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REVIEW ARTICLE

Plant Extract as Selective Pesticide for Integrated Pest Management

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ABSTRACT
The over use of chemical pesticides causes environmental and health problem have been the matter of concern so plant extracts which known as biocide or green pesticides can be an alternative good source of chemical pesticide due to their safe, eco-friendly and more compatible properties. These are being used to manage the pest and minimize the yield loss. The different types of plant extract used as biocides such as neem, garlic, tobacco, kappettiya, syringe, ginger and many others are being utilized to control and manage the pest or disease of different plants. The petroleum ether extract of periwinkle, can be used to control the pest Uzi fly during sericulture. The neem extract of different concentrations show significant effect to control pest of rice, betel leaf and vegetable. Garlic bulb extract, tobacco and kappettiya leaf extract, Eve's apple latex/ fruit/ seeds extract, lilac flower extract, neem leaf/ seeds or it oil all are act as potential insecticide to tea, rice, betel leaf and vegetables pest. The purpose of this review has revealed to control pest in some economically important crops through different plant extract for sustainable agriculture.

KEY WORDS: *Plant Extracts, IPM, Green Pesticide, Sustainable Agriculture*

Introduction

About 35% on the field and 14% in storage around 50% in total crops are lost annually attacked by insect and pest, which adversely affects the world food production during crop growth, harvest and storage (Jitendra *et.al*. 2009). To minimize these losses several management approaches has been conducted, including chemical, biological, physical, and cultural methods. The use of pesticide has contributed immensely to the increase in agricultural productivity and to the improvement in human health, particularly the eradication of vector born disease undoubtedly. However, it has been established that use of synthetic organic pesticides, particularly the chlorinated hydrocarbons lead to serious environmental pollution (water, air and soil), affecting human health and causing death of non-target organisms (animals, plants, and fish) (Biswas *et.al. 2014)*.

The over use of pesticides causes environmental and health problem have been the matter of concern for both scientists and public in recent years. Scientists found that a number of plants possess pesticidal activity. Plant extracts and essential oils are safe, eco-friendly and more compatible with environmental components compared to synthetic pesticides so they come under “Green pesticides” category. Now an increasing trend in use of botanicals with more than 2400 bioactive plant species identified for their insecticidal and anti - pathogenic properties (Karunamoorthi, 2012). This review has revealed some biologically effective green pesticide for sustainable agriculture.

Selective pesticide for IPM

Integrated pest management (IPM) emphasizes on use of pesticides having selective toxicity as against the use of

broad spectrum pesticides. Plant products can be considered as better options for pest control, if they can be categorized for having differential efficacy against different insects, in pest control (Emden, 1989). IPM system to control pest in some economically important crops through different plant extracts are describe here.

In Rice

Yield losses ranging from 21 to 51 percent have been estimated due to moderate to serious incidence of stem borer, gall midge, plant hoppers and other sporadic pests in the rice growing areas (Islam *et.al.* 2004) though yield losses have been found to be highly variable by rice culture, location, season and field. Sri-Lankan farmers use Kappettiya (*Croton laccifer* L.) of Plant Family *Euphorbiaceae* to control Paddy bugs and Eve's apple (Tabernaemanta dicotoma) for traditional pest management activities in Sri-Lanka (Widanapathirana and Dassanayake, 2013). *Cycas circinalis* has been used in traditional Agriculture for pest management because it's male reproductive structure when decaying, emits a strong odor (Mamannan and Natarajan, 2010). Some plants are reported as insecticidal activity against rice pests i.e. *A. indica* for Stem borer (*Scirpophega incertulus*) Rice weevil (*Sitophillus oryza*), rice moth (*Sitotroga cerealella*) and Gandhi bug (*Leptocorsia oratoris*); *Pongamia pinnata* for Yellow stem borer (*Scirpophaga incertulus*); *Polygonum hydropiper* L. for *Sogatella furcifera* and *Nilaparvata lugens; Shorea robusta* for Rice hispa (*Dicladispa armigera*); *N. tabaccum* for Stem borer (*Scirpophega incertulus*) and leaf folder (*Cnaphalocrocis medinalis guenee*); *Colocasia esculenta* for Case worm (*Nymphalla depunctalis*); *Citrus grandis* for *Sciropophega incertulus; Moringa oleifera* for *Sciropophege incertulus; Costus speciosus* for Rice hispa (*Dicladispa armigera*); *Saccharum spontanum* for Leaf folder (*Cnaphalocrocis medinalis guenee*) and caseworm (*Nymphalla depunctalis*); *Vitex negundo* for all major type of insect and pest (Barman *et.al*., 2014). 20% w/v extract of *Tephrosia vogelii* plant highly effective against termites, *Synacanthotermes zanzibarensis*, citrus aphids, *Toxoptera citricidus* and red spider mites, *Tetranychus urticae* leads to an increased mortality of more than 90% in all three species 24 hours after the treatment (McDavid and Lesseps, 1994). Ethanol extract of (leaves of *Calotropis procera, Zanthoxylum rhesta, Croton tiglium, Vitex negundo and Chromolaena odorata*, root-bark of *Zanthoxylum nitidum,* stem bark of *Crataeva nurvala*) seven plants were found highly effective (90 -100% mortality) against *Nymphula depunctalis* (Kelm and Nair, 1998).

In Tea Cultivation

Tea (*Camellia sinensis* L.) is one of the most useable beverages worldwide, which is attacked by variety of herbivores and the profiles of pests vary from region to region. 1033 arthropods have been recorded to feed on different parts of tea plants worldwide (Chen and Chen, 1989; Hazarika *et.al.* 2009) which can lead yield loss 5% to 55% (Rattan, 1992; Sivapalan, 1999; Somnath *et.al.* 2009). *Helopeltis theivora* (Tea Mosquito Bug), *Helopeltis shoutedeni, Adoxophyes bonmari, Homona coffearia* (Cranham, 1966), *Xyleborus fornicates,Oligonychus coffeae* (red spider mite), *Toxoptera aurantii* (Aphd) etc. causes serious damage in tea cultivation (Gotoh and Nagata, 2001; Sohail *et.al.* 2012), as a result insecticides is being used to boost production. Several international regulatory bodies have fixed maximum permissible limit of pesticidal residues in tea leaves for the growing concern over pesticidal residue in tea leaves and environmental impact of pesticides.

To solve this problem several plant extracts are examined which show that Neem seed extract is effective for controlling variety of pest in tea cultivation. A 2% Neem extract gave appreciable control of aphid, efficacy show 80%, 68% and 66% mortality of aphid after 24 hours, 72 hours and 1 weak (Sohail *et.al.* 2012) where 5% Neem extract gave control of red spider mites as well as pink, purple, yellow and scarlet mites in tea (Radhakrishnan, 2010) Neem formulations reduced the *Calacarus carinatus*(purple mite) population by 70% in 7 day (Subaharan and Regupathy, 2006) and 300ppm azadiractin could get 50 to 75% reduction of different pest of tea (Rahman *et.al.* 2006). Beside Neem several other botanical extracts including methanolic extract of *Clerodendron infortunatum*is toxic to *H. theivora* producing 95% mortality (Somnath *et.al.* 2009), 2% of tobacco and garlic extract causes 98% and 75% mortality of aphid after 24 (Sohail *et.al.* 2012).

In sericulture

During larval phase, silkworms are feed exclusively on fresh mulberry leaves and they have a bitrophic relationship with *Exorista sorbillans* (Uzi fly) which is a parasitoid of silkworm. To control Uzi fly the application of insecticides in or near sericulture projects is not possible because, silkworm is highly susceptible to insecticides and they can be harmed by chemicals on the leaves. (Hannig *et.al.* 2009).

Several plant extracts are examined to solved this problem which show that the petroleum ether extract of *Catheranthus roseus* (periwinkle), *Ocimum sanctum* and *Ageratum conyzoides* caused 46 %, 6.67%, 86.21% mortality respectively after 24h and 100%, 33.79%, 100% mortality respectively after 48h of Uzi fly at 5% concentration. Most effective LC50 value of the petroleum ether extract of *A. conyzoides* was recorded as 0.74%. Toxicity of these petroleum ether extracts were compared with *E. sorbillans* (Uzi Fly) and larvae of *Antheraea assama* (silkworm) and which showed no mortality of late instars larvae of *A. assama* till 48h at 10% concentration while they were highly toxic to the parasitoid *E. sorbillans* (Bora *et.al.* 2012). Another experiment show that economic characters of silkworm like cocoon weight and pupal weight of treated larvae did not vary significantly from that of control larvae; but significanty decrease shell weight after application of essential oil of *A. conyzoides* at all dosages (Khanikor, 2011).

In Betel Leaf Cultivation

The betel vine *Piper betel* is highly susceptible to different sorts of diseases, pests and some natural calamities. *Sclerotium rolfsii* a soil born fungus and omnipathogenic organism which causes root rot disease of betel vine which decreases the production of betel leaf. Many researchers reports about antifungal activities of garlic, neem, allamanda (Islam, 2005; Rahman *et.al.* 1999; Mohanty *et.al.* 1995). To evaluate the effect of different plants extracts and namely rhizome of turmeric, rhizome ginger, neem leaf, tobacco leaf, tobacco leaf extract in water, tobacco leaf extract in cow's urine where cow's urine used at different concentrations (70%, 60%, 50%, 40% and 30%) on the growth and sclerotia formation of *S. rolfsii*. It is found that tobacco leaf extract in cow's urine was more effective in both of sclerotia formation and mycelial growth inhibition (Amin *et.al.* 2013).

In Home Garden & Vegetables

The diamondback moth, *Plutella xylostella* L. (Lepidoptera: Plutellidae), was recorded as a pest on cabbage in South Africa as early as 1917 (Gunn, 1917), which may causing more than 90% crop loss (Verkerk and Wright, 1996). Neem and syringe (*Syringa* vulgaris L.) extracts is effective against *P. xylostella*, significantly reducing the survival of larvae feeding on cabbage leaves (Charleston *et.al.* 2001), *Crocidolomia binotalis* Z. (Lepidoptera: Pyralidae) also no longer fed on leaves that had been treated with neem extracts (Fagoonee, 1981). At low concentrations of syringe extract caused a disturbance of metamorphosis of IV instars of cabbage pests *Pieris xylostella* and of various larval instars of the other three species *Pieris brassicae* L., *Pieris rapae* L. (Lepidoptera: Pieridae) and *Mamestra brassicae* L. (Lepidoptera: Noctuidae) at higher concentrations. Extracts from seed kernels of syringa at 2% concentration gave an anti-feeding rate for *P. rapae*. When sprayed on the leaves of Chinese cabbage exposed to I instar larvae of *P. rapae*, the extract caused 75% mortality at a concentration of 5000 ppm and 20% mortality at a concentration of 1000 ppm (Zhang and Chiu, 1983).

In peanuts several type of pest can damage yield which can be controlled by botanical pesticides easily. Ginger rhizome extract and Custard apple leaf for Aphids; Ginger, garlic, and chilli extract and Ginger rhizome extract for Corn earworm; Garlic oil spray for Leafhoppers; Coriander seed extract and Basil leaf extract for Spider mites; Garlic bulb spray for Thrips; Garlic oil spray and Neem oil extract for Whiteflies; Papaya water extract for White grubs; Basil leaf extract for Root knot nematodes may use in peanuts cultivation to minimized crop losses (Bissdorf and Weber, 2009). Results of aphid mortality obtained at 12 days after spraying indicated that plants sprayed with Solanum (spray and buttermilk), and garlic buttermilk had 100% mortality, Lippiaspray, garlic and chilli spray and tobacco spray had 77%, 70% and 10% aphid mortality, respectively (Mhazo *et.al.* 2011).

Studies on botanical insecticides against *B. tabacihave* focused particularly on essential oils of different plants, such as *Thymus vulgaris, Allium cepa, Allium sativum, Satureja hortensis, Achillea biebersteinii, Cinnamomum verum, Syzygium aromaticum, Alkanna strigosa, Ballota undulate, Galium longifolium, Lepidium sativum, Peganum harmala,*

Pimpinella anisum, Ruta chalepensis, Retama raetam and Urtica pilulifera, where 60-100% mortality has been reported (Aalan *et.al.* 2004; Al-Mazraawi and Ateyyat, 2009; Ateyyat *et.al.* 2009).

Application of neem seed kernel extract against tomato fruit borer (*Helicoverpa armigera*), brinjal fruit borer (*Leucinodes orbonalis*), serpentine leaf miner (*Liriomyza trifollii*), and diamond back moth (*Plutella xylostella*) are well known IPM technologies (Mohanty *et.al.* 1995). Though USAID-HARVEST introduced a botanical insecticides mixture that can effectively kill or stunt the most common pests we find in our crops such as; aphids, whiteflies, leafhopper, Thrips, certain beetles, caterpillars etc. To produce this botanical insecticide Tuber of *Diocorea Hispida* (3kg) Bark of *Phyllanthus emplica* (5kg), *Annona sqamosa* (2kg), fruit of *Strychnos nux-vomica* (5kg), *Datura metel* (4kg), *Capsicum frutescens* (2kg), *Azadirachta indica* (5kg), leaf of *Derris elliptica* (3kg), Rhizomes of *Alpinia galanga* (2kg) mixed with *Tinospora crispa* (3kg), *Ocimum basilicum* (0.5kg), *Nicotiana tabacum* (1kg) and *Cuscuta maritime* (2kg) plant part which are chop into small pieces (not longer than 3 cm) and put them in a clay jar filled with 200 liters of water and 30 to 50 liters of animal urine. After mixing the solution well and covered the jar with the lid tightly it'll ferment for 15 to 20 days. This solution (1 liter) can use by mixing with 15 liters of water and five grams of washing detergent for spraying twice per week on all types of vegetables as well as on rice (Usaid-Harvest. 2012).

Discussion

An important essence of integrated pest management is to consider the whole ecosystem as the management unit. A consensus approach is to keep the natural ecosystem largely intact. While attempts are made to control pests and pathogens in the agricultural fields, issues regarding their impact on non-targeted organisms as well as human and environmental health must be taken into consideration. After this review we found some effective botanicals for Instigated Pest Management. The advantages of botanical pesticides lie in their rapid degradation and lack of persistence and bioaccumulation in the environment, which have been major problems in synthetic use.

References

Aalan I., Ozbek H., Calmasur Ö., and Sahin F. (2004) Toxicity of essential oil vapours to two greenhouse pests, TetranychusurticaeKoch and BemisiatabaciGenn. Industrial Crops and Products. 19(2):167-173.

Al-Mazraawi M.S. and Ateyyat M. (2009) Insecticidal and repellent activities of medicinal plant extracts against the sweet potato whitefly, *Bemisiatabaci* (Hom.:Aleyrodidae) and its parasitoid *Eretmocerus mundus* (Hym.: Aphelinidae). Journal of Pest Science. 82(2):149-154.

Amin R., Sarker B.C., Adhikary S.K., Sultana S. and Zubair T. (2013) Effect of Some Botanical Extracts and Cow's Urine on *Sclerotiumrolfsii* Causal Agent of Foot And Root Rot of Betel Vine. The International Journal of Engineering and Science (IJES). 2(9):77-82.

Ateyyat M.A., Al-Mazraawi M.S., Abu-Rjai T. and Shatnawi M.A. (2009) Aqueous extracts of some medicinal plants are as toxic as imidacloprid to the sweet potato whitefly, *Bemisiatabaci*. Journal of Insect Science.9(15).

Barman D., Nath N., Rao S. and Barman B. (2014) Bioresource Utilization in the Management of Insect and Pest in Rice Cultivation by Garo Tribe of West Garo Hill District, Meghalaya.Int. J. Pure App. Biosci. 2(3):298-304.

Bissdorf J. and Weber C. (2009) Field Guide to Non-chemical Pest Management in Peanut Production.Pesticide Action Network (PAN) Germany pp1-28.

Biswas S.K., Rahman S., Kobir S.M.A., Ferdous T. and Banu N.A. (2014) A Review on Impact of Agrochemicals on Human Health and Environment: Bangladesh Perspective. Plant Environment Development 3(2):31-35.

Bora D., Khanikor B. and Gogoi H. (2012) Plant based pesticides: Green environment with special reference to silk worms. In: Soundararajan, R.P. (Eds.), Pesticides— Advances in Chemical and Botanical Pesticides, InTech, Rijeka, pp171-206.

Charleston D.S., Dicke M., Vet L.E.M. and Rami K. (2001) Integration of biological control and botanical pesticides - evaluation in a tritrophic context.Proceedings of the 4th International Workshop, Melbourne, Australia.

Chen Z. and Chen X. (1989) An analysis of world tea fauna.J.Tea Sci. 9:13-22.

Cranham J.E. (1966) Tea pests and their control.Ann.Rev.Entomol. 11:491-514.

Emden H.F.V. (1989) Pest control.Cambridge University Press. London. pp82-105.

Fagoonee I. (1981) Behavioral response of *Crocidolomiabinotalis* to neem. In: Natural pesticides from the neem tree (*Azadirachtaindica* A. Juss). In: Schmutterer, H., Ascher, K.R.S. and Rembold, H. (Eds.), Proceedings of the first international neem conference. Rottach-Egern, Germany 16-18 June 1980. GTZ, Germany.

Gotoh T. and Nagata T. (2001) Development and reproduction of *Oligonychuscoffeae* (Acarina: Tetranychidae) in Tea. Int. J. Acarol. 27:293-298.

Gunn D. (1917) The small cabbage moth. In: Union of South Africa Department of agriculture and Forestry. Bulletin No. 8.

Hannig G.T., Ziegler M. and Marcon P.G. (2009) Feeding cessation effects of chlorantraniliprole, a new anthranilicdiamide insecticide, in comparison with several insecticides in distinct chemical classes and mode-of-action groups.Pest Management Science. 65:969-974.

Hazarika L.K., Bhuyan M. and Hazarika B.N. (2009) Insect pests of tea and their management.Annual Review of Entomology. 54:267-284.

Islam M. (2005) Country news, Holiday Publication Limited. 8:3-4.
Islam Z., Heong K.L., Hazarika L.K., Rajkhowa D.J., Ali S., Dutta B.C. and Bhuyan M. (2004) Current status of rice pest and their management in Assam, India A discussion with extensive agents.Int Rice Res. Newsletter (Manila) 29(2):89-91.

Jitendra K., Nitin K. and Kulkarni D.K. (2009) Plant-based pesticides for control of *HelicoverpaamigeraonCucumis*.Asian Agric. History. 13(4):327-332.

Karunamoorthi K. (2012) Medicinal and Aromatic Plants: A Major Source of Green Pesticides/ Risk-Reduced Pesticides. Med Aromat Plants 1:137.

Kelm M.A. and Nair M.G. (1998) Mosquitocidal compounds and a triglyceride, 1,3-dilinoleneoyl-2-palmitin from *Ocimum sanctum*. J. Ag. Food Chem. 46:3092-3094.

Khanikor B. (2011) Evaluation of extracts and essential oils of *Ocimumand Ageratum* against uzi fly, *Exoristasorbillans* (Wiedemann), a parasitoid of *Antheraeaassama* Westwood. Ph.D. Thesis. Dibrugarh University.Dibrugarh. India.

Mamannan M.A.R. and Natarajan G.M. (2010) Bio-safety evaluation of cycas seed extract on Tilapia, *Oreochromismossambicus* by oxidative metabolism. Journal of Biopesticides. 3(1):232-236.

McDavid A. and Lesseps R.S.J (1994) Effects of *Tephrosiavogelii* leaf extracts on several crop pests. In: Natural Plants Products as Pesticides. Proceedings from the first National Symposium in Zambia held in Lutsaka, 2nd-5th August of 1994. ISSN 1104-6422.

Mhazo M.L., Mhazo N. and Masarirambi M.T. (2011) The Effectiveness of Home Made Organic Pesticides Derived from Wild Plants (*Solanumpindiriforme* and *Lippiajavanica*), Garlic (*Allium sativum*) and Tobacco (*Nicotianatobacum*) on Aphid (*Brevicoryne brassica*)

Mohanty A.K., Kar A.K. and Setti P.N. (1995) Efficacy of crude plant extracts of some selected plants in controlling brinjal blight and fruit rot pathogen, *Phomopsisvexans*. Crop Research Hisar. 9(3):447-448.

Radhakrishnan B. (2010) Indigenous botanical preparations for Pest and disease control in tea. Bull. UPASI tea research Foundation. 55:31-39.

Rahman A., Sarma M., Manorama B., Karansingh, Gurusubramanian G. and Hazarika M. (2006) Prospects in use of neem formulations and biocides in tea pest management in North east India.Crop Research Hissar. 31:160-170.

Rahman G.M.M., Islam M.R. and Wadud M.A. (1999) Seed treatment with plant extracts and hot water: a potential biophysical method of controlling seed borne infection of wheat. Bangladesh J. Training Develop. 12(1-2):185-190.

Rattan P.S. (1992) Pest and Disease Control in African Tea: Cultivation to Consumption. In: Wilson K.C. and Clifford M.N. (Eds.), London:ChapmanandHall. pp.331-352.

Sivapalan P. (1999) Pest Management in Tea.In Global Advances in Tea Science. In: Jain, N.K. (Eds.), NewDelhi: AravaliBooks. pp.625-646.

Sohail A., Hamid F.S., Waheed A., Ahmed N., Aslam N., Zaman Q., Ahmed F. and Islam S. (2012) Efficacy of different botanical Materials against APHID *Toxopteraaurantii* on tea (*Camellia sinensis* L.) cuttings under high shade nursery. J. Mater. Environ. Sci. 3(6):1065-1070.

Somnath R., Gurusubramanian G. and Mukhopadhyay A. (2009) Neem based Integrated Approaches for the Management of Tea Mosquito Bug, *Helopeltistheivora Waterhouse* (Miridae: Heteroptera) in Tea – a useful quality control criterion. IJAVMS. 3:4-11.

Subaharan K. and Regupathy A. (2006) Effect of neem formulations on the purple mite *Calacaruscarinatus* infesting tea. J. Plantation crops. 34:435-438.

USAID-HARVEST. (2012) Botanical Insecticide, Preparation and Use. Technical Bulletin #28: Available online in www.CambodiaHARVEST.org

Verkerk R.H.J. and Wright D.J. (1996) Multitrophic interactions and management of the diamondback moth: a review. Bulletin of Entomological Research. 86:205-216.

Widanapathirana C.U. and Dassanayake D.L.A.L.A. (2013) The Use of Plant Parts in Pest Control Activities in Traditional Sri Lankan Agricultural Systems.International Journal of Scientific & Technology Research. 2(6):150-152.

Zhang X. and Chiu S.F. (1983) The anti-feeding and repellent effects of meliaceous plants to some insect pests.Journal of SouthChina Agricultural College. 4:1-7.