

## Green Chemistry in Agricultural Pest Management Programmes

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### Abstract

The article deals with recommendation of plant products as eco-friendly alternative of synthetic pesticides in agricultural pest management programme and emphasizes plant based green pesticides as important component in achieving ever green revolution in view of their high efficacy and favourable safety profile.

**Keywords:** Plant products; Essential oils; Pest

Agriculture has been extremely crucial for survival of human and associated animals since very long. It is also the basis of economic growth, particularly in the developing countries. Tropical and subtropical zone act as epicentre of food production because these areas provide seat for growth of multiple crops annually. Agriculture in tropical and sub-tropical belt is normally associated with attack of several pests due to congenial environmental conditions which sometime leads to tremendous loss of produce, thereby, creating catastrophic condition followed by famine in the concern area [1]. The situation worsens if these incidents appear in an area maximally dependent on agriculture.

Both pre- harvesting and post-harvesting stages are affected by pest but the post-harvest stages are mainly concern with the attack of fungi, insects and rodents [2]. During storage rodents and insects mainly attack seed grains, fungi and bacteria attack variety of substances including both raw and processed food materials. The hot and humid environment exponentially increases the occurrence frequency of the aforementioned microbes. Microbial contamination not only quantitatively deteriorates the stored commodities but sometime they produce secondary metabolite which are extremely harmful. Aflatoxins are few of that kind of mycotoxins secreted by *Aspergillus flavus* and *Aspergillus parasiticus*. Aflatoxins are reported hepatotoxic, carcinogen and mutagen [3] and causes aflatoxicosis in human being. About 25% of the world crops and 4.5 billion of the world population are facing direct risk of aflatoxin contamination [4].

For minimizing crop impairment due to pests, several chemical means are available and they have been in use for last seven decades and their utilization increased following the discovery of BHC (Benzene hexachloride), DDT, chlorinated cyclodienes, carbamates and organophosphates. These chemical pesticides tremendously increased the crop production and helped in success of green revolution. However, such synthetic pesticides have raised serious environmental problems and created hormonal imbalance, polluted ground water, having role in ozone depletion [5] and induced resistance in pests such as use of benzimidazole group of fungicides developed resistance in fungus and complicated the disease control practices. In view of negative impact of synthetic pesticides we need some green alternative of the synthetic pesticides for the management of pests.

History suggests the best alternative i.e., plant based pesticides; supported by the use of locally available plants against pest which is mentioned in Bible [6]. In India, onion bulbs have been used as insect repellent during storage of grains and we should also underline the tremendous use of neem (*Azadirachta indica*) as pesticide historically. In China also use of botanical pesticides is an ancient practice such as use of *Melia azaderach* as antihelminthic, use of *Stemona* sp root extract against lice and *Artemisia* sp against mosquitoes [7]. Other than the historical use, these botanicals are eco-friendly [8], renewable, systemic in action, safe for human and non target organisms, present in nature for millions of years without any adverse effect and having diverse

biological effect, leading to minimum chance of resistance development in pests, make them a favourable substitute of synthetic pesticides.

Modern pesticide industry emphasizes the use of rotenone, pyrethrum and nicotine obtained from *Derris*, *Chrysanthemum* and *Nicotiana* respectively [9]. For centuries plants and insects have parallel pattern of evolution which made them interdependent. They communicate with each other through allelochemicals which exhibit different effects over insects such as repellent, antifeedant, oviposition deterrent, larvicidal or ovicidal effect. These allelochemicals are basically alkaloids, polyphenols, terpenes or isoprenoids [10]. Flavonoids obtained from *Calotropis procera* showed contact toxicity against *Callosobruchus chinensis* and ovicidal effect on bruchid eggs. Essential oils (EOs) of some plants belonging to family Lauraceae and Lamiaceae bear compounds such as eugenol, camphor, borneol, bornyl acetate, thymol and linalyl acetate. These compounds were found suitable as fumigant against adult of *Sitophilus oryzae*, *Tribolium castenium* and *Rhyzopertha dominica* which are common storage pest [11]. These plant products are potent antimicrobial also. Among different plant products, EOs of different plants have been reported efficacious to reduce the population of pests, biodeteriorating the post-harvest produce. A lot of reports are present on the antifungal and antibacterial properties of the EOs. Certain EOs such that *Ocimum sanctum*, *Mentha spicata*, *Rosemarium officinale*, *Apluda mutica*, *Cymbopogon citratus*, *Ceasulia axillaris* and *Piper betel* etc. have been reported to suppress aflatoxin production from *Aspergillus flavus*. Antioxdant property of these EOs is also useful in preventing lipid peroxidation of storage grains during storage which is a key factor for qualitative deterioration of stored grains and to minimize their shelf life.

Now a day's several plant based pesticides are available commercially for application in different areas such as carvone, derived from EO of *Carum carvi* and available with trade name of TALENT in the Netherland; a neem product with trade name SoluNeem™ containing azadirachtin and other bioactive component of neem and is highly effective as bio insecticide for field crops and vegetables; cinnamon oil based aphidicide/miticide/fungicide with trade name Cinnamite™ and Valero™ having cinnamaldehyde as active ingredient is also available [12]. Currently EcoSMART Technologies, an US based company,

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S No	Plant based pesticides	Source	Uses	Reference
1	Carvone	EO of <i>Carum carvi</i>	Antimicrobial, repellent	[1,14]
2	Neem, SoluNeem™	<i>Azadirachta indica</i>	Bio insecticide, Antibacterial	[6,15]
3	Rotenone	<i>Derris elliptica</i> <i>Lonchocarpus utilis</i> <i>Tephrosia</i> sp.	Insecticide, Piscicide	[6,16]
4	Pyrethrum	<i>Chrysanthemum cinerariaefolium</i>	Insecticide	[6,16]
5	Nicotine	<i>Nicotiana</i> sp.	Insecticide	[17]
6	Cinnamite™ and Valero™	EO of <i>Cinnamon</i> sp.	Aphidicide, miticide and fungicide	[12]
7	EcoPCO <sup>R</sup> and Bioganic™	Eugenol and 2-phenethyl propionate	Insecticide	[12]
8	Wasapower	Root extract of <i>Wasabia japonica</i>	Preservative	[13]
9	DMC Base Natural	50% EO from rosemary, sage, and citrus and 50% glycerol	Preservative	[19,20]
10	Sabadilla	Seeds of <i>Schoenocaulon officinale</i>	Insecticide	[6,18]

Table 1: Popular plant based pesticides and their uses.

developed aerosol and dust based insecticides comprised of mixture of EOs compounds such as eugenol and 2-phenethyl propionate with trade name EcoPCO<sup>R</sup> and Bioganic™. Some EO-based preservatives are also popular such as “DMC Base Natural” comprised of 50% EO from rosemary, sage, and citrus and 50% glycerol. Another formulation “Wasapower” a developed by Sekisui Plastics Co. Japan, is comprised of root extract of *Wasabia japonica* [13] (A list of popular plant based pesticides is given in Table 1).

A lot of plant based products have been formulated for application as pesticides in green management of plant pests. These pesticides also act as green alternative of toxic synthetic pesticides. In view of their diverse effects and multi-component nature, plant based green pesticides would be highly suitable in pest management programme particularly against those which have developed resistance for single component pesticides. The formulation process of the botanical pesticides are little bit costly but this can be overcome by different means such as mass cultivation of the active plants and increasing efficacy by microencapsulating the active component. However, the plant based green pesticides are recognised as important component in achieving ever green revolution in view of their high efficacy, eco-friendly nature and favourable safety profile.

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