Potential of botanicals for the management of forest insect pests of India, an overview

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ABSTRACT

This paper reviews the botanicals evaluated against forest insect pests of India and presents the impact of neem and other plant products against major forest insect pests. Various neem products were found effective in field condition against many forest insect pests like the rohida defoliator, *Patialis tecomella*, the babul defoliator, *Taragama siva*, the desert locust *Schistocerca gregaria*, the babul whitefly *Acauldaleyrodes rachipora*, the spiralling whitefly, *Aleurodicus dispersus* and the teak defoliators *Hyblea puera* and *Paliga machaeralis* etc. Neem oil and neem oil based formulations were used to contain the populations build up of *A. dispersus* on roadside plantations of *Bauhinia variegata* and *Michelia champaca*. Neem cake, pongam cake and VAM were commonly applied in combination for the management of sucking pests on seedlings. Other than neem about 58 plant species were reported to have pest management properties on forest insect pests. In these plants, mostly crude extracts were reported to have different type of pest management properties in laboratory condition against defoliating pests. Not much work has been carried out on other group of insects like sap suckers, wood borers, gall inducers etc. Extractives of different parts of *Capparis decidua* were found to possess aphidicidal principles against three species of aphids *viz.*, *Aphis gossypii*, *Lipaphis erysimi* and *Mysus persicae*. Plant products other than neem were not practically used much for pest control. It is recommended to have national, regional and international coordinated effort to exploit botanicals that are more potent as an integral component of pest management in different cropping systems including forestry.

Key words: Botanicals, forest insect pests, pest management

INTRODUCTION

The use of synthetic pesticides during the last half century has often been careless and indiscriminate which resulted in malicious effects on the environment and leads to “ecological backlash” (Sundararaj, 1997). Concern about this has led to a surge of research into alternative pest control technologies. One of the efforts is the development of botanical insecticides as a novel and safer alternative strategy. Botanical insecticides, which contain plant extracts as active components, are safer as well as environmentally friendlier than synthetic insecticides. Use of these chemicals of plant origin, commonly called ‘botanicals’ or ‘phytochemicals’ have attracted particular attention because of their specificity to insect pests, their biodegradable nature and their potential for commercial application (Bishop and Thronton, 1997;Shukla et al., 2000). These materials have been, since time immemorial, reported to be devoid of the various disadvantages, which are associated with the use of synthetics. Bioactivity of plant-based compounds is well documented in literature and is a subject of increasing importance. Knowledge of the toxic plants, their toxic principles and their biological activity is of paramount importance not only to enable them to be utilized as natural pest control agents and replace the commercial synthetic pesticides but also to enable us to understand the nature of their toxicity to non-targeted animals. The efficient use of such renewable natural resources is becoming increasingly important worldwide. There is no doubt that many plant secondary metabolites affect insect behaviour, development and reproduction. Characterization and identification of these
substances is an important first step in understanding the effect of plants on insect life. The botanicals thus obtained offer better compatibility with other biological pest control agents than that of the synthetics and this has brought them to sudden prominence in pest management programme.

Neem- A potential source of biopesticide

Neem (Azadirachta indica) products are known in use in India from time immemorial against noxious insects. Because of its legendary insect repellant and medicinal properties, it being identified as “the most promising of all plants” and at the present moment it is the source of most promising pesticides. More than 100 protolimonoids, limonoids or tetratenortriterpenoids and some nonterpenoid constituents have been isolated from various parts of neem (Koul et al., 1990). From the neem seed extract alone, over 57 components have been isolated and identified (Jacobson, 1988). It is now well established that azadirachtin, the most important phagorepellent of neem kernels protects plants against insect attack. Bernays and Chapman (1977) indicated azadirachtin as the most potent antifeedant against insects like Locusta migratoria migratorioides and Schistocerca gregaria. It exhibits strong antifeedant activity against locusts as well as growth inhibiting properties (Rembold et al., 1980). Neem kernel extracts or their oil repel insects, act as antifeedant, cause growth disruption, deformities or mortality and impairing egg production (Sieber and Rembold, 1983). The review offer further evidence for the impact of neem products against the major forest insect pests of India. The control of forest pests like poplar defoliator, Pygaera cupreata (Bhandari et al., 1988), babul defoliator, Taragama siva (Sundararaj et al., 1995), the rohida defoliator, Patiaius tecomella (Sundaraj and Murugesan, 1995), the babul whitefly, Acaudaleyrodes racipiora (Sundararaj et al., 1995; 1996, Sundararaj, 1999a, b), the teak defoliators, Eutectona machaeraxis and Hyblaea puera (Kulkarni et al., 1996; Remadevi and Raja Muthukrishnan, 1988; Murugan et al., 1999; Sree et al., 2008) using different neem products have been tested and found useful. Dubey and Sundararaj (2004) demonstrated neem oil as effective like that of commercial neem formulations and Chlorpyriphos in containing the nymphal populations of A. disperses infesting trees of Michelia champaca and B. variegata.

Neem seed kernel suspension as effective repellent against the polyphagous desert locust Schistocerca gregaria was demonstrated (Pradhan and Jotwani, 1971; Singh, 1985; Sundararaj et al., 1985). Ramarethisam et al. (2002) repored insecticidal property of azadirachtin against Eurema hecabe on Cassia fistula, Ambika et al. (2007) recommended neem seed oil against Pemplia morosalis on Jatropha and Murugesan et al. (2008) recommended nimbicidin against Caryxodon serratus infesting seeds of many forest trees. The application of neem cake alone or in combination with other seed cakes and VAM was recommended to control whiteflies in nurseries (Sundararaj, 2010). As the neem products proved its practical utility, they are recommended for large-scale application in forestry.

Other plant products

A perusal of literature revealed that other than neem about 58 plant species were reported to have pest management properties on forest insect pests (Table 1). Mostly crude extracts were found to have different type of pest management properties in laboratory condition against defoliating pests of teak, poplar, subabul, bamboo etc., without identifying the active principles in the plant products. Defoliating insects were mostly used as test insects except the report of Sharma et al. (1992) who reported insecticidal properties of 15 plant oils against the sap sucking psyllid Heteropsylla cubana. Similarly extractives of different parts of Capparis decidua were found to possess aphidical principles against three species of aphids viz., Aphis gossypii on marwar teak (Tecomella undulata), Lipaphis erysimi on mustard (Brasica campestris) and Myus persicae on cabbage (Brassica oleracea) (Table 2). The order of aphidical potential of extract is root > seed > stem bark > branch > wood. These plant products are probable sources of some biologically active agents for pest management for the future. Although the potential of various plant species in pest management has been demonstrated, the plants
Table 1. Plant products other than neem reported to have pest management properties against tree pests of India

<table>
<thead>
<tr>
<th>Tree species</th>
<th>No. of plant species reported</th>
<th>Nature of plant products</th>
<th>Pest species and their nature</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia nilotica</td>
<td>1</td>
<td>Leaf powder: 1</td>
<td>Seed feeders: <em>Bruchidius</em> sp., and <em>Caryodon serratus</em></td>
<td>Insecticidal</td>
<td>Murugesan et al., 2008</td>
</tr>
<tr>
<td>Ailanthes sp.</td>
<td>3</td>
<td>Leaf extract: 3</td>
<td>Defoliator: <em>Atteva fabriciella</em></td>
<td>Antifeedant</td>
<td>Ahmed et al., 1991;</td>
</tr>
<tr>
<td>Bambusa balcooa</td>
<td>6</td>
<td>Leaf extract: 6, Flower extract: 2</td>
<td>Defoliator: <em>Crypsiptya coclesalis</em></td>
<td>Antifeedant</td>
<td>Kulkarni and Joshi, 1998; Kulkarni and Joshi et al., 1999; 2003</td>
</tr>
<tr>
<td>Bamboo spp</td>
<td></td>
<td></td>
<td>Termites</td>
<td>Resistant to degradation, Antifeedant</td>
<td>Borthakur and Gogoi, 2009</td>
</tr>
<tr>
<td>Dalbergia sissoo</td>
<td>5</td>
<td>Leaf extract: 5</td>
<td>Defoliator: <em>Plecoptera reflexa</em></td>
<td>Antifeedant</td>
<td>Kulkarni et al., 1997b; Meshram, 2000</td>
</tr>
<tr>
<td>Feronia elephantum</td>
<td>1</td>
<td>Leaf extract: 1</td>
<td>Defoliator: <em>Papilio demolis</em></td>
<td>Antifeedant</td>
<td>Meshram et al., 1996</td>
</tr>
<tr>
<td>Gmelina arborea</td>
<td>1</td>
<td>Plant oil: 1</td>
<td>Defoliators: <em>Calopepla leayana</em>, <em>Eupterote giminata</em></td>
<td>Antifeedant</td>
<td>Singh and Sushilkumar, 1998</td>
</tr>
<tr>
<td>Leucaena leucocephala</td>
<td>15</td>
<td>Plant oil: 15</td>
<td>Sap sucker: <em>Heteropsylla cubana</em></td>
<td>Insecticidal</td>
<td>Sharma et al., 1992</td>
</tr>
<tr>
<td>Pongamia pinnata</td>
<td>2</td>
<td>Leaf extract: 2</td>
<td>Defoliator: <em>Lamprosema niphaelis</em></td>
<td>Growth inhibition</td>
<td>Deepa and Remadevi, 2007a</td>
</tr>
<tr>
<td>Poplar spp</td>
<td>3</td>
<td>Bark extract: 1, Leaf extract: 2, Root extract: 1</td>
<td>Defoliator: <em>Clostera cuprea</em></td>
<td>Antifeedant</td>
<td>Ahmad et al., 1997</td>
</tr>
<tr>
<td>Tamarindus indica</td>
<td>1</td>
<td>Leaf powder: 1</td>
<td>Seed feeder: <em>Bruchidius</em> sp., and <em>Caryodon serratus</em></td>
<td>Insecticidal</td>
<td>Murugesan et al., 2008</td>
</tr>
<tr>
<td>Tectona grandis</td>
<td>36</td>
<td>Bark extract: 5, Leaf extract: 27, Seed extract: 4, Seed oil: 1, Tuber extract: 1, Wood extract: 1</td>
<td>Defoliators: <em>Hyblaea puera</em></td>
<td>Growth inhibition</td>
<td>Sundararaj et al., 2004; Ramana et al., 2004; Deepa and Remadevi, 2005; Senthil Nathan and Sehoon, 2006; Ramana and Himaveethi, 2006; Ramana et al., 2007</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Paliga machaerolis</td>
<td>Insecticidal, Larvicidal, Ovicidal</td>
<td>Deepa and Remadevi, 2007b</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Antifeedant</td>
<td>Krishnakumar et al., 2011</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Growth inhibition</td>
<td>Javaregowda and Naik, 2006; Ramana, 2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Antifeedant, Growth inhibition</td>
<td>Meshram, 1995; Kulkarni et al., 1997a; Murugesan et al., 2003; Sundararaj et al., 2004; Durairaj, 2009</td>
</tr>
</tbody>
</table>

have not been exploited commercially (Srinivasan, 2012) and as of now except neem other botanicals are not practically used in pest control. Geden (2012) is of the view that further research on blends of essential oils with other botanicals and improved formulations and delivery systems could lead to substantial improvements in the performance of botanicals. 

In conclusion synthetic insecticides have been used to contain insect populations since the inception of green revolution with the significant increase in crop production. However, the consequent pollution jeopardizes the agricultural as well as forestry business. In this context, plant products are preferred over synthetic chemicals as they are non-
persistent and are compatible. Over 2,000 plant species have been reported to possess pesticidal activity but only a handful of pest control products directly obtained from plants are in use. Botanicals used as insecticides presently constitute 1% of the world insecticide market and in Indian market it is less than 1%. To enjoy widespread use, plant based products must demonstrate efficacy that is competitive with existing chemicals and must remain within the reach of resource limited farmers in the developing countries. Besides, there is a need for promoting the use of plant products in the insect pest management programs. Undoubtedly, neem compared to other plant products can boost the biopesticide industry if ventures of its commercial production and village industry are set up so that its neem products are available to the reach of planting community all round the year. Besides with the recent spell of research on botanicals, it is recommended to have national, regional and international coordinated effort to exploit botanicals as an integral component of pest management in different cropping systems including forestry.

REFERENCES


Table 2. Efficacy of extracts of *Capparis decidua* on different species of aphids.

<table>
<thead>
<tr>
<th>Aphid species</th>
<th>Host Plant</th>
<th>Method of application</th>
<th>Mortality (%) over control with 1% extracts of different parts of <em>Capparis decidua</em> at 48 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aphis gossypii</em></td>
<td><em>Tecomella undulata</em></td>
<td>Dipping</td>
<td>Seed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spraying</td>
<td>94.85</td>
</tr>
<tr>
<td><em>Lipaphis erysimi</em></td>
<td><em>Brassicca compestris</em></td>
<td>Dipping</td>
<td>96.64</td>
</tr>
<tr>
<td><em>Mysus persicae</em></td>
<td><em>Brassica oleracea</em></td>
<td>Spraying</td>
<td>93.33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dipping</td>
<td>93.33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spraying</td>
<td>90.00</td>
</tr>
<tr>
<td>CD (P= 0.05%)</td>
<td></td>
<td></td>
<td>5.76</td>
</tr>
</tbody>
</table>


Sundararaj, R. 1999b. Field evaluation of neem cake with biofertilizers and conventional fertilizer
against the incidence of the babul whitefly *Acaudaleyrodes rachipora* (Singh) (Aleyrodidae: Homoptera) on *Acacia nilotica* seedlings. *Pestology*, 22(12): 9-12.


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