Essential oils as an alternative role in pest management

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Abstract-Indiscriminateusage of pesticides and its impact in the environment in the long run has caused an alarming situation as the quality of the food crop are deteriorated, human health and non-target organism are being harmed continuously. Despite of the instant action the chemicals produced in management perspective we cannot overlook the other side of the story that it creates. Some pesticides can even remain in the soil for over 8 years while some has the ability to destroy the active physiological process of a cell causing a change in the stable functioning of cell division. These setbacks caused by the chemicals can be counteract through other Eco-friendly approaches such as Essential oils from various plat families. These oils have broad spectrum action, low toxicity to non-target organisms and efficiently manage many pests. Some oils exhibit different mode of actions these causes a delay in developing resistance to the pest on the contrary pests develops resistance to most of the synthetic chemicals when continuous application the chemicals are employed. Therefore, Essential oils can play a pivotal role in pest management as an alternative role to synthetic chemicals. Integrating essential oil as a component in IPM can result in satisfactory outcome with desired yield.

Key words:-Essential oils, Eco-friendly, chemicals, Pest management

Introduction-Essential oils are defined as oils which are volatile in nature and are characterized by emission of strong odors. They are the secondary metabolites of the plant known to have wide range of biological properties and occur in almost any part of the plant (seeds, leaves, trichomes etc.). They are obtained by distillation of the plant part and comprises of complex constituents. They are known to have 20-60 components of which are characterized into group of two distinct biosynthetical origins, terpenes and terpenoids forming the major group and the other major component as aromatic and aliphatic constituents (Pichersky *et al.,* 2006).For example, major component in *Origanum compactum* essential oil are carvacrol (30%) and thymol (27%), linalol (68%) *Coriandrum sativum*essential oil, α- and β-thuyone (57%) and camphor (24%) of*Artemisia herba-alba* essential oil, 1,8-cineole (50%) of the*Cinnamomum camphora* essential oil, a-phellandrene (36%) and limonene (31%) of leaf and carvone (58%) and limonene (37%) of seed Dill (*Anethum graveolens*) essential oil, menthol (59%) and menthone (19%) of Peppermint(*Mentha piperita*)essential oil. It may also be noted that composition of the same species can differ, for example Kouminki*et al*., 2007reported that in *Xylopia aethiopica* the main constituents were of α-pinene, β-pinene, 3-carene and terpinen-4-ol. WhileJirovetz *et al*., 2005revealed thesame plant were composed of α-pinene, terpinen-4-ol, sabinene, α-terpineol,1,8-cineole, myrtenol and kaurane.Essential oil plays a crucial role in crop protection as antibacterials, antivirals, antifungals, insecticides and also attracts insects to favor the dispersion of pollens and seeds.Essentialoilsare known to exhibit neurotoxic, citotoxic, phototoxic and mutagenic action in different organism, and it acts at multiple levels in the insects, thereby reducing the development of resistance (Libs and Salim, 2017).In recent years, a series of studies have revealed that essential oils (EOs) derived from plants have proven to be toxic to different pests (Dugassa *et al*. 2009,, Nerio *et al*., 2010, Kumar *et al*., 2012). Essential oils that exhibit insecticidal properties have broad action on affecting the target pest *viz.,* repellant, antifeedants, growth inhibitors, oviposition inhibitors and ovicides (Hussein *et al*., 2017). Around 2000 plant species are reported to possess insecticidal properties (Perez *et* al., 2010). The main advantages of essential oil are their non-toxicity to humans and also are used in the treatment of many ailments (Upadhyay, 2013).Hence they are also grouped under "Green pesticides" which include all nature oriented materials that can reduce the pest population and increase food production and Consequently, Essential oils are playing a pivotal role of pest control in organic food production globally (Abdel, 2016). Insect pest are known to cause a per cent yield reduction of about 10-30% and due to the heavy dependence on synthetic chemicals for the management

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of the insect pest the development of resistance to the particular chemicals are increasing eventually along with the hazardous impact to the environment. Essential oils come into play to combat such situations as an alternative to synthetic chemicals.In this chapter, we discuss the potential, efficacy and constraints of some common Essential oils that can play a vital role in pest management.

Conventional techniques of essential oil extraction

i.Hydro distillation:-It is one of the oldest methods of extracting oils from the plants. In this technique the plant materilas are mixed with a solvent or water and then heated, this causes evapouration of the oils. This is then followed by liquefaction of the vapours in a condenser.Various techniques have been developed for hydro distillation namely, water immersion, direct vapor injection and water immersion and vapor injection.

ii.Steam distillation:-This technique is mainly applied for aromatic plants, Steam distillation is one of ancient and official approved methods for isolation of essential oils from plant materials. In this method the samples are not crushed but simply are introduced for steaming. As the steam passes through the gourd like apparatus used in this method the pores of the plants are macerated by the flow of the steam which eventually releases the oils.

The principle of this technique is that the combined vapor pressure equals the ambient pressure at about 100 °C so that the volatile components with the boiling points ranging from 150 to 300 °C can be evaporated at a temperature close to that of water.

iii.Cold pressing method:-It is also known as scarification method and is one of the best methods of extracting essential oil. 100% pure essential oil can be obtained by this method. It involves a mechanical exertion to the sample, the plants surface are scrubbed which removes the oil present in it then the whole plant is squeezed in which the oils reach the surface and then finally are separated by the process of centrifugation

Neotenic techniques of essential oil extraction

i.Supercritical Fluid Extraction (SFE):-In this technique two components are involved the extractant and the matrix with supercritical fluids as the solvent for extraction. In SFE almost 90% of the technique is employed using carbon dioxide as CO, is non-flammable, cheap, non-toxic and are easily removed from the extract.CO, are sometimes mixed

with ethanol or methanol.This techniques resultin high yield and low viscosity, many essential oils which cannot be extracted from steam distillation are effectively processed by this method. On the contrary, it is a very expensive method and operational function requires sophisticated knowledge to run.

ii. Microwave Assisted Hydro Distillation (MAHD):-In this technique,domestic microwave ovens (EMM-2007X, Electrolux, 20l) with wave frequency of 2450 MHz are used.A dimension of (46 x 28 x 37) cm cavity at the top of microwave is drilled. Then a flask of 1000 ml are placed inside the oven and connected to Liebigcondenser through the hole. It should be taken into care that the hole be closed by using polymers like PFTE to prevent the heat loss. The plant samples mixed with distilled water are placed in the flask and heated by microwave at around 600 W for 2 hours.

Table 1: Physical properties of components of essential oils

Essential oil components	Chemical formula	Molecular weight	Boiling point	Plant source	Uses
Ketones Alcohols Camphor	$C_{10}H_{16}O$	152.23	204	*Lavandula stoechas*	Antispasmodic, sedative, insecticides
Monoterpenes D-Limonene	$C_{10}H_{16}$	136.23	175.4	Citrus lemon	Antifungal and antioxidant
g-Terpinène	$C_{10}H_{16}$	136.23	183	*Origanum vulgare*	Antioxidant
Terpenic, oxides,1,8 cineole	$C_{10}H_{18}0$	154.25	176	Eucalyptus	Anti-inflammatory, insecticides
Oxygenated sesquiterpened α-Bisabolol	$C_{15}H_{26}0$	222.37	153	*Matricaria recutita*	Antimicrobial
Terpenic oxides Cis-rose oxide	$C_{10}H_{18}0$	154.25	70-71	*Rosa damascene*	Anti-inflammatory
Cinnamaldehyde	C_9H_8O	132.16	248-250		Bactericide, insecticide and fungicide

1.Camphor oil:-Camphoris a terpenoid, white or transparent solid with a strong aroma. It is extracted from the woods of the camphor laurel (*Cinnamomum camphora*) found in Asia. It can be also extracted from other related trees, *Ocotea usambarensis*. Camphor can also be synthetically produced from oil of turpentine. Camphor has been reported to have repellent activity against insect pest. The percentage of camphor in *Cinnamomum camphora*can be as high as 51% whereas in leaves of rosemary and camphorweed can be about 10-20% and 5 % respectively.Camphor has been extensively used for over centuries for many purpose, it was used as a circulatory stimulant and a tranquilizer by the Chinese people and in the fireworks by the Japanese. During the Black Death, a Plague in Europe which has devastated half of the population during the 14^{th} century Camphor was used as a fumigant. The oil is one of the most well-known and widespread commercially important aroma chemicals, with an annual market value of 80–100 million US$ (Chen*et al.,* 2013). Arabi *et al*., 2008 evaluated the fumigant toxicity of *Perovskia abrotanoides*oil against *S. oryzae* and *T. castaneum*and reported that its major component comprised of camphor (28.38%) and 1, 8-cineole (23.18%) and the concentration of the oil at 322 µl/l air resulted in 100% mortality of both the insect pest.Kamal and Elhady, 2012 revealed the essential oil from *Artemisia judaica* inhibited the oviposition of,*Callosobruchus maculatus*by 92.5, 86.0, 61.8, 42.7 and 12.5%, in the concentration of of 63.7, 31.9, 15.9, 8.0 or 4.0 µg/cm² respectively and the chemical composition of the essential oil was analyzed by GC-MS and constituted of oil piperitone (32.4%), camphor (20.6%) and (E)-ethyl cinnnamate (8.2%).

2.Citronella oil-Citronella oil is prepared from the plant *Cymbopogan* species. It is native to Asia, Citronella and its essential oil has been use for more than thousands of years having both acaricidal and repellent properties.Citronella oil constitutes of about 15 chemical components. Of which, Citronellal contributes to the highest proportion with about 51.5% of its total composition and the other component comprises of Geraniol,Citronellol,Limonene, Germacrene.In a report, mortality of *B. tabaci*increased with the concentration of the oil with the highest mortality recorded at the highest concentration (6.66 lL/L air) tested (percentage of survival reduced to 94.3% in comparison to control treatments). Furthermore, in a dual choice bioassay the essential oil was highly repellent against females of B. *tabaci* (Saad *et al.,* 2017). In another study, the field experiment reported that treatment of citronella oilat 2.0 mL/L significantly reduced fruit damage by *H. armigera*similar to the plots treated with spinosad @ 60 g a.i/ha. Fruit damage was reduced significantly by 72% with the application of (Setiawati *at al*., 2011). After extraction process of *C. winterianus* the major constituents comprised of geraniol(28.62%), citronellal (23.62%) and citronellol (17.10%) and concluded that Essential oil of *C. winterianus* at 1% (w v-1) resulted mortality of 34.3% and 96.9% in *F. schultzei*and *M. persicae*population respectively (Pinheiro1 *et al.,* 2013).

3.Eucalyptus oil-Eucalyptus originates from Australia; around 800 species have been reported of which most of them are native of Australia. It belongs to family Myrtaceae and can grow upto 25 feet high with a spread of around 5-10 feet. The oils are extracted from the young twigs and leaves after steam distillation process. It is pale yellow and has camphoraceous aroma. The main component of Eucalyptus oil is cineol which has both fumigant and contact insecticide.It has been reported that around 47 components constitutes the oil complex eucalyptol (72.71 %), α pinene (9.22 %), α - terpineol (2.54 %), (-)-globulol (2.77 %),α terpineolacetate (3.11 %), and alloaromadendrene (2.47 %).

Table 2: Classes of eucalyptus oil

The Medicinal Oils .	Whichcontain substantial amounts of eucalyptol (cineol). TheIndustrial Oils, containing terpenes, which are used for flotation purposes in miningoperations
The Aromatic Oils,	Characterized by their aroma with different groups of barks such as 1. Stringybark - strands can be pulled off in long pieces. It is thick with a spongy texture 2. Ironbark - hard, rough and deeply furrowed. It is soaked with dried sap exuded by thetree which gives it a dark red or even black colour. 3. Tessellated - bark is broken up into many distinct flakes. These flakes are like cork andcan flake off. 4. Ribbon - this has the bark coming off in long thin pieces but still loosely attached in 5. Some places. The pieces can be long ribbons, firmer strips or twisted curls.

(Patil *at al*., 2014)

Eucalyptus oil at 3%effectivelycontrols hoppers and aphids with leastdamage to the natural enemies.In 2013, Mousa *et al.,* reported the combination effect of garlic and eucalyptus oils in comparison toorganophosphate insecticides against some piercing-sucking faba bean insect pest and natural enemies population.The population of leafhoppers and plant hoppers was found to be reduced inthe following order: garlic oil (68.07%) > dimethoate (67.90%) > pestban (64.02%) > eucalyptus oil (43.27%). Similarly, the efficiency for controlling aphids was found to be as follows:garlic oil (90.96%) > pestban (89.44%) > eucalyptus oil (80.66%) > dimethoate (76.14%).Based on theresults conducted by Nowrouziasl *et al.,* 2014, the mortality of*Sitophilus Oryzae*adults increased with increasing concentration with exposure timefrom 24 to 72 h. The LC… € values of essential oil of *E. camaldulensis, E. grandis, E.viminalis, E. microtheca* and *E. sargentii* on adults of *S. oryzae* were 17.49, 15.65,14.73, 11.11 and 11.94 µl/lair, respectively. They reported thatafter 48 h of fumigation the highest and lowest toxicity was*E. microtheca* (LC… € = 11.11 µl/lair) and *E. camaldulensis* (LC… € =17.49 µl/lair), respectively.

4.Neem oil-Neemoils are extracted from the plant neem (*Azadirachta indica*), which belongs to family meliaceae and is originated from India. The oil consists of many components of around 100 biologically active components of which main active constituent are Azadirachtin, a triterpinoid which cause 90% of the effect to the pest followed by nimbin, nimbidin,nimbidol. Leaves contain ingredients such as nimbin,nimbanene, 6-desacetylnimbinene, nimbandiol, nimbolide,ascorbic acid, 7-desacetyl-7-benzoylazadiradione, 17-hydroxyazadiradioneand nimbiol. Quercetin and ß-sitosterol,polyphenolic flavonoids reported from neem leaves exhibit antibacterial andantifungal properties. Azadirachtin has broad mode of action to the target pest, it can affect the pests growth, molting, it has anti feedant, ovipositional property and it can also affect the concentration of ecdysone and Juvenile hormones. The oil is mainly extracted from the seedsas compared to the rest of the plant partsand 50 kg of fresh fruit can yield 30 kg of seed of which 6 kg of oil can be extracted and 24 kg of seed cake. The oils have been reported low toxicity to non-target organisms and therefore can have promising value in pest management. Some pest efficiently controlled by the oil includes *Anophelesstephensi, A. culicifacies,Ceraeochrysa claveri, Cnaphalocrocismedinalis*, *Diaphorinacitri*, *Helicoverpa armigera*, *Mamestrabrassicae*, *Nilaparvatalugens*, *Pierisbrassicae* and *Spodoptera frugiperda.* Arachnidtargets include *Hyalomma anatolicumexcavatum* and *Sarcoptesscabie* var.cuniculi larvae (Campos *et al*., 2016).Nayak *et al*., 2014 reported low population of mustard aphid, saw fly, painted bug and cabbage Webber in all the IPM modules when compared to the farmers' practice of scheduled based insecticide application,the minimum population of aphid (13.56/10 cm twig of plant), saw fly (3.93 larvae/10 plants), cabbage Webber (4.20 caterpillar/10 plants) and painted bug (4.86 bugs/10 plants) were recorded in the IPM module comprising of two foliar spray 300 ppm Azadirachtin @ 5 ml/l of water at 40 and 55 days after sowing (DAS), twice release of *Chrysoperla zastrowii*Sillemi @ 20000/ha at 50 and 60 DAS and installation of yellow sticky traps (@ 25/ha.On the other hand natural enemies such as lace wing bugs, coccinellid beetles, syrphid flies and honey bees were significantly higher in all the IPM plots in comparison with farmers practice. Seed extract from neem, black pepper, mahogani and garlic bulb of three doses were evaluated against legume pod borer and the neem seed extract applied@150 and 100 g/l and mahogani seed extract @ 100 g/l of water

7 days intervalson the country beanshowed significant reduction of flower andpod damage with significantly higher yield of bean in both the seasons (Rouf and Sardar, 2011). Biswas, 2013 conducted a field experiment with eight treatments evaluated against mustardaphid and reported the aphid population was maximum (180 per plant)at the pod formation stage of mustard crop. Aphids population was significantly reduced to 63.16-72.55% in mustard crop with the application of neem leaf extracts whereas NSKE reduced 73-81 per cent aphid population and among the different dosesof neem extracts, 50g neem seed/L of water recorded the highest aphid population reduction over pretreatment(81%) withhigh BCR (3.88) followed by 75g neem seed/l treated plots having reduction of 80% and BCR 3.78.

Table 3: Some essential oils with their target pest

Plants	Parts used	Target insect pest
Schinus molle	Fruit and leaf	*Trogoderma granarium*
Artemisia scoparia	Leaves	*Callosobruchus maculatus*
Laurelia sempervirens	Leaves	*Tribolium castaneum*
Carum copticum	Aerial parts	*Plutella xylostella*
Perovskia abrotanoides	Aerial parts	*Sitophilus oryzae*
Zhumeria majdae	Aerial parts	*Plodia interpunctella*
Citrus reticulata	Peel	*Callosobruchus maculatus*
Citrus limon	Peel	*Callosobruchus maculatus*
Citrus aurantium	Peel	*Callosobruchus maculatus*
Salvia bracteata	Aerial parts	*Sitophilus oryzae*
Ocimum basilicum	Aerial parts	*Aphis craccivora*
Curcuma longa	Seeds	*Agrotis ipsilon*
Carum carvii	Leaves	*Rhyzopertha dominica*
Origanum vulgare	Leaves	*Nezara viridula*
Origanum onites	Leaves	*Plodia interpunctella*
Zataria multiflora	Leaves and stems	*Brevicoryne brassicae*
Artemisia judaica	Aerial parts	*Spodoptera sp*

(Tawab, 2016)

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