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REVIEW ARTICLE

PESTICIDAL ACTIVITY OF PLANTS ON SELECTED INSECT PESTS

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ABSTRACT

During last few decades the use of chemical pesticides has increased dramatically in both developed and developing countries. The use of synthetic chemicals to control insect pests and phytopathogens results in several ecological problems. The synthetic insecticide residues left in the soil and water cause toxic effects on fishes, wild life, domestic animals and finally humans. Biopesticides are naturally occurring substances derived from animals(e.g. nematodes), plants and microorganisms(e.g. *Bacillus thuringenesis, Trichoderma*). Biopesticides are applied in similar manner like chemical pesticides, very effective in the the control of pests and ecologically friendly in nature. The secondary metabolites like phenols, alkaloids and terpenoids etc are naturally produced from plants and posses biological properties like antimicrobial, antifungal and pesticidal properties. This review focussed mainly on the nature of different insect pests listed below 1.*Acanthoscelides obtectus* 2.*Brevicoryne brassicae* 3.*Callosobruchus chinensis* 4.*Callosobruchus maculates* 5.*Crocidolomia pavonana* 6.*Corcyra cephalonica* 7.*Epilachna varivestis* 8.*Helicoverpa armigera* 9.*Henosepilachna vigintioctopunctata* 10. *Macrotermes bellicosus* 11. *Rhyzopertha domin ica* 12. *Sitophilus oryzae* 13. *Spodoptera litura* 14. *Tribolium castaneum* and the damaged caused by them to different crops in field and storage. The aim of this review is to improve awareness about the plants and their products which can be used in the manufacture of biopesticides at industrial level.

INTRODUCTION

The 21st century agriculture sector of both the developed and developing countries facing many problems. Farmers are under pressure for more food and fibre to feed the growing population with a smaller rural labour force. In addition the agricultural crops are often encountered by phytopathogens and herbivorous insects. When the crops are attacked by insects and pests the weight and quality of the grains decreases. At the same time nutritional value of the grains reduced and make it unfit for human consumption. Anually the crop loss due to pests and diseases is about 35% on the field and 14% in storage(Simon Koma Okwute, 2012). Insects and phytopathogens decreases food production by attacking the agricultural crops during crop growth, harvest and storage. To reduce the food crisis for the growing population and improve human and animal health, the damage caused by the pests and phytopathogens should be eliminated. The revolution against pests and diseases in agriculture started in 1800 by using chemicals as pestcides and fungicides(K.Rani *et al*., 2013). The synthetic organic pesticides for example the chlorinated hydrocarbons and DDT increased grain production in agricultural crops by controlling the pests and diseases. But the uncontrolled use of chemical pesticides causes severe environmental pollution. Human beings, domestic animals and other non target organisms are under threat due to unhealthy conditions in soil, water and air. It is the time to replace synthetic pesticides with the biopesticides which controls pests in environmentally friendly way. Naturally obtained materials from plants, animals, bacteria, fungi and algae which have pesticidal activity are called biopesticides. The application of biopesticides in crop field and on stored grains is similar to chemical pesticides.

In the nineteenth century Bassi and Pasteur started the study of pathology of insects. In 1879 Mechnnikoff and in 1888 Krassilnikow studied about the muscordine fungus *Metarrhizium anisopliae* and applied it to control the grain and the sugar beet pests(JeVrey C. Lord, 2005). White and Dutky in 1940 made significant contribution to insect pathology by using the spores of milky disease bacterium *Bacillus popilliae* against Japanese beetle(Walter Ernest Fleming, 1968). However the real interest of researchers towards microbial insecticides was the issue of eight patents to *Bacillus thuringenesis* in between 1960-63. The Environmental protection agency (EPA) of United states of America registered for the first viral insecticide using the studies of Balch and Bird

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in 1944 and Steinhaus and Thompson in 1949 respectively(Nasrine Moazami., 1998).

At present farmers are using biopesticides to control insect pests and diseases throught the world. The industries in the agricultural sector all over the world turned towards the production of bioinsecticides, biofungicides and bionamaticides. The global biopesticide market in 2011 was dominated by North america with 40% global biopesticide production. According to M.A. Hoy (1999) the US biopesticide market value is around $205 million at present and expected to increase to approximately $300 million by 2020. The key features for the development of global biopesticide market are the demand for the residue free crop production, growing organic food market and easy registration than chemical pesticides. Now in India and China also farmers got awareness and adopting biopesticides in crop protection. In India biopesticides represent only 5% of the overall pesticide market and 12 types of biopesticides have been registered under the Insecticide Act, 1968 at present(Y. Thakore, 2006).

Plants produces different varieties of secondary metabolites i.e. alkaloids, terpenoids, phenol and flavanoids etc by natural mechanism. Many number of plants and their products are used in ayurveda and folk medicine because of their theraupatic value. The naturally produced secondary metabolites possess pesticidal activity in addition to theraupatic value. Now the agricultural sector globally is in urgent need for the production of potential biopesticides from the extracts of botanicals because the production of biopesticide from the plant and their extracts requires less time, minimal technology and low cost when compared to microbial biopesticides.

Insect pest

Insects populations develop in all possible environments and found all over the world. Insects belong to invertebrate phylum Arthropoda and have very successful evaluative history. Insects differ from other animals in several aspects like wings, malleable exoskeleton, habits diversification, high reproductive potential, desiccation resistant eggs and metamorphosis. Many insects knowingly or unknowingly acts as vectors to many diseases. Some more insects lives on crop plants for food. This review mainly discussed about different types of insects and the damage caused by them to agricultural crops and stored food products. In addition this review emphasises on the nature of different plants and the insecticidal activity of their extracts on selected insect pests.

Acanthoscelides obtectus

The central america native *Acanthoscelides obtectus* spread to many countries in grain shipments. It takes food from leguminous plants and specially on beans. The bean weevil belongs to the order coleoptera and family bruchidae. The light to dark brown coloured insect grows 2-5mm in size(Chelidze I.A, 1966). The insect needs warmer climates of temperature i.e. 27-29°C for adults, 24-27°C for larvae. The adult bean weevil lives in seeds and seed pods of leguminous plants during hibernation and comes out to mating in april (Egorov A.B, 1989).

Recent investigation reveals that the extracts of *Vernonia amygdalina* were highly toxic to *A.obtectus.* The small shrub of the tropical Africa *V.amygdalina* belongs to the family *Asteraceae*. The bioassay has indicated that the toxic effect of the leaf extracts against *A.obectus* was proportional to the concentration and time (S. A. Adeniyi *et al*.,2010).

Brevicoryne brassicae

Cabbage aphids (*Brevicoryne brassicae*) is a native of Europe and now it is seen in all parts of the world. They belongs to the family Aphididae and appear in grayish-white to powdery blue in appearance due to waxy covering but actually they are grayish green in colour. The cabbage aphids feeds on only the *Brassicaceae* plants (Amin, A. H. and G. M. ElDefray, 1981). Pepper mint (*Mentha piperata*) is native to Europe but now it is cultivated in all parts of the world. It is a hybrid plant and belongs to the family *Lamiaceae*. Pesticidal activity of the hybrid plant extracts against cabbage aphids were studied by leaf disc bioassay method. The assay revealed the secret that the ethanolic plant extract at 500 and 1000ppm were very lethal to cabbage aphids after 24hrs exposure (Nagappan Raja *et al*., 2014).

Callosobruchus chinensis

Callosobruchus chinensis is a common pest of many stored legumes and generally called as adzuki bean weevil (Srinivasan, T; Durairaj, C., 2008). However it is not a true weevil and belongs to the family *Chrysomelidae*. It was seen first in China in 1758 that's why it got the species name chinensis. It is also called Chinese bruchid, pulse beetle and cow pea bruchid(Chandra, Girish., 2014). Now it is cosmopolitan in distribution due to commercial export of beans. The insect in the adult stage looks brown in colour with black and grey patches over the body. The Chinese bruchid exhibits sexual dimorphism where females are heavier and larger than males (Varma, S., Anadi, P., 2010). It is possible to control the population of this insect by using the extracts of *Gmelina arborea*. The plant belongs to the family lamiaceae and grows at altitudes up to 1,500 meters naturally in India, Myanmar and southern provinces of china. This fast growing deciduous tree is generally called as Beech wood tree and grows up to 30m height.The extracts of this plant contains insecticidal components and can control 90% population of *Callosobruchus chinensis* within 12 hours (Partha P. Choudhury, 2012).

Callosobruchus maculatus

The cow pea seed weevil(*Callosobruchus maculates*) also feeds on stored legumes and belongs to the family *Chrysomelidae*. This reddish brown coloured insect is not a true weevil and contains two central black spots on the elytra. The insect shows sexual dimorphism and cosmopolitan in distribution throughout the world except Antarctica. The beetle is native of West Africa and now seen in all the countries except Antarctica (Tran, B. M. D. and P. F. Credland, 1995). *Jatropa curcas* is a flowering plant of the *Euphorbiaceae* family. It is resistant to drought and pests. The seeds of

Jatropa curcas are generally used in the production of biodiesel. Ravindra V. Kshisagar (2010) studied the pesticidal activity of *Jatropa* oil against *C.maculatus.* At all selected dosages the eggs of the insect were impotent to produce the larva. The field marigold plant *Calendula arvensis* is native to Central and Southern Europe. The *Asteraceae* plant is now seen all over the world. The methanolic extract of *Calendula arvensis* was highly toxic to *Collosobruchus analis,* a closely related insect to *C.maculatus* and the activity was dose dependent (Rehman Ullah**,** 2012).

Allium sativum is a bulbous plant commonly known as garlic. It grows 1-4 meters in height. The fleshy sections of the garlic bulb are called cloves which are used for human consumption in both raw or cooked form. Trisulfide, di-2-propenyl and diallyl disulfide is the maor component of Garlic oil. The fumigation of garlic oil on stored products controls the bruchids population 100% (Lalla fatima Douiri *et al.,* 2013). Not only *A.Sativum*, methanolic extracts of *Tagetes erect* (family *Asteraceae*), *Ailanthus excel* (family: *Simaroubaceae*) were also highly effective against *C.maculatus* (Diwan RK *et al.,* 2014).

Crocidolomia pavonana

The moth *Crocidolomia pavonana* belongs to the family Crambidae. It is generally called as Cabbage Cluster Caterpillar and found in South Africa, India, Australia and Java and Reunion. The larvae of cabbage cluster caterpillar mainly feeds on *Brassicaceae* plants and considered as notorious agricultural pest on cabbages. Edy Syahputra (2013) studied the insecticidal activity of *Barringtonia sarcostachys.* The tree grows up to 40 meters height and the trunk diameter is 50 centimeters. It belongs to the Lecythidaceae family and the bark is brown, reddish brown, grey or blackish in colour. The bark extract of *B. sarcostachys* has shown strong lethal effect on the larvae of *C. pavonana* which is nearly equivalent to the lethal effect of neem seed extract.

Corcyra cephalonica

Corcyra cephalonica is a pyraloid moth of the family *Pyralidae*. The caterpillars of this rice moth feeds on dry plant stuffs such as seeds, mainly cereals. *Azadirachta indica* is a fast growing tree and belongs to the family *Meliaceae*. This ever green is generally called as neem and grows up to 40 meters height. Neem products are used as antifungal, antibacterial, anti diabetic and antiviral in siddha and ayurveda. Chandra Shekar Pathak *et al*., (2012) in an ssay confirmed that the acetone extract of neem seeds was highly toxic to the third instar larvae of *C.cephalonica*.

Epilachna varivestis

The notorious agricultural pest, *Epilachna varivestis* is generally called mexican bean beetle. The insect is found in Mexico and the eastern United States. It is seen in large numbers in irrigated areas of the west rocky mountains. It generally prefers wet areas and cannot tolerate extremely dry areas (Auclair JL, 1959). The Mexican beetle generally seen on common bean varieties (*Phaseolus vulgaris*), Lima bean (*Phaseolus lunatus*) and Soya bean (*Glycine max*). It is also found on alfalfa (*Medicago sativa*) and various clovers (*Trifolium* spp). It mainly eats leaves and also prefers fruits and flowers (Biddle AJ *et al*., 1992). The essential oil of the medicinal plant *Psoralea corylifolia* is highly lethal to the pupa of *Epilachna* insect when the insecticidal activity was determined in dark conditions at 24^0C and 68% relative humidity (Gupta *et al.,* 2013).

Helicoverpa armigera

The cotton bollworm, *Helicoverpa armigera* is a major pest of cotton and cosmopolitan in distribution. It is highly variable in both size and colour. The body length of cotton bollworm varies from 12 mm to 20 mm with a wingspan of 30–40mm. The head of the larva is yellow with several spots. The larva is pale coloured on the ventral side, three dark stripes extend along the dorsal side and one yellow light stripe is situated under the spiracles on the lateral side. The larva mainly attacks cotton blooms. Other than cotton it also attacks tomato, chick pea, sorghum and cow pea (Bhatt, N. J. and P. K. Patel., 2001). *Cleistanthus collinus* is a poisonous plant belongs to the family phyllanthaceae. The Leaf extract of this plant has shown insecticidal activity against the cotton boll worm in lab conditions (A.G.Deshmukh *et al***.,** 2013).

Henosepilachna vigintioctopunctata

The beetle, *Henosepilachna vigintioctopunctata* mainly feeds on the foliage of potatoes, brinjal and also other solanaceous crops. The body of the potato ladybird is nearly 7mm long, round, convex, glossy and consists of 28-spots. The adults usually hibernate under fallen leaves at the edges of woods, in bushes and also under plant residues in the fields (Ghosh, S. K and Senapati, S. K., 2001). *Achyranthes aspera* has shown highest insecticidal activity against the selected pest. The plant belongs to Amaranthaceae family and seen throughout the tropical world. It is a common weed and found in many places as an introduced species. It is possible to control the damage caused by *H. vigintioctopunctata* by using the ethyl acetate extracts of *A. aspera* (Kuppusamy Elumalai *et al.,* 2014).

Macrotermes bellicosus

The largest termite, *Macrotermes bellicosus* is indigenous to Africa and South-East Asia and belongs to the family termitidae (D G Mackean & Ian Mackean., 2013). The termite is an emerging pest on cocoa. There are two worker castes, the major workers and the minor workers in the population of *M.bellicosus*. After taking care of the queen both the workers leave the nest where minor workers builds under ground passages from the nest and major workers are busy in gathering the food (Hinze, B., and R. H. Leuthold., 1999).

Phyllanthus amarus Schum. & Thonn belongs to the family Euphorbiaceae, is a small herb well known for its medicinal properties. *P. amarus* is an important plant of Indian Ayurvedic system of medicine which is used in the problems of stomach, genitourinary system, liver, kidney and spleen. Where

as *Acassia albida* is a legume native to Africa and the Middle east and belongs to the family fabaceae. It is a thorny tree growing up to 6–30 m tall and 2 m in trunk diameter. Another plant *Tithonia diversifolia* is a species of flowering plant in the Asteraceae family that is commonly known as the Tree marigold, Mexican sunflower, Japanese sunflower. It is native to eastern Mexico and Central Ameria. It has shown great potential in raising the soil fertility in soils depleted in nutrients. It has shown to increase plant yields and the soil nutrients of nitrogen (N), phosphorus (P), and potassium (K). Different concentrations of ethanolic extracts of *P. amarus*, *A. albida* and *T. diversifolia* were active against *M. bellicosus* and shows higher percentage mean mortality of 64 – 91 %, 36.4 – 76 % and 36 –68%, respectively(A. V. Oyedokun *et al*., 2011).

Rhizopertha dominica

Rhyzopertha dominica is commonly called as the lesser grain borer, American wheat weevil, Australian wheat weevil and stored grain borer. It is a pest of stored cereal grains and belongs to the family Bostrichidae(Granousky, T. A. 1997). *Peganum harmala*, commonly called as wild rue, Syrian rue, African rue and Aspand and belongs to the family Nitrariaceae. The plant extracts has shown promising insecticidal activity with 80% mortality on *R.dominica*(Amandeep Kaur Mann and Meera Srivastava.,2013).

Sitophilus oryzae

The rice weevil (*Sitophilus oryzae*) is a storage pest attacks mainly wheat, rice and maize. The adults are with a long snout and 2 mm long. The body is brown/black in colour. Adult rice weevils are able to fly and can survive for up to two years. The larva develops within the grain, hollowing it out while feeding. It then pupates within the grain kernel and emerges 2–4 days after eclosion(Birch LC., 1944). In the filter paper diffusion method the extract of *Cinnamomum sieboldii* root bark gave 100% mortality at 2 days after treatment(Young-Joon Ahna *et al*., 2003). *Annona squamosa* belongs to the family Annonaceae. It is a large evergreen, straggling shrub or small tree, commonly occurring in India. In english it is know as Custard apple. It has significant medicinal value and is used as antitumour, wound healing, diuretic. Annana squamosa contain alkaloids, protein, amino acid, carbohydrate, glycosides, phytosterols, tannins and phenolic compounds. The ethanol extract of *Annona squamosa* produced significant effect on *S.oryzae*(J.Ashok kumar *et al*., 2010)**.** Recent research investigations also reveals that different extracts of *Xylopia aethiopica* and *Dennettia tripetala* of Annonaceae(Donald A. Ukeh *et al*., 2012), *Cymbopogon nardus (L.) Rendle* of poaceae(Win Myint Thein *et al*., 2013) has shown satisfactory insecticidal activity against *Sitophilus oryzae(L)*.

Kayode D. Ileke *et al*., 2014 evaluated entomocidal activity of powders and extracts of *Azadirachta indica, Zanthoxylum zanthoxyloides, Anacardium occidentale* and *Moringa oleifera* against *Sitophilus oryzae(L)* in the laboratory at ambient temperature of 28±2 ^{o}C and relative humidity of 75±5%. Both the powder and extracts of all the plants has shown promising results. S. Bhuvaneswari *et al*.,2014 studied lavicidal and pesticidal activities of aromatic plants from Yelagiri hills i.e. *Cinnamomum verum* of Lauraceae, *Chrysanthemum* sp. of Asteraceae, *Lantana camara* of Verbenaceae and *Eucalyptus citriodora* and *Callistemon citrinus* of the family Myrtaceae, from Yelagiri Hills of Tamil Nadu, India. Among all the plants *Lantana camara* is found to possess high larvicidal potency. Eziukwu,C *et al*.,2014 evaluated the comparative Assessment of the insecticidal potency of tobacco leaf extract (*Nicotiana Tabacum*), Black Pepper Seeds (Uziza) Extract (*Piper Guineense*) and African Pepper Seeds (Uda) Extract (*Xylapia Aetiopica*) against *Sitophilus zeamais* and *Sitophilus oryzea*. The extracts *of Xylopica aetiopics* and *Piper guineaense* had the highest percentage of mortality (88% and 84%) respectively) when compared with the other treatments under laboratory conditions at 30^{0}C, 24 hour light/dark regimes.

Spodoptera litura

Spodoptera litura is (Cotton leaf worm) is found in the Indo-Australian tropics. The larvae feed on cotton, castor leaves and has been recorded from over 40 mostly dicotyledonous plant families(Brown, ES and Dewhurst, CF., 1975). The volatile oils were obtained from *Foeniculum vulgare* (flowers and seeds), *Coriandrum sativum* (seeds), *Daucus carota* (flowers), *Pelargonium graveolens* (leaves and flowers), *Origanum majorana* (leaves and flowers), and *Salvia officinalis* (leaves) were proved to be toxic to the third instar larvae after 24 hours of exposure. However, the highest mortality was observed in the essential oils of *F. vulgare* seeds, *D. carota* flowers, and *O. majorana* leaves(Salaheddine Souguir *et al*., 2013). Methanol extracts of *Abrus precatorius* were found to be most significant ovicidal activity 100% at 300ppm concentration. The significant larvicidal activity was recorded from the highest concentration of methanol extract at 500 ppm(Elumalai Kuppusamy *et al*.,2015). Jaqueline Scapinell *et al*., 2014 studied the insecticidal and growth inhibiting action of the supercritical extracts of *Melia azedarach* on *Spodoptera frugiperda*. Larval mortality increased by raising the extract concentration.

Tribolium castaneum

The red flour beetle (*Tribolium castaneum*) belongs Tenebrionidae family. It is a storage pest on food grains like cereals, beans and nuts. The United Nations, in a recent post-harvest compendium, estimated that *Tribolium castaneum* & *Tribolium confusum*(the confused flour beetle) are "The two most common secondary pests of all plant commodities in store throughout the world"(Mills, J. and White, N.,1994). The red flour beetle is originated in Indo-Australian origin and can't survive outdoors. The adult lives more than three years. It looks like the confused flour beetle, except with three clubs at the end of each of its antennae (Howe, R., 1962).

According to earlier records dichloromethane extracts of *Mentha rotundifolia* L, (*S.Clement et al*.,2003) and methanol extract of *Peganum harmala* seeds (Fouad Sahay *et al*., 2006) has shown satisfactory insecticidal activity against the stored grain pest *Tribolium castaneum*(Herbst). Ahmed Noureddine

Helal *et al*., (2008) studied insecticidal activity of methanolic and ethyl acetate extracts of *Mantisalca duriaei* on red flour beetle and gained positive results.

M. Mostafa *et al*., (2012) studied insecticidal activity of n-hexane, methanol and water extracts of *Tamarindus indica*, *Azadirachta indica*, *Cucumis sativus*, *Eucalyptus species*, *Switenia mahagoni*, and *Psidium guajava* leaves by using the film residue method against a red flour beetle *Tribolium castaneum* Herbst. The hexane extract of four plants showed a strong toxic effect on red flour beetle. The LC50 results revealed that the hexane extract of *Cucumus sativus* is the most toxic to the pest followed by *Azadirachta indica* and *Tamarindus indica*. Tofazzal Hossain *et al*.,(2012) studied the insecticidal activity of three plant extracts Helencha (*Enhydra fluctuans* Lour), Ghetu (*Clerodendrum viscosum* Vent) and Kalomegh (*Andrographis peniculata* Wall) against stored grain pest *Tribolium castaneum* (Herbst). The overall results suggest that these three plants have potential insecticidal effect which might be used in pest control. Research records also shows that different extracts of *Curcuma longa*(K.Sujatha *et al*., 2013), *Citrus reticulata* and *Citrus sinensis* oils(Saleem *et al*., 2013), *Digitalis purpurea* (Mansoor Ahmad *et al*., 2013) and *Zingiber officinale*(Wand Khalis Ali *et al*.,2013) has also shown 100% insecticidal activity against *Tribolium castaneum*.

CONCLUSION

Plants are the natural factories to produce potential secondary metabolites having promising biological activities like antibacterial, antifungal, cytotoxic activity and pesticidal activities etc. Biopesticides are naturally derived materials used in the control of plant pests and diseases which are safer than chemical pesticides. Synthesis of biopesticdes by using plant and their extracts is very cost effective process than microbial biopesticdes. The review mainly focused on different plants and their extracts having insecticidal activity against selected pests. Plants like *Vernonia amygdalina*, *Gmelina arborea*, *Abrus precatorius*, *Azadirachta indica* and *Curcuma longa* has shown 100% insecticdal activity against selected insect pests. Different plants and their extracts discussed in the review are useful in the manufacture of biopesticides at industrial level.

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