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Azadirachta indica - A Tree With Multifaceted Applications: An Overview

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Abstract

Neem (*Azadirachta indica* A. Juss) is perhaps the most useful traditional plant in India.Not only India, it is world widely distributed but known as different names other than neme.It is an evergreen,temperature tolerant,flowering plant.It is a natural product which has much to offer in solving global agricultural, environmental and public health problems from time immemorial. The neem tree has over centuries been used as herbal plant; including its use against insect pests. In India use of neem tree in record from a very long time. Neem based pesticides play a vital role in pest management and hence have been widely used in agriculture. Mostly all parts of the neem tree like the bark, leaves, flowers, seeds and fruit pulp are used.They are mostly used in the powdery or in the extract form like leaf extract,kernel extract,cake extract, Pongam-aloe and neem extract, Custard apple-neem-chilli extract,oil spray etc. It acts in many ways like insect growth regulator,feeding deterrent,oviposition deterrent,sterilizer,inhibitor of chitin synthesisis etc. Beside this, neem also act as good manure,fertilizer,soil conditioner,urea coating agent etc. In the agricultural field.Actually it is meant to serve as an ecofriendly and sustainable-agriculture initiative.Present review corroborates a depth analysis for the insect pest control by different neem chemicals, like Azadirachtin, Nimbin, Nimbidin, Salanin, Salannol, Quercetin, Gedunin etc.

Keywords : Elixir, Extract, Multifacet, Pest, Powder, Tree.

INTRODUCTION:

Extensive usage of broad spectrum synthetic pesticides during the last century is a concern of environmental threat worldwide [13,31] . Moreover, pest resistance to pesticides and consequently the increased costs of sproduction have also aggravated the drawbacks of these chemicals [7,13] .Therefore, various alternative measures of pests control including botanical extracts were studied during the last decades, [47,60]

Neem was 'discovered' in the western world in 1959 when a German entomologist noticed that it was the only green standing after a swarm of locusts swept through the Sudan. Among the recognized 'pesticidal' plants, the neem tree, *Azadirachta indica* provides a unique source for numerous active ingredients having insecticidal properties.

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. *Azadirachta indica* is native to India and naturalized in most of tropical and subtropical countries. The importance of neem is recognized in the report of US National Academy of Sciences entitled 'Neem - a tree for solving global problems' in 1992. Neem-based products were proved as medium- to broad-spectrum insecticides against various field and store pests [50]

EXTENT OF LOSS BY INSECT PESTS:

Insect pests cause heavy food grain losses in storage, particularly at the farm level in tropical countries. Insect pest infestation has been reported as the major cause of food grain losses in most developing countries [57]. Food grain losses in India during storage ranges at about 10% of the total production [30]. In Sub-Saharan Africa, food grain losses during storage at farm level can reach as high as 25-40% [15]. Post-harvest losses of grains are also higher in developing countries.It has been reported stored grains losses as high as 30% and an average of 8.7% during 3 to 6 months storage period in Nigeria [1]. Particularly implicated *Sitophilus zeamais* as one of the common grain pests in tropical countries such as Nigeria.[1,32]

DISTRIBUTION OF NEEM PLANT:

A native to east India and Burma, it grows in much of south East Asia and West Africa, and more recently Caribbean and south and Central America. In India, it occurs naturally in Siwalik Hills, dry forests of Andhra Pradesh, Tamil Nadu and Karnataka to an altitude of approximately 700 m. 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 often naturalized in Peninsular Malaysia, Singapore, Philippines, Australia, Saudi Arabia, Tropical Africa, the Caribbean, Central and South America [37]

TAXONOMY AND NOMENCLATURE:

Its scientific name, *Azadiracta indica*, is in fact derived from *Azad-Darakth*.Two species of *Azadirachta* have been reported, viz – *Azadirachta indica A.* Juss , native to Indian subcontinent and *Azadirachta excels* Kack.-confined to Phillipines and Indonesia [37].

The taxonomic classification of neem is: *Kingdom*:Plantae; *Order*:Rutales, *Suborder*:Rutinae, *Family*:Meliaceae, *Subfamily:*Melieae; *Tribe*:Melioideae, *Tribe*: Melioideae; *Species*: *Indica*.[19,41]

VERNACULAR NAMES:

In North Queensland, the name 'neem' is erroneously applied to '*Melia azedarach*' ('white cedar'). The tree is variously known as '*Divine Tree*' '*Heal All*', 'Nature's

Drugstore' '*Village Pharmacy'* and '*Panacea for all diseases*' in Indian Ayurvedic tradition. In East Africa it is known as *Muarubaini* (*Swahili*), which means the 'tree of the 40', as it is supposed to cure 40 different diseases. Neem tree is also known as '*arista*' in Sanskrit- a word that means '*perfect, complete and imperishable*'. The Sanskrit name '*nimba*' comes from the term '*nimbatisyasthyamdadati*' which means 'to *give good health*'. The Persian name for the neem of India is *Azad-Darakth* or the 'free tree'. India has shared its '*free tree*' and knowledge of its utilisation with the world community. The freedom of diverse species to exist and the freedom of people to exchange knowledge about them are best symbolised in the neem.

Neem has variable spellings with variable meanings [37]. English: neem, Indian lilac, French: azadira d'Inde, margousier, azidarac, azadira, Guajarati: Danujhada, Limbado, s Hindi: neem, nimb, Kannada: Bemu, Bevinamara, Bivu, Kaybevu, Burmese: tamar, tamarkha Urdu: nim, neem Punjabi: neem Tamil: vembu, veppan Sanskrit: nimba, nimbou, arishtha (reliever of sickness) Sindhi: nimmu Sri Lanka: kohomba Farsi: azad darakht i hindi (free tree of India), nib Malay: veppa Singapore: kohumba, nimba Indonesia: mindi Nigeria: dongoyaro Kiswahili: mwarubaini (muarobaini)

CHARACTERISTICS OF NEEM PLANT:

The neem tree is drought resistant and thrives normally in areas with sub-arid to sub-humid conditions, with an annual rainfall between 400-1200 mm.[18] Neem is generally evergreen but can shed most of its leaves under dry conditions. Neem is a type of mahogany, a fast-growing evergreen tropical to subtropical tree that can reach a height of 50-65 feet. Neem can tolerate high summer temperatures (up to 50 ˚C) but does not tolerate frost or temperatures below 4 ˚C (leaf fall and death may result). Neem grows best in areas where annual rainfall is 450–1200 mm (with optimum growth where annual rainfall is around 1100 mm), but can tolerate annual rainfall as low as 150 mm if its roots can access ground water within 9–12 m of the ground surface [56]. Once established it is very drought tolerant and can survive 7–8 month dry seasons.

The compound (pinnate) leaves are in alternate fashion, 20–40 cm long , with 20–30 dark green, serrated leaflets, each about 3–8 cm long. The terminal leaflet is often absent. Young leaves are reddish to purplish in colour. Petioles are 70–90 mm long. The bark is deeply fissured in structure. Flowers are cream in colour, perfumed and arranged in axillary clusters. Each inflorescence is 15–25 cm long and comprises 150–250 individual flowers. Each flower is about 1 cm in diameter with five petals, ten stamens and one style. The ovary is syncarpous, superior, and three-celled with 1–2 ovules per cell. The fruits are glabrous, olive-like drupe, 1–3 cm in diameter, varying in shape from elongate oval to roundish. It is yellow when ripe and comprises a sweet pulp enclosing a single seed (rarely 2–3 seeds).Neem has a strong root system with a deep tap root and extensive lateral roots. Suckers can be produced following damage to the roots [23]

INSECT PESTS OF NEEM PLANT:

Oryzaephilus surinamensis and *O.acuminatus* infest old neem seed kernels [46,58] . Neem is known to be infested by scale insects *Palvinaria maxima* and *Aspidotus orientalis*, lepidopteran *Helopeltis theivora*, and geometrid moth *Ascostis selenaria* [6]. Minor defoliating agents are acridid grasshopper *Orthacris simulans*, fire ants *Solenopsis* spp. and *Latoia lepida* (Cram), coleopteran *Cryptocephalus ovulum* and lepidopteran *Laspeyresia aurantiana* and *Cleora cornaria*.

CHEMISTRY OF NEEM:

Neem plants contain several thousands of chemical constituents having insecticidal property. Enormous active ingredients are found in all botanical parts of the neem tree, but concentrated largely in the seed kernels. A group of limonoids (triterpenoids) including Azadirachtin, Nimbin, Nimbidin, Salanin, Salannol, Quercetin, Gedunin are reported. Terpenoids from different parts of the neem plant are also extracted. Out of these, most active and well studied compound is Azadirachtin ($C_{35}H_{44}O_{16}$) of different types (A to K) have been isolated. The neem terpenoids are present in all parts of the plant. Limonoids contain insecticidal activity [33]. Two tetranortriterpenoids, 1 1 - epiazadirachtin H [44] and AZ-K [21], have been isolated from neem seeds. Site of synthesis and accumulation of the neem-chemicals have also been identified as 'secretory cells' in seed kernels. Seeds contain tignic acid responsible for the distinctive odour of the oil [51]. More than 20 sulphurous compounds responsible for the characteristic smell are also present. It had reported non-volatile, somewhat heat labile constituents in neem leaf extract which blocked aflatoxin biosynthesis in *Aspergillus flavus* and *Aspergillus parasiticus*.[62]

PLANT PARTS AND PRODUCTS OF NEEM:

For centuries the Neem tree has been noted for its unique insecticidal and miticidal properties. For hundreds of years, the local villagers in India, Bangladesh and Pakistan put neem tree in their granaries and cup boards to keep away weevils and other insects.Using of different neem derivatives as insect repellent agents are as follows :

Neem seed: Seed azadirachtin has mainly repellent, anti-feedant, toxic and growth regulatory effects. The water extract of neem seeds was effective as natural insecticides for combating storage and field pests. The new seed have more repellent effect. Neem oil is an extract from the seeds of the Neem tree .Neem oil works to smother and repel pests. The product suffocates all of the life stages of aphids, citrus black flies, fruit flies, and leafminers [11] .Seed kernels of neem are the source of Azadirachtin and related Limonoids (AZRL), which has been well known since ancient times as a potent biopesticides against a variety of insects [38] .

Neem leaves: Neem leaves are also used in storage of grains [11] .Twigs of neem when tender is used as green manure after decomposing and widely incorporated in rice cultivation fields.Neem leaf

extracts have been found to have insecticidal properties. They are used as green leaf manure and also in preparation of litter compost mealy bugs, whiteflies and scale, among others, as well as mite adults and eggs. Neem Oil kills pests quickly and repels them for up to one-to-two weeks.

Neem bark: Neem bark has insecticidal properties. Bark in powdered form is also used to control fleas and sucking pests in rice cultivation [11]

Neem root: Neem root in powdered form are also used to control fleas and sucking pests in rice cultivation.

APPLICATIONS OF NEEM:

Neem used as fertilizer: The material left after oil is squeezed out from seeds and is popularly known as the seed cake. It acts as a bio-fertilizer and helps in providing the required nutrients to plants. It is widely used to ensure a high yield of crops, particularly rice and sugarcane. It acts as a soil enricher, reduces the growth of soil pest and bacteria, provides macro nutrients essential for all plant growth, and helps to increase the yield of plants in the long run, bio degradable and eco-friendly.

Neem used as manure: Neem is rich in sulphur, potassium, calcium, nitrogen, etc. Neem cake is used to manufacture high quality organic or natural manure, which does not have any aftermaths on plants, soil and other living organisms. It can be used directly by mixing with the soil or it can be blended with urea and other organic manure. It is bio-degradable and eco friendly, nourishes the soil and plants by providing all the macro and micro-nutrients, helps to eliminate bacteria responsible for denitrifying the soil.

***Neem as urea coating agent*:** Neem and its parts are being used to manufacture urea coating agent to improve and maintain the fertility of soil. Use of neem urea coating agent helps to retard the activity and growth of the bacteria responsible for denitrification. It prevents the loss of urea in the soil. Urea coating is generally available either in liquid form or powdered form. Neem urea coatings are excellent natural or bio pesticides, environmental friendly, non-toxic, reduces urea consumption, convenient and easy to apply, high soil fertility and increases the yield of crops.

Neem as soil conditioner: Neem seed granules or powdered seeds are used to manufacture the soil conditioner. It can be applied during sowing of plants also prevents them from being destroyed by certain pests and insects. Organic soil conditioner is gaining popularity in agricultural industry. This natural soil conditioner is also multi-functional and in the sub tropical regions. Neem soil conditioner application in plantation crops is known to be soil enhancers that help to increase its fertility.

***Neem as fumigant*:** Neem tree has been used against household, storage pests and crop pests. Neem pest fumigant is eco friendly and available in gaseous state and is used as a pesticide and disinfectant. This natural fumigant not only kills pests but also affects them negatively by acting as feeding and oviposition deterrence, mating disruption, inhibition of growth etc.Neem fumigant helps to protect stored rice grains from pests. One of the major benefits of this organic fumigant is that pests do not develop resistance to it and This natural product does not leave any residue on plants [22].

PREPARATION OF NEEM BIOPESTICIDE FORMULATION FOR FARM LEVEL APPLICATION:

Neem kernel extract: Fifty grams of neem kernel are required for use in 1 litre of water. The outer coat is removed before pounding. The seeds of three to eight months old is used. Otherwise, the quantity of azadirachtin in the seeds is quite low and hence they cannot be efficiently used for pest control. The pounded neem kernel powder is gathered in a muslin pouch and soaked overnight in water. The pouch is squeezed and the extract is filtered. To the filtrate, an emulsifier like *khadi* soap/ solution soap (with no detergent) is added. The emulsifier helps the extract to stick well to the leaf surface.

***Neem leaf extract*:** For 5 litres of water, 1 kg of green neem leaf is required. The leaves are soaked overnight in water, grounded and the extract is filtered. The extract is suited for use against leaf-eating caterpillars, grubs, locusts and grasshoppers. To the extract, emulsifier is also added.

Neem cake extract: A hundred grams of neem cake are required for 1 litre of water. The neem cake is put in a muslin pouch and soaked in water overnight. It is then filtered and an emulsifier is added at the rate of 1 millilitre for 1 litre of water, after which it is ready for spraying.

***Neem oil spray*:** Thirty millilitres of neem oil are added to the emulsifier and stirred well to ensure that the oil and water can mix well. After this, 1 litre of water is added and stirred well. It is very essential to add the emulsifier with the oil before adding water. A knapsack sprayer is used for dispersion.

Pongam, aloe and neem extract: One kilogram of pounded pongam cake, 1 kg of pounded neem cake and 250 g of pounded poison nut tree seeds are put in a muslin pouch and soaked overnight in water. In the morning, the pouch is squeezed and the extract is taken out and is mixed with 1/2 litre of aloe-vera leaf juice. To this, 15 litres of water are added. This is again mixed with 2-3 litres of cow's urine. Before spraying, 1 litre of this mixture is diluted with 10 litres of water.

***Custard apple, neem, chilli extract*:** Five hundred millilitres of water are added to 2 kg of ground custard apple leaves and stirred. This is filtered to get the extract and the filtrate is kept aside. Separately, 500 gm. of dry fruits of chilli are

soaked in water over-night. The next day, this is ground and the solution filtered to get the extract. One kilogram of crushed neem fruits is soaked in 2 litres of water overnight and the extract is filtered. All the three filtrates are subsequently mixed with 50-60 litres of water, filtered again and sprayed over the crops.

MODE OF ACTION OF NEEM FORMULATION:

The action of neem products as pest control agents can be manifested in different ways. The use of neem products does not give immediate results. Some patience is required after the application of neem products. Those insects which feed on plant tissues, therefore, easily succumb. However, natural predators like spiders feed only on other insects while bees feed on nectar. Hence they rarely come in contact with significant concentrations of neem products. Neem extracts do not exhibit this type of effect on pests but affect them in several other ways.

Insect growth regulation: The growth regulatory effects of Azadirachtin and other neem-related products are very much effective for pest control. A major action of Azadirachtin is to modify hemolymph ecdysteriod and juvenile hormone by inhibiting the release of morphogenetic peptide, prothoracicotropic hormone (PTTH), and allatotropins from the brain-corpus cardiacum complex [5] . Neem products also work on juvenile hormones. The insect larva feeds and as it grows, it sheds its old skin. When the neem components, especially azadirachtin, enter the body of the larva, the activity of ecdysone is suppressed and the larva fails to moult, remains in the larval stage and ultimately dies. If the concentration of azadirachtin is not high enough, the larva will die only after it has entered the pupal stage. If the concentration is lower still, the adult emerging from the pupa will be 100% malformed, and absolute death occur.

Feeding deterrent: When an insect larva sits on a leaf, it will want to feed on it, this particular trigger of feeding is given through the maxillary glands. Peristalsis in the alimentary canal is thus speeded up, and the larva feels hungry and starts feeding on the surface of the leaf. If the leaf is treated with a neem product, because of the presence of azadirachtin, salanin and melandriol, there will be an anti-peristaltic wave in the alimentary canal which produces something similar to a vomiting sensation in the insect [29]. Because of this sensation, the insect does not feed on the neem-treated surface. Its ability to swallow is also blocked.So,it can be said that Azadirachtin(AZ) and AZ-containing extracts from the neem tree show distinct antifeedant activity, primarily through chemoreception (primary antifeedancy), but also through reduction in food intakedue to toxic effects after consumption (secondary antifeedancy) in lethal quantities. Antifeedant activity of neem products has been found in Orthoptera, Isoptera, Hemiptera, Coleoptera, Lepidoptera, and Diptera [34].

Oviposition deterrent: Neem controls pests by preventing the females from depositing eggs, known as oviposition deterrence, and comes in very handy when the seeds in storage are coated with neem kernel powder and neem oil. After this treatment, the insects will not feed on them. Further damage to the grains will be halted and the female will be unable to lay its eggs during the egg-laying period of its life cycle.When oviposition sites were treated with Azadirachtin or other neem-related products, oviposition repellency, deterrency, or inhibition occurred in Coleoptera, Lepidoptera, and Diptera [14,49,50].

***Fecundity suppression and Sterilisation*:** The interruption of insect reproduction is also an important feature of AZ compounds. Because ecdysteroidis one of the hormones regulating vitellogenesis,and Azadirachtin can modify hemolymph ecdysteriod by inhibiting the release of PTTH and allatotropins from the brain-corpus cardiacum complex, adverse effects on ovarian development, fecundity, and fertility (egg viability) occur in Orthoptera, Hemiptera,Heteroptera, Coleoptera, Lepidoptera, Diptera, and Hymenoptera [5,34,49,50] and spermatogenesis in males is also affected by using Azadirachtin [52]

***Inhibition of Sexual communition*:** The sexual behavior of the males and females in mating and response to sexual pheromones [16], are also affected by AZ treatment.

Inhibition of Chitin synthesis: The formation of chitin or the hard part covering of the insect is inhibited as a result of applying neem product on storage food which inhibits or prevents normal metamorphosis of immature stages to the adult stage.

***Changes in biological fitness of larvae and adults*:** The biological fitness of both the larvae and adult of many insect species has substantially reduce at different dosage of neem products. Changes in biological fitness included reduced lifespan [61], high mortality [16], loss of flying ability [61], low absorption of nutrients [61], immunodepressions [8] enzyme inhibition [35], and disruption of biological rhythms [54].

Repellent: The smell of neem is enough to repel leaf eating insects (such as grasshoppers and leafhoppers). Neem oil formulation find wide usage as a bio-pesticide for organic farming, as it repels a wide variety of pests including the mealy bug, beet armyworm, aphids, the cabbage worm, thrips, whiteflies, mites, fungus gnats, beetles, moth larvae, mushroom flies, leaf miners, caterpillars, locust, nematodes and the Japanese beetle. Grasshoppers have been observed to starve to death rather than eat neem as the only food source.

SPRECTRUM OF ACTIVITY:

Various folk remedies for neem include use as an anthelmintic, antifeedant, antiseptic, diuretic, emmenagogue, contraceptive, febrifuge, parasiticide, pediculocide and insecticide. It has been used in traditional medicine for the treatment of tetanus, urticaria, eczema, scrofula and erysipelas. It has been an age-old practice in India to mix dried neem leaves with grains meant for storage. The practice of mixing neem materials with stored products became rooted as part of traditional wisdom and culture. It has recorded that mixing of neem leaves (2-5%) with wheat, rice, or other grains is even now practised in many villages in India and Pakistan [40]. Mixing of neem leaf paste with the mud that is used for making earthen bins and overnight soaking of gunny bags in boiled neem leaf extract (2-10%), which are then used for storing grain. All the parts of neem like seed, flowers, bark, and leaf can be used to produce high quality product. Products derived from Neem tree act as powerful Insect Growth Regulators (IGR) and also help in controlling several nematodes and fungi. Neem products reduce insects' growth in crops and plants.

In Ghana, cacao beans mixed with 8% neem leaves remained free from attack by *Ephestia cautella* up to 9 months in storage [17]. In Nigeria, the traditional use of neem for protecting stored grains is well-documented [12,20,39]. The characteristic garlicky odor of neem materials permeating the closed storage environment presumably repelled insects and bitter compounds in neem materials mixed with the stored grain discouraged insect feeding. Probably, the oil present in neem seed or kernel also discouraged egg deposition on grains, particularly on leguminous seeds. There could also be other less visible but significant effects of neem on behaviour and physiology of stored product pests.

The traditional uses of neem may differ in different regions or with farmers of different cultural backgrounds. For example in southern Sind, Pakistan, farmers mix dried neem leaves with grains stored in jute sacks, or they apply crushed neem leaves on the inner surfaces of mud bins before filling them with grains [26]. In central Sind, where *"palli"* (a giant basket) made of plant materials is a common storage structure, crushed neem leaves mixed with mud are used as plaster for its inner sidewalls and top. In southern Punjab, Pakistan, neem leaf extract is sprinkled on wheat straw packed at the bottom of *"palli"* 2 to 3 days before filling with grain. A survey of various types of on-farm storage practices revealed that a combination of two or three control measures, including the use of neem leaves, was used by 29% of the farmers in Punjab and 47% of the farmers in Sind [10]. In Sri Lanka, farmers burn neem leaves to generate smoke for fumigation against insect pests that attack stored paddy and pulses [45]. Also, chopped green leaves are kept over the heap of paddy in a container; as leaves dry up, they are replaced periodically. [2,3] conducted a survey of post-harvest control practices of 145 farmers in 11 districts of six provinces in India. They found that 30-60% of the farmers who stored wheat, rice, sorghum, and millet, used 4-10% neem leaves (wt/wt) for protection. The grain was stored in large, open straw baskets or in jute bags.

For centuries, India's farmers have known that the Neem trees withstand the periodic infestations of locusts. Neem extracts applied to vegetable crops repel locusts [24] .Like most plants, neem deploys internal chemical defences to protect itself against leaf- chewing insects. Neem contains several active ingredients, and they act in different ways.For example, one outstanding neem component, azadirachtin, disrupts the metamorphosis of insect larvae. By inhibiting molting, it keeps the larvae from developing into pupae, and they die without producing a new generation. In addition, azadirachtin is frequently so repugnant to insects that scores of different leaf-chewing species - even ones that normally strip everything living from plants - will starve to death rather than touch plants that carry traces of it.

COMMERCIAL POINT OF VIEW:

Neem insecticides are being manufactured and exported to various countries as a lot of research has been conducted to test the safety and efficacy of neem for use as an insecticide [27,42]. Neem is the most important among all bio-insecticides for controlling pests. These pesticides do not leave any residue on the crop like other chemical pesticides.

Azadirachtin is the main ingredient used to manufacture bio pesticides. Neem oil and seed extracts are known to possess germicidal and anti-bacterial properties which are useful to protect the plants from different kinds of pests. neem insecticides do not leave any residue on the plants. Bioactive compounds of neem, such as azadirachtin, affect behaviour, growth and development, and survival and reproduction of stored product insects has been reviewed [25,34,36,38,48,49,55]. Azadirachtin has emerged as wonderful natural biopesticide for pest control due to its efficacy, biodegradability and minimum side effects [38]. Although the sensitivity of stored product insect pests to neem materials varies, almost all the species are sensitive to neem. Neem pesticides are being manufactured and exported to various countries as a lot of research has been conducted to test the safety and efficacy of neem for use as a pesticide [4,59]. One of the most important advantages of neem-based pesticides and neem insecticides is that they do not leave any residue on the plants.

CROP PEST MANAGEMENT AND NEEM FORMULATION:

Neem is non-toxic and it can be used in combination with other pesticide and oil for more effectiveness. Instead of killing the pests, it affects the life cycle of the pests. Anti-feedant properties found in neem compounds helps to protect the plants. Pests generally do not develop a resistance to neem based pesticides. Neem pesticides are generally water soluble and help in the growth of the plants. It acts as pest repellent and pest reproduction controller. Neem is being used to manufacture bio-insecticide that is environmental friendly and do not have any toxic effects on plants and soil. Neem insecticides are used to protect both food as well as cash crops like rice, pulses, cotton, oils seeds, etc. Great for use on all crops,

trees, plants, flowers, and fruits and vegetable round the home as well as organic and commercial growers. Active ingredient Azadirachtin, found in neem tree, acts as an insect repellent and insect feeding inhibitor, thereby protecting the plants. This ingredient belongs to an organic molecule class called tetranortriterpenoids. It is similar in structure to insect hormones called 'ecdysones', which control the process of metamorphosis as the insects pass from larva to pupa to adult stage. According to recent studies conducted on parts of neem, it was found that neem seed extracts contain azadirachtin, which in turn works by inhibiting the development of immature insects. Neem oil or the neem seed oil is extensively used to manufacture insecticides used for different crops. Neem oil enters the system of the pests and obstructs their proper working. Insects do not eat, mate and lay eggs resulting in the breaking of their life cycle. The neem oil insecticides only target the chewing and sucking insects.

PEST TOXICITY:

In tests over the last decade, entomologists have found that neem materials can affect more than 200 insect species as well as some mites, nematodes, fungi, bacteria, and even a few viruses. The tests have included several dozen serious farm and household pests like Mexican bean beetles (*Epilachna varivestis*) , Colorado potato beetles (*Leptinotarsa decemlineata*) , Locusts (*Orthoptera*) , grasshoppers (*Caelifera),* Tobacco budworms (*Heliothis virescens),* Six species of cockroach, Cotton and tobacco pests etc. in India, Israel, and the United States; Cabbage pests in Togo, Dominican Republic, and Mauritius; Rice pests in the Philippines; Coffee bugs in Kenya, Japanese beetles in Ohio Stored corn, sorghum, beans, and other foods against different pests [9].

FUTURE CONSIDERATION:

The current crop of pests has developed resistance to a wide range of pesticides available. Farmers are thus caught in a vicious circle the moment they start using chemicals. The Indian people have for millennia used this tree in agriculture, public health, medicine, cosmetics and livestock protection. The technology and practices that are being promoted are aimed at rejuvenating local low-cost use of neem as a bio-control agent. It is meant to serve as a sustainable-agriculture initiative. The Centre for Indian Knowledge Systems has been involved in various efforts relating to the use of natural products for pest control and crop protection.

The powdery form is normally used for the preservation of stored seed-bean grains against weevil attacks or mixed with dry grounded clay or sawdust and sprinkled over young plants, such as maize and sorghum, against pest infestation. Rain water or dew helps dissolve the extract active substance, which get into the plant through translocation. The extracts, however have some application problems including their effect period, lasting for 4-8 days, thus there is a need for many applications in a season. The aqueous extracts are sprinkled on field crops against various pests. The increasing demand for high quality food, free from chemical residues, makes it imperative that non-chemical means of protecting stored products or crops against insect damage be used. Investigations on the effectiveness of neem extracts as organic pesticide is vital, but the development of standardized formulation and certification of the neem-pesticide products is even more crucial.

The use of dried neem leaves or leaf powder would not need any standardization, except probably ensuring the minimum effective quantity required for mixing with grain. However, appropriate macshinery, *e.g.* decorticator, seed/kernel crusher, pulverizer, will be needed for village level processing plants [53] for producing quality seed/kernel powder and oil. Also, as azadirachtin, the principal bioactive ingredient in neem, is heat sensitive, cold processing technology for neem seed would be needed. Neem oil obtained by cold processing of seed is light in color and can be rich in azadirachtin ($\geq$2,000 ppm) [43] Oil,thus obtained, could be standardized for chemical properties and ingredients, biological activity, and its efficacy stabilized and further enhanced by the addition of stabilizers, antioxidants, synergists, compatible plant products with pest control properties (*e.g.* pyrethrins), or even synthetic insecticides. Also, improved methods of application, *e.g.*, mechanical mixers for uniform and bulk coating of oil on grain, use of slow release dispensers/sachets which could be placed at different depths in storage structures, bins or bags, could be devised for ensuring and enhancing efficacy.

The neem tree thrives on waste and marginal lands. Unlike pyrethrum (which requires careful cultivation), neem, once established, becomes a perennial source of pest control materials and other useful products. Despite the setback to the traditional pest control uses of neem due to the advent and popularization of synthetic insecticides, new interest in the pest control potential of neem has grown worldwide since the past decade. However, if full benefits are to be achieved, then further patronage is needed from governments, policy makers, administrators, public and private organizations, national and international programs, and the donor community. Collecting and processing of neem seed and foliage will have to be undertaken on an organized scale. For example, in India, in spite of the growing demand, neem seed collection is barely 25% of the total produce. Also, more trees will have to be grown to ensure availability around the year of the raw material.

The complexity of the azadirachtin molecule will preclude its economic synthesis in the near future. So, neem seed will be the basic material needed for the production of neem-based pesticides, enriched formulations, or plain seed powder or oil. Studies of averting such a possibility would prolong the useful life of neem materials in stored product management.

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