms available in various formulations. Sharp edges of theground diatoms scratch the insect's outer body covering, and waxy or oily outerlayer of soft-bodied insects, which reportedly die eventually from dehydration. However, the diatomaceous earth is also categorizedand considered a mechanical barrier orrepellent because some insects will not crawl onor feed upon plant foliage sprinkled with it. Before buying or applying diatomaceous earth, farmers should read the label and look for theinsect control formulation, since some brandsare not labelled for vegetables, and applicator must wear a dust mask when applying diatomaceous earth to plants. It is considered apesticide, but it is non-toxic to birds and mammals, on the other hand diatomaceous earthcan be a disadvantage because it may also killbeneficial insects and it is lesseffective against pests in humid weather (Steven and Clydette, 1990; Sarwar, 2015 f).

3.4.7. Kaolin Clay

It is considered non-synthetic, and pests may be controlled through mechanical and physicalmethods, including non-synthetic controls such as repellents. Kaolin is naturally occurring clay that results from weathering of aluminous minerals, such asfeldspar, with kaolinite as its principal constituent. Kaolin is a common mineral,generally regarded as safe, used asan anti-caking agent in processed foods and an additive to cosmetics, toiletries, and healthproducts. It is also used as an inert carrier in some pesticides and enhances the performanceof some microbial products.For application as a plant protectant, kaolin is grounded and processed to reach a uniformparticle size. Applied in suspension in water, kaolin produces a dry white film layer ofinterlocking, microscopic particles on the surface of leaves, stems and fruits after evaporation ofthe water. This material has several modes of activity, acts as a physical barrier, prevents insects from reaching vulnerable plant tissue, and it acts as a repellent by creatingan unsuitable surface for feeding or egg-laying. It acts as a repellent by creatingan unsuitable surface for feeding or egg-laying. The uniform white film may also disrupt theinsect's host-finding capability by masking the colour of the plant tissue. Furthermore, particlesof kaolin act as an irritant to the insect. After landing on a treated surface, particles of kaolinbreak off and attach to the insect's body, triggering an excessive grooming response thatdistracts the pest. It has been shown to be effective against several orchard pests, including apple maggot, white apple leafhopper and pear psylla (Puterka et al., 2000; Larentzaki et al., 2008).

3.4.8. Pesticidal Soaps

Pesticidal soaps are potassium or ammonium salts of fatty acids and allowed for use as insecticide, miticide, algaecide, moss killer, and herbicide only forfarmstead maintenance such as roadways, ditches, etc., but not permitted on food crops or fallowfields. Ammonium soaps are permitted as animal repellents as long as there is no contact with edible portions of crop or with soil. Pesticide soap products work by disrupting the cuticle (skin) layer and suffocating soft-bodied insects. To be effective, the spray solution must contact and thoroughly cover thetargeted pest. Once the soap dries on the plant surface, insects and mites will not be affectedby the residue. But, soaps have little efficacy against insect eggs.Pesticide soap products are effective against some aphid, mealybug, whitefly mite and other soft-bodied species (Lawson and Weires, 1991; Liu et al., 1996).

4. Integrated Pest Management

Integrated Pest Management (IPM) is a combination of insect pests management techniques to reduce the need for pesticides, which relies on monitoring pests and pest's damage, and techniques include maintaining healthy plants that resist insects better, encouraging natural predators or parasites of pests, using non-chemical means to remove insects; and when using pesticides, selecting the one that is least toxic, most effective, most pest specific and has the least potential impact on the environment (Ware, 1994; Sarwar, 2012; 2013; 2015 g; 2015 h; 2015 i).

5. Conclusion

Although this publication provides background information on organic products, readers should consult product label for specific application directions and all insecticides should be used only in the manner specified on the product label. This also provides application guidelines for use and a description of the effects of each material on the environment and human health. In summary, organic pesticides provide an alternative to conventional pesticides in IPM programs, and many formulations have been approvedfor organic production. Organic insecticides offer effective alternativesfor the control of many insect pests. Their greateststrength is their safety, as these are essentiallynontoxic and non-pathogenic to animals and humans.Although not every insect pest problem can be controlledby the use of anorganic insecticide, these productscan be used successfully in place of more toxicinsecticides to control many farms and gardens pests, and several important field crop and forest insects.Because most of organic insecticides are effective against only a narrow range of pests and since these insecticides are vulnerable to rapid inactivationin the environment, users must properly identifytarget pests and plan the most effective application. But these same qualities mean that organicinsecticides can be used without undue risks ofhuman injury or environmental damage. Consequently, organic insecticides are likely tobecome increasingly important tools in insectmanagement.The pesticide information presented in this publication can beup-to-dated with federal and state regulations, and the user might be responsiblefor determining that the intended usage is consistent with the label of the product being used, use pesticides safely also read and follow brand directions. The information given herein is for learning purposes only and reference to commercial products or trade names is made with the understanding thatno discrimination is intended and no endorsement by the authors is implied.

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