



Neem products and their agricultural applications

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ABSTRACT

“Rice is Life” for millions of people and staple food for more than half of the worlds’ population. The demand for rice is growing with ever increasing population. At present the grain yield in rice has to be increased and the yield achieved has to be sustained. The field studies at Wetlands, Tamil Nadu Agricultural University Coimbatore resulted in compilation of agronomical use of neem and its by products in rice cultivation. The Wetland Farm at Agricultural College and Research Institute, Coimbatore is situated in the Western Agro Climatic Zone of Tamil Nadu at 11° North Latitude and 77° East Longitude at an altitude of 426.72 m above MSL. The properties of neem as insecticide, antifeedant, hormonal, antifungal, antiviral and nematicide properties is well known. These activities are brought out with neem use in the form of leaves, leaf extracts, seeds, cakes, oil and fruit extracts. The neem and its products are used in seed treatment, manurial application, increasing nutrient efficiency by which the grain yield in rice crop is enhanced and its sustainability is seen in rice based cropping system. Evaluation of these products in managing the rice crop, through agronomical cultural practices at various stages of crop growth has been discussed in detail in this paper.

Key words: Agronomical cultural practices, neem, rice

Neem, *Azadirachta indica* is native to the arid regions of the Indian sub continent, where it grows to 12-24 m high at altitudes between 50 and 100 m with 130 mm of sufficient rainfall per annum for its normal growth. In India, neem is known for its use and is more utilized in rice cultivation. Neem is also called ‘*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 seeds, bark and leaves contain compounds with proven antiseptic, antiviral, antipyretic, anti-inflammatory, anti-ulcer and antifungal uses. *Azadirachta indica* can be propagated easily by seed, or 9 to 12 month-old neem seedlings can also be transplanted. Fresh fruit yield per neem tree ranges between 37 and 50 kg per year. Forty kg fruit yields nearly 24 kg of dry fruit (60%), which in turn gives 11.52 kg of pulp (48%), 1.1 kg of seed coat (4.5%), 1 kg of husk (25%) and 5.5 kg of kernel (23%). The kernel gives about 2.5 kg of neem oil (45%) and 3.0 kg of neem cake (55%).

Neem is recognized today as a natural product which has much to offer in solving global agricultural, environmental and public health problems. Researchers worldwide are now focusing on the importance of neem in the agricultural industry. The magical tree and hundreds of its active compounds are used to manufacture a number of products. Natural properties of neem do not have any toxic reactions,

so they are helpful in plant protection and management. 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. Neem products are used as neem insecticide, neem pesticide, neem pest fumigant, neem fertilizer, neem manure, neem compost, neem urea coating agent and neem soil conditioner.

Applications of Neem

Neem oil is extracted from the seeds of the neem tree and has insecticidal and medicinal properties due to which it has been used in pest control in rice cultivation. Neem seed cake (residue of neem seeds after oil extraction) when used for soil amendment or added to soil, not only enriches the soil with organic matter but also lowers nitrogen losses by inhibiting nitrification. It also works as a nematicide. Neem leaves are used as green leaf manure and also in preparation of litter compost. Neem leaves are also used in storage of grains. Twigs of neem when tender is used as green manure after decomposing and widely incorporated in rice cultivation fields. Neem (leaf and seed) extracts have been found to have insecticidal properties. It is used as foliar spray and in treating seeds in rice cultivation. Neem bark and roots also have medicinal properties. Bark & roots in powdered form are also used to control fleas & sucking pests in rice cultivation. Neem

has anti-bacterial, anti-fungal and anti-nematicidal properties and positive effect in combating several diseases in rice cultivation, and there are many active constituents of Neem which are still to be exploited.

1. 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. Neem is used as a fertilizer both for food crops and cash crops, particularly rice and sugarcane crop.

Benefits: Neem seed cake performs the dual function of both fertilizer and pesticide, acts as a soil enricher, reduces the growth of soil pest and bacteria, provides macro nutrients essential for all plant growth, helps to increase the yield of plants in the long run, bio degradable and Eco friendly and excellent soil conditioner.

2. Neem used as Manure

Manure is any animal or plant material used to fertilize land especially animal excreta for improving the soil fertility and thus promoting plant growth. Neem manure is gaining popularity because it is environmental friendly and also the compounds found in it help to increase the nitrogen and phosphorous content in the soil. It 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 obtained by using high technology extraction methods like cold pressing or other solvent extraction. It can be used directly by mixing with the soil or it can be blended with urea and other organic manure like farm yard manure and sea weed for best results.

Benefits: 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, ideal for cash crops and food crops, increases the yield of crops, helps to reduce the usage of fertilizer, thus reducing the cost of growing plants, antifeedant properties that help to reduce the number and growth of insects and pests.

3. 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. The fertility of the soil can be measured by the amount of Nitrogen, Potassium and Phosphorous it has; there are certain bacteria found in soil, which denitrify it. 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. It can also be used to control a large number of pests such as caterpillars, beetles, leafhoppers, borer, mites etc. Urea coating is generally available either in liquid form or powdered form. Properties of Neem Urea Coating are Anti feedant, anti fertility and pest growth regulator.

Benefits: Neem Urea Coatings are excellent soil conditioners, 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.

4. 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 or can be sprinkled and raked into the soil. The process of sprinkling should be followed by proper irrigation so that the product reaches the roots. It is a natural soil conditioner that helps improve the quality of soil, thereby enhancing the growth of plants and fruits. Organic soil conditioner is gaining popularity in agricultural industry, not only in Asian countries like India but also in western counterparts such as USA, UK and Australia.

Benefits: Neem is a natural soil conditioner that helps improve the quality of soil, thereby enhancing the growth of plants and fruits. It not only helps the plants grow, but also prevents them from being destroyed by certain pests and insects. Organic soil conditioner is gaining popularity in agricultural industry. Because they are organic, they have no harmful effects and are cheaper than the other soil conditioners. 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 a soil enhancer that help to increase its fertility.

5. Neem as fumigant

Neem tree has been used against household, storage pests and crop pests. Neem pest fumigant is available in gaseous state and is used as a pesticide and disinfectant. It is being used by a large number of countries on a commercial basis by farmers and agriculturists. This 100% natural product is being exported as it is non toxic and does not affect the environment. It assumes more importance in developing countries where millions of deaths are reported every year due to the accidental intake of synthetic pest fumigants. 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. According to studies undertaken, 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.

With the increasing trend of using bio fertilizers, insecticides and pesticides, neem is being increasingly cultivated and grown all over the world to get active ingredient-azadirachtin, responsible for stopping the growth cycle of insects and pests, fungi etc. Neem is also assuming a lot of importance in crop management. Considering the fact that neem is not only a cheaper, naturally occurring product and an effective method to control pests and insects, but also has no side effects on plants or other living beings, it is not a wonder that researches are being carried to try neem and its products for large scale production of natural pesticides and insecticides. This is a good opportunity for manufacturers and exporters to produce quality bio agricultural products. 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. This natural product does not leave any residue on plants.

Benefits: Neem fumigants are eco friendly, do not harm other micro organisms, are non toxic, and do not contaminate terrestrial and aquatic environment. Pests do not develop resistance to it, there are no negative after effects, are relatively less expensive, are pest repellent and nourish the soil and function as pest reproduction controller.

Neem as pesticide

Neem pesticides play a vital role in pest management and hence have been widely used in agriculture. There has been an evident shift all over the world from synthetic pesticides to non-synthetic ones; this is largely because of the wide spread awareness of the side effects of these synthetic pesticides not only on plants and soil but also on other living organisms. This is a great opportunity for neem pesticides manufacturers to cash in on the growing popularity of natural or herbal pesticides. 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 (Anis Joseph *et al.*, 2010; Vethanayagam, and Rajendran, 2010). 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. One of the most important advantages of neem-based pesticides and neem insecticides is that they do not leave any residue on the plants.

Neem pest control is very beneficial for proper crop and pest management

It also helps to nourish and condition the soil, it is environmental friendly, it 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. The transition from use of synthetic products to natural ones is evident in agricultural industry also. Excessive use of synthetic insecticides has resulted in a series of problems like the development of insect resistance to insecticides, harm to other natural enemies of insects, toxic effects on plants and soil etc. Neem is being used to manufacture what is known as the natural or bio insecticide, that are 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, 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. It is interesting to note that neem doesn't kill insects, but alters their life process. The major parts/extracts of neem seed that are used for making neem insecticides.

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. Another interesting function of neem oil pesticides is that they do not harm the beneficial insects. The neem oil insecticides only target the chewing and sucking insects.

Mode of Action

Neem acts as a biopesticide at different levels and in various ways. Primarily it acts as antifeedant *ie.*, when an insect larva is hungry and it wants to feed on the leaf but if the leaf is treated with neem product, because of the presence of azadirachtin, salaninand melandriol there is an antiperistaltic wave in the alimentary canal and this produces something similar to vomiting sensation in the insect. Because of this sensation the insect does not feed on the neem treated surface and ability to swallow is also blocked. Secondly it acts as

oviposition deterrent *ie.*, by not allowing the female to deposit eggs comes in very handy when the seeds in storage are coated with neem kernel powder and/or neem oil. It also acts as insect growth regulator. It is a very interesting property of neem product and unique in nature, *ie.*, it works on juvenile hormone.

Chemistry of neem

Neem plants contain several thousands of chemical constituents. Of special interest are the terpenoids from different parts of the neem plant. Of its biological constituents the most active and well studied compound is Azadirachtin. However, in most traditional preparations of neem as pesticide or medicine a mixture of neem chemicals are present and provide the active principles. Several kinds of azadirachtins (A to K) have been isolated, the most abundant of which is Azadirachtin. The neem terpenoids are present in all parts of the plant, in the living tissues. Recently, the site of synthesis and accumulation of the neem chemicals have been identified as secretory cells. Secretory cells are the most abundant in the seed kernels. The secretory cells can be seen with iodine solution. Besides the terpenoids, neem also contains more than 20 sulphurous compounds responsible for the characteristic smell of crushed seeds and neem oil (Table 1).

Table 1. Specifications for neem kernel oil

Characteristic	Requirement
Maximum moisture and insoluble impurities Lovibond colour (1/4 in cell), expressed as Y + 5R, not deeper than	0.3 % by weight
Refractive index at 40°C	45.0
Specific gravity,	1.4615 – 1.4705
Saponification value	0.908 – 0.934
Iodine value (Wij's method)	180-205
Maximum acid value	65-80
Maximum unsaponifiable matter	15
Minimum titre	2% by weight
	36°C

Source: Indian Standards Institution specification 4765. The colour index indicates the degree of deterioration of non-fatty constituents present in the seed vis-à-vis quality of oil.

Requirements of neem cake for manuring

Characteristic	Requirement
Maximum moisture (%by mass)	10.0
Minimum water-soluble organic N % by mass on moisture-free basis	2.5
Maximum total ash (% by mass)	13.0
Maximum acid-insoluble ash (% by mass) on moisture-free basis	5.0

Source: Indian Standards Institution specification 8558.

Rice is the staple food and its demand is ever increasing in India. Rice area has increased from 36.46 million hectares (1960's) to 44.6 million hectares (2007-2008) and production has gone up from 39.31 million tons (964-65) to 96.14 million tons (2007-08) and the productivity also got increased from 1078 to 2191 kg ha⁻¹. The earliest documentation of neem mentions the fruit, seeds, oil, leaves, roots and bark for their advantages. These benefits are listed in the ancient documents 'Carak-Samhita' and 'Susruta-Samhita'. Neem has a garlic-like odour, and has a bitter taste. Apply 12.5 t of FYM or compost or green leaf manure @ 6.25 t/ha. Incorporated @ 20 kg /ha *in situ*, to a depth of 15 cm.

Neem treated urea and coal-tar treated urea

Blend the urea with crushed neem seed or neem cake 20% by weight. Powder neem cake to pass through 2mm sieve before mixing with urea. Keep it overnight before use (or) urea can be mixed with gypsum in 1:3 ratios, or urea can be mixed with gypsum and neem cake at 5:4:1 ratio to increase the nitrogen use efficiency. For treating 100 kg urea, take one kg coal tar and 1.5 litres of kerosene. Melt coal-tar over a low flame and dissolve it in kerosene. Mix urea with the solution thoroughly in a plastic container, using a stick. Allow it to dry in shade on a polythene sheet. This can be stored for a month and applied basally.

Plant Protection Measure

Table 2 reveals the various pest management using neem oil (3%) or NSKE (5%) either alone or in combinations.

Table 2. Recommendations of use of neem oil and NSKE for different pest management

Brown planthopper - <i>Nilaparvatalugens</i>	Neem oil 3% Neem seed kernel extract 5% or soil application @ 25 kg/ha
Black bug - <i>Scotinophoralurida</i>	Spray Neem seed kernel extract 5% or soil application @ 25 kg/ha
Earhead bug - <i>Leptocorisaacuta</i>	Neem seed kernel extract 5% or soil application @ 25 kg/ha
Sheath rot - <i>Saroclodium oryzae</i>	NSKE (5%) or Neem oil 3%
Sheath blight - <i>Rhizoctoniasolani</i>	Foliar spray with Neem oil at 3%
Bacterial leaf blight - <i>Xanthomonasoryzae</i> p.v. <i>oryzae</i>	Spray neem oil 3% or NSKE 5%

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