


Review Article
REVIEW ON NEEM (AZADIRECTA INDICA A. JUSS.) AS A POTENTIAL SOURCE OF ORGANIC PESTICIDE
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ABSTRACT

Extensive usage of broad spectrum synthetic pesticides during the last century has created so many environmental problems worldwide, most of the pesticides and chemicals are not biodegradable and due to bioaccumulation can enter into food chain and affects human and animal health. To overcome such problems focus on the use of plant based pesticides is the need of time. Because of their easy biodegradation, least toxic to the non-target organisms, economic and easy availability popularity of such plant based pesticides increases day by day. Among the recognized pesticidal plants, the *Neem* tree *Azadirachta indica* A. Juss., belonging to the family meliaceae proved for numerous active ingredients of insecticidal and pesticidal properties. The active principle of *Neem* tree is azadirachtin, a nortriterpenoids, possesses broad spectrum activity at low use rates, and classical growth regulator activity and unique mode of action (ecdysone disruptor) make azadirachtin as an ideal candidate for insecticide resistance, integrated pest control and organic pest control programme. *Neem* products are effective against various pest of crop field such as whiteflies, leaf miners, fungus, aphids, and many leaf eating caterpillars and also in stored grains like rice, wheat, corn etc. This review gathered information related to the *Neem* tree as a better biopesticides and try to develop awareness about side effects of chemical pesticides and benefits of biopesticides among farmers, agricultural industry and in laymen.

KEYWORDS: Biopesticide, Insecticide, *Azadirachta indica*, Synthetic pesticide, Phytoconstituents.

INTRODUCTION

The *Neem* tree *Azadirachta indica* A. Juss. Belonging to the family Meliaceae, Order Rutales, is known for its various pharmacological activities such as Abortifacient, antibacterial, antifilarial, antifungal, antiviral, antimalarial, antinematodal, antipyretic, insecticidal, antispermatogenic, antitumor, antiyeast, immunomodulator etc.^[1,2] One of the synonym of *Neem* is '*Krimighna*', representing the insecticidal property of neem. Also there are lot of references are found in the classical *Ayurvedic* text about the insecticidal property of neem, such as *Neem* leaves are the important ingredient of '*Dhoopan karma*' i.e. used as a insect repellent, *Neem* leaves are also used in Small pox, in bath water, on the bed of patients to protect the patients against further infection. *Neem* oil is also most useful in various skin diseases like Scabies, Eczema, pemphigus, urticaria etc. external application of *Neem* oil get relief in such patients.^[3] Various part of the tree are used in India for different medicinal purposes and *Ayurveda* regards the tree as a '*Sarva roga nivarini*'.

In spite of these medicinal uses *Neem* tree has received world-wide attention in recent years for its promising insecticidal, pesticidal, antifeedant, and repellent effect against various pests. The insecticidal property of *Neem* has been recognized for a long time among the farmers of Indian subcontinent. Over 2400 plants are known to elaborate insecticidal and insect repellent property^[4], but only *Neem* holds out the promise of providing a highly effective, non-toxic to non-target

organisms, eco-friendly and means of controlling or eliminating insect pest which inflict losses in agricultural production. *Neem*-based products were proved as medium to broad-spectrum insecticides against various field and store pests.^[5] The key active ingredient from *Neem* is Azadirachtin, a nortriterpenoid which exhibits classical insect growth regulator effects on the immature stages of insects. There are lot of studies proves the antifeedant, reproductive and IGR effect of azadirachtin on many species of insects but the mechanism of action on molecular level is still being elucidated.^[6]

Habitat and distribution of *Neem* tree

The *Neem* tree is indigenous to South Asia. It is found in most part of the Indian subcontinent in the tropical and subtropical, semi-arid to wet tropical regions. Indian settlers have been responsible for its introduction to the African countries, where it is abundant in the tropical region from Somalia in the East to Nigeria, Mauritania, and Togo etc. in the West. It is also spread out in south and Central America. It is cultivated and frequently naturalized throughout the drier regions of tropical and subtropical India, Pakistan, Sri Lanka, Thailand and Indonesia. It is also grown and naturalized in Peninsular Malaysia, Singapore, Philippines, Australia, Saudi Arabia, Tropical Africa, and the Caribbean.^[7]

Morphology of *Neem* tree^[8,9]

It is a tree 40-50 feet height, with a straight trunk and long spreading branches forming a broad round

crown; it has rough dark brown bark with wide longitudinal fissures separated by flat ridges. The leaves are compound, imparipinnate, each comprising 5-15 leaflets. The compound leaves are themselves alternating with one another. It bears many flowered panicles, mostly in the leaf axile. Fruits are green, turning yellow on ripening, aromatic with garlic like odour. Fresh leaves and Flowers come in March-April. Fruits mature between April and August depending upon locality.

Phyto-constituents from *Neem* tree [10, 11]

In India, pioneering work on the isolation and identification of *A. indica* compounds was initiated in 1942 and has continued in various parts of the world.

Leaves: *A. indica* leaves has been shown to contain crude fibre (11-24%), carbohydrates (48-58%), crude proteins (14-18%), fat (2.3-6.9%), ash (7.7-8.5%), calcium(0.8-2.4%), and phosphorus (0.13-0.24%), as well as number of amino acids. Recently, a 2D -TLC method revealed the presence of carotenoids in the leaves of *A. indica*.

Oil: rich in fatty acids and cake has high sulfur content as compare to other oil cakes.

Gum and Bark: polysaccharides and numbers of sugars have been identified.

Seed karnel: is the most effective part of *A. indica*. It has a combination of pesticidal active ingredients which are together called "triterpene" more specifically "limnoid". The four best limnoid compounds are: Azadirachtin, Salanin, Meliantriol and Nimbin.

Pest species susceptible to Azadirachtin

Azadirachtin is active in nearly about 550 insect species [12] mostly in the orders:

- Coleoptera - Eg. Beetles and weevils.
- Dictyoptera - Eg. Cockroaches and mantids
- Diptera - Eg. Flies
- Heteroptera - Eg. Trug bugs
- Homoptera - Eg. Aphids, leaf hoppers, wasps and ants.
- Isoptera - Eg. Termites
- Lepidoptera - Eg. Moths and butterflies.
- Orthoptera - Eg. Grasshoppers, katydids
- Siphonaptera - Eg. Fleas
- Thysanoptera - Eg. Thrips

Biopesticides are superior to chemical pesticides

Chemical pesticides are used widely because they can be applied whenever and wherever needed and the most important thing is the reliability of control method. The contribution of pesticides to increase agricultural yield cannot be denied, but synthetic pesticides have caused unprecedented hazards to the human beings, animal and environment,[12] they also may accelerate development of the pest biotypes resistant to specific pesticidal chemicals.[13] On the other hand biopesticides or natural pesticides are active principle derived from plants for the management of pest with growing demand for environmentally sound pest management strategies; they were reported to show minimal cost and ecological side effects. These biopesticides are affects only target pest and target organisms, effective in very small quantities, decompose quickly and provide the residue free food and a safe environment. Botanical pesticides reduce or delayed the development of resistance in pest population by used

in rotation or in combination with other insecticides. When incorporated in integrated pest management programs, botanical pesticides can greatly reduce the use of conventional pesticides. Plant based insecticides not only induce acute toxicity to pests but also show feed deterrence and/or repellence effect. [14]

Advantages of using pesticides of *A. indica*

As compare to other natural pesticides *A. indica* possesses some distinct advantages such as, 1) these trees are typically grow in the tropical and subtropical parts of Asia, but nowadays they are also cultivated in other warm regions of the world because of their considerable climatic tolerance. This tree even survives on waste and marginal lands. As compare to pyrethrum (which requires careful cultivation), *Neem* tree once established becomes perennial. *Neem* tree adapted to wide range of temperature between 0 degree to 45 degree Celsius and an altitude upto 1500 meters above sea level. It requires minimum rainfall of 450mm for its survival. It grows well on Calcareous soils with Ph upto 8.5 even in the presence of hard pan at a soil depth of 1.5- 2.0 m. [15]

- 2) It is relatively cheap and easily available. [16]
- 3) Its complex mixture of active ingredients which functions differently on various parts of the insect life cycle and physiology, make it difficult to pest to develop resistance to it. [16]
- 4) *Neem* pesticides are environmental friendly and do not contaminate terrestrial and aquatic environment. [16]
- 5) They are non- toxic [16]
- 6) They can be used in combination with other pesticide and oil for more effectiveness. [16]
- 7) They posses anti feedant properties, which help to protect the plants. [16]
- 8) Pests generally do not develop resistance to them. [16]
- 9) They are generally water soluble and help in the growth of the plants. [16]
- 10) They act as pest reproductive controller. [16]
- 11) They help to nourish and condition the soil. [16]
- 12) They are relatively less expensive. [16]

Preparations of *Neem* used as pesticides [16, 17, 18]

Sr. no.	Preparation	Mode of application
1.	Powder	Spray
2.	Oil	Hand sprayer/ Broom sprinkling method
3.	Alcoholic or ethanolic extract	Hand sprayer/ Broom sprinkling method
4.	Aqueous extract	Hand sprayer/ Broom sprinkling method

Commercial formulations from *Neem*

The bioactive components in *Neem* tree are normally extracted in organic solvent particularly methanol, ethanol, acetone, hexane, petroleum ether, diethyl ether, chloroform or methyl chloride. etc. [19]

Neem based insecticides used in Indian market are: [20,21,22]

- 1) Repelin
- 2) Wellgro

- 3) Nimbosol
- 4) Neemark

Azadirachtin a main constituent of *Neem*

Azadirachtin isolated in 1968, is the most potent locust antifeedant discovered to date.^[25] Azadirachtin a nortriterpenoid belonging to the limonoids. It is the most biologically active constituent of *Neem*, and its concentration in seed kernels is said to be about 2-4% by weight.^[23] Azadirachtin has little or no impact on pollinators such as honey bees, bumblebees and other non-target organisms. Azadirachtin is an ideal complementary insecticide in IPM systems because it effectively kills the phytophagous insects while having minimal impact on beneficial. Azadirachtin has little or no activity against mites or adult beneficials.^[26] UV light is responsible for photo-oxidation of azadirachtin, so that neem preparations are kept away from sunlight. Sunscreens such as Para Amino Benzoic Acid (PABA) could be added to reduce the photo-oxidation of azadirachtin by UV light.^[26] Also azadirachtin preparations are unstable in nature, in general higher the azadirachtin concentration in the final formulation, greater is the instability. Therefore at present, there are several patent regarding procedures and compositions that claim to confer unique stability to azadirachtin.^[27] The yield of azadirachtin varies greatly with the soil, the climate, maturity of the seeds and length of storage.^[28]

Mode of action of azadirachtin

The molecular formula of azadirachtin: $C_{35}H_{44}O_{16}$ ^[29]

The efficacy of *Neem* is linked to the physiological action of azadirachtin. It acts as an Insect Growth Regulator (IGR) on larval insects like disruption of moulting, growth inhibition, malformation which may contribute to mortality. This is attributed to a disruption of endocrine events as the down- regulation of haemolymph ecdysteroid level through the blockage of release of PTTH, prothoracicotropic hormone, from the brain- corpus cardiacum complex, or to a delay in the appearance of the last ecdysteroid peak showing a complete moult inhibition. There are also effects on allatropin and juvenile hormone titres.^[30] Antifeedant effect of azadirachtin is highly variable among pest species and even those species initially deterred are often capable of rapid desensitization to azadirachtin^[31]

Safety value of *Neem* pesticide

Several researches are reported that azadirachtin is non-toxic to mammals^[32] and did not show chronic toxicity. *Neem* products were neither mutagenic nor carcinogenic and they did not produce any skin irritations or organic alterations in mice and rats, even at high concentrations.^[33]

CONCLUSION

Extensive usage of broad spectrum synthetic pesticides during the last century has created so many problems worldwide; therefore various alternative measures of pest control were studied during the last decades including botanical extracts. *Neem* tree are found throughout India with a myriad of uses in medicine, as well as pest control. *Neem* based pesticides are extensively used in agriculture practices throughout the world. It contain

azadirachtin, which is a predominant pesticidal active ingredient, having antefeedant, ovipositional, deterrence, repellence, growth disruption, sterility and larvicidal action against great variety of pest. *Neem* derivatives are degrade faster in sunlight than in storage environment and therefore, could provide satisfactory protection to stored grains against insect pests without requiring repeated application. *Neem* provides a suitable option for developing eco-friendly and sustainable pesticides. Currently a very small percentage of farmers use *Neem*-based products as a substitute to synthetic pesticides as the general awareness of such practices remains limited. Azadirachtin, derived from *Neem* seed kernels, has been proved to be a potent and effective pesticide. Total chemical synthesis of azadirachtin is challenging results in low yield of synthesis and remains a bottleneck for commercial bulk manufacturing. *Neem* products are suitable for integrated pest management because of their low toxicity to non-target organisms, easy preparation and compatibility with other bio-products. So there is need to educate all farmers for judicious use of pesticides, use of biotechnology and bio-pesticides via proper application of integrated pest management programs would positively reflect on human health, agriculture, biodiversity and ecosystem management to minimize environmental problems caused by pesticides.

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