Review of literature

Azadirachta indica A. Juss (Meliaceae) is an Indian tree, commonly called the neem tree. It has many useful compounds that act as insecticide. Neem insecticides have in their composition Azadirachtin, a Tetrano-triterpenoid plant limonoid which can be isolated from the seeds of the neem tree (Mordue & Blackwell, 1993). Azadirachtin is also termed Azadirachtin (Rembold, 1989). Several commercial preparations are available including: Azatin, Bioneem, Neemies, Safer’s ENI, Wellgro, RD-Repelin, Neemguard, Neemark and Neemazal. Neem seed oil is often a starting material for such insecticides, their biological activity being related to its Azadirachtin content (Isman et al., 1990). Among the natural products, one of the most promising natural compound is Azadirachtin, an active compound extracted from the Azadirachta indica A. Juss (neem) tree (Family Meliaceae). Whose antiviral, antifungal, antibacterial and insecticidal properties have been known for several years (Harikrishnan R.e.t al., 2003). Azadirachtin is active in nearly 550 insect species (Anuradha A 2008), mostly in orders Coleoptera (beetles and weevils); Dictyoptera (cockroaches and mantids); Diptera (flies); Heteroptera (true bugs); Homoptera (aphids, leaf hoppers, wasps, and ants); Isoptera (termites); Lepidoptera (moths and butterflies); Orthoptera (grasshoppers, katydids); Siphonaptera (fleas); and (AgroForestryTree Database). In India, pioneering work on the isolation and identifications of A. indica constituents was initiated in 1942 and has continued in various parts of the world. Leaves have been shown to contain crude fibre (11-24%), carbohydrates (48-58%), crude protein(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 a number of amino acids. Recently, a two dimensional TLC method has revealed the presence of carotenoids and other constituents in the leaves of A. indica. Its oil is rich in fatty acids and cake (the
solid residue following explusion of the oil) has a high sulfur content relative to other oil cakes. A number of sugars and polysaccharides have been identified in the gum and bark of *A. indica*. In addition to these general types of constituents, a number of novel compounds have isolated from most parts of the tree (Fulekar M.H 2005). All parts of the *A. indica* tree possess insecticidal activity but seed karnel is the most effective. It has a multitude of pesticidal active ingredients which are together called “triterpene” more specifically “limnoids”. The four best limnoids compounds are: Azadirachtin, Salannin, Meliantriol, and Nimbin. Azadirachtin (C35H44O16) itself is a group of compounds such as Azadirachtin A,B,C,D,E,F,G etc. Of these, azadirachtin-A (AzaA) is the most plentiful and biologically active one which has shown repellent, antifeedent and insecticidal activity against a number of insect pests and it is generally Aza A that is used for commercial insecticides (Barceloux D 2008).

Vegetable Crops: Mustard aphid (*Aphis erysemi*) is found to be regular and major pest of vegetables and mustard in addition to its act as a vector for Yellow Mosaic Virus of blackgram. Cabbage aphid (*Brevicornye brassicae*) is also reported as an important pest of cabbage in hilly areas (Garg D.K 1996). Losses due to mustard aphid (*Lipaphis erysimi*) could be minimized by spraying the leaf and karnel extracts of *A. indica* on mustard crop (Atwal 1964). 1.5% oil spray of *A. indica* showed 100 per cent mortality to this aphid26. Against cabbage aphid, *Brevicornye brassicae* 12 % leaf extract of *A. indica* and leaf extract of *Annona squamosa* were found to show strong anti-feedancy to this aphid, whereas 0.5 % *A.indica* oil spray on cauliflower showed repellency to *B.brassicae* (Singh K. and Sharma P.L. 1986). According to Ketkar  C.M 2003). 5 % seed kernel extract of *A. indica* can be effective against aphid or leaf beetle of brinjel, white fly, jassid and fruit borer of okre, red pumkin beetle (*Raphicopalpa foveicollis*) of pumkin, *Helicoverpa*
armigera of tomato, important pest of cabbage in hilly areas (Garg D.K 1996). Losses due to mustard aphid (Lipaphis erysimi) could be minimized by spraying the leaf and kernel extracts of A. indica on mustard crop (Atwal A.S. and Pajni H.R 1964). 1.5% oil spray of A. indica showed 100 per cent mortality to this aphid (Mani A et al., 1990). Against cabbage aphid, Brevicornye brassicae 12 % leaf extract of A. indica and leaf extract of Annona squamosa were found to show strong anti-feedancy to this aphid, whereas 0.5 % A. indica oil spray on cauliflower showed repellency to B.brassicae (Singh K 1986). According to (Ketkar 2003), 5 % seed kernel extract of A. indica can be effective against aphid or leaf beetle of brinjal, white fly, jassid and fruit borer of okre, red pumpkin beetle (Raphiclopalpa foveicollis) of pumpkin, Helicoverpa armigera of tomato.

Potato: Some of the important insect pests of potato like potato tuber moths (Phthorimaea operculella, Polyphagous defoliator, Henosepilachna vigintioctopuntata) are known to cause considerable losses in potato cultivation in sub-hill and hill regions (Siddig, S.A. 1987). Spray application of neemrich (a A. indica based formulation) protected the crop against this pest (Prakash A et al., 2008).

Formulations include emulsifiable concentrates (ECs), suspension concentrates (SCs), ultra low volume (ULV) formulatio-ns (Feuerhake and Schmutterer, 1985) and granular formulatio-ns (Saxena, 1989). Successful control of pests with neem products can be obtained with the use of solvents for the formulations of field applications (Mordue & Blackwell, 1993). The effects of azadirachtin on insects include feeding and oviposition deterrence, growth inhibition, and fecundity and fitness reductions (Schmutterer, 1990). Azadirachtin is a common example of a natural plant defence chemical affecting feeding, through chemoreception (primary antifeedancy), that consists in the blockage of the input from receptors that normally respond to phagostimulants,
or from stimulation of specific deterrent cells or both and through a reduction in food intake due to toxic effects if consumed (secondary antifeedancy), where food intake is reduced after application of azadirachtin in ways which bypass the mouth part chemoreceptors (Mordue & Blackwell, 1993). Antifeedancy can be assessed from crude to refined neem extracts to neem enriched extracts to pure azadirachtin. Lepidoptera show effective sensitivity to azadirachtin with antifeedant effects at concentrations ranging between 1 and 50 ppm. Azadirachtin has also growth regulatory effects 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 oult inhibition. There are also effects on allatropin and juvenile hormone titres (Mordue & Blackwell, 1993). Dealing with reproduction, adverse effects on ovarian development, fecundity and fertility have been reported (Karnavar, 1987). As the neem-based insecticides are not toxic to humans and many beneficial arthropods, and the pests are unlikely to become resistant, these insecticides have been advocated to replace synthetic insecticides become the more sensible to be used in most pest management programs (Walter, 1999).

Under laboratory conditions, low doses of azadirachtin (10 and 20 ppm) did not harm hymenopteran parasitoid Apanteles glomeratus but its host, final instar Pieris brassicae had reduced feeding and gradually died. But the parasitoid is killed when larval instars are treated in the field. A delay in spraying neem extracts until later larval stages appear would be convenient according to Schmutterer (1992). Low doses of neem seed extracts (NSE), 10 ppm of active ingredient, allowed hymenopteran parasitoids to emerge unharmed and these
were able to mate and seek new fruit fly hosts, enhancing the effectiveness of biological control. Green gram was completely protected against Callosobruchus spp. when soaked for 20 minutes in a 1% solution of neem oil extractive (Attri and Prasad 1980). Coco beans mixed with 8% neem leaves remained free from attack by *Ephestia cautella* up to 9 months in storage (Fry 1938). On cowpea and bambara groundnut, neem oil at 8 ml/kg seed not only reduced oviposition (Schmutterer 1988), but also killed larvae; the activity persisted more than 90 days on cowpea and for 180 days on bambara groundnuts (Pereira 1983). In Sri Lanka, farmers burn neem leaves to generate smoke for fumigation against insect pests that attack stored paddy and pulses (Ranasinghe 1984).

Ahmed and Koppel (1987) conducted a survey of storage control practices of farmers in 11 districts of six provinces in India. They found that more number 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. Wheat. Jotwani and Sircar (1965) in India were the first to demonstrate that powdered neem kernel when mixed with wheat seed at a proportion of 1-2 to 100 (wt/wt) parts satisfactorily protected against *S. oryzae*, *R. dominica*, and *Trogoderma granarium* for 270, 320, and 380 days, respectively. Rahim (1997) found that an ethanolic neem kernel extract, containing azadirachtin, at 75mg/ kg protected stored wheat against *R. dominica* for up to 48 weeks. There are also some studies that prove the neem’s lack of toxicity against spiders and mites. Like Chiracanthium mildeu (predator of citrus fruit) with its prey Tetranychus cinnabarinus that is highly susceptible to neem *Phytoseiulus persimilis* is also not harmed by NSE, specially its fecundity while *T. cinnabarinus* is up to 58 times more toxic than it. Delphastus pusillus a coccinellid predator was not toxic to azadirachtin when applied either the plant or *Bemisia tabaci* eggs (Hoelmer et al., 1990).