Adoption of Neem as a Pesticide in Agriculture: An Experimental Study

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ABSTRACT

Since ancient times, various parts of the neem tree are used in various agricultural, animal husbandry, health, medical, cosmetics and other fields. Neem tree is considered as invaluable and found in almost all parts of the country, every roadside, every field and nearly every house. Flowering on the neem tree occurs between phalgun to Baisakh (February to April) and it fruits comes nearly June to July. Several organic compounds are found in the neem tree viz., Azadirachtin, Maliantriol, Nimbin, Nimbidin etc. Neem has miraculous powers and may be used as insecticidal, larvicidal, antimalarial, antifeedant, antifungal, antitubercular, antiviral, antiallergic, antidermatic, antigingvitic, anti-inflammatory, anti-periodontitic, antipyrrhoeic, anti-seborrhoeic, antifuruncular, bactericide, nematicidal, piscicidal, amoebicidal, diuretic, spermicidal (contraceptive) etc. But, the application of neem as a biopesticide to prevent infestation of crops by pests is quite recent. This study reveals the adoption pattern of various neem based biopesticide preparations among farmers of Agra district of Uttar Pradesh.

Key words : *Neem; Biopesticide; Agriculture;*

Since ancient times various parts of the neem tree is used in agriculture, public health, medicine, toiletries, cosmetics and animal husbandry. The botanical name of neem is Azadirachtin indica having its derivation from the Persian name Azad-Darakth and also called as 'free tree'. Neem tree is considered as invaluable that it is found in all parts of the country, every roadside, every field and almost every house. Flowering on the neem tree occurs between phalgun to Baisakh (February to April) and it fruits comes nearly June to July. Several organic compounds are found in the neem tree viz., Azadirachtin, Maliantriol, Nimbin, Nimbidin etc.

With the introduction of chemical based pesticides in agriculture and their concurrent side-effects on human body have triggered the use of biological extracts, especially neem has increased to a large extent. Such use of chemical pesticides have provide short term gains but continuous use of chemicals lead to development of resistance among pests and farmers were caught in a vicious circle. Neem has miraculous powers and may be used as insecticidal, larvicidal, antimalarial, antifeedant, antifungal, antitubercular, antiviral, antiallergic, antidermatic, antigingvitic, anti-inflammatory, anti-periodontitic, antipyrrhoeic, anti-seborrhoeic, antifuruncular, bactericide, nematicidal, piscicidal, amoebicidal, cardiac, diuretic, spermicidal (contraceptive) etc. Several organic compounds, viz., Azadirachtin, Maliantriol, Nimbin, Nimbidin, etc are found in the neem tree of which Azadirachtin is highly effective over a wide range of pests. Researches reveal that the bio-active ingredients in neem are effective over nearly 200 species of insects, the fact which leads its increased use in modern crop and grain protection as indicated by *Weintraub (1997)*. Since most neem products belong to the category of medium- to broad-spectrum pesticides, i.e., they are effective over a wide range of pests. Researches conducted by *Naumann et al (1996)* have revealed that neem based biopesticide have proved to be highly effective in controlling a wide range of pests as well as in controlling stored grain pests.

Hence it is necessary to develop and promote eco-friendly techniques and practices in the farmers fields making them self-reliant and no longer dependent on chemical pesticides, i.e., a step towards sustainable agriculture. Enabling farmers to prepare neem based organic biopesticides at their own backyard is possible

by providing them continuous training and readymade hand-outs materials. Several preparations viz., neem leaf extract, neem seed kernel extract, neem cake extract, neem oil emulsion may be prepared by the farmers at their own backyard and may be used singly or in combination with other plant extracts. In order to expose the farmers for various neem based organic bio-pesticidal preparations, as reported by *Schroeder et al (1987)*, a number of training programmes have been performed as mentioned below -

Preparation of Neem Seed Kernel pesticide: The flowering on the neem tree occurs between phalgun to baisakh (February to April) and it fruits comes nearly between June to July. These fruits were collected and the outer pulp is removed to obtain the neem seeds. Thereafter neem seeds are dried till the moisture content level comes to nearly 8-10%. Usually six to eight months old neem fruits are used for preparation of neem seed kernel extract, in order to get the high quantity of Azadirachtin, an organic biopesticide as also reported by *Aschier (1993)*.

The neem seeds are then decorticated to obtain the neem kernel, which is then grinded to obtain the neem powder. Nearly 100 grams of grinded neem seed powder is collected in a muslin cloth and soaked in 500 ml of water for an overnight. The muslin cloth is stirred, squeezed and strained to obtain the milky white colored filtrate of neem kernel extract. Water is added to the filtrate in the ratio of 100 grams of neem kernel powder in 2 liters of water. Nearly 5 ml of emulsifier is added to help the pesticides stick well to the leaf surface. The spraying is conducted on crops preferably in the late afternoon. This is effective against a wide range of insects except aphids, white flies and stem borers as reported by *Koul (1998)* and *Koul (1999)*.

Preparation of Neem leaves pesticide: Nearly 20 liters of water is filled in mud pot and 5.0 kg of neem leaves are added to it along with a piece of small copper. The pot is air tightly packed and placed 2 feet below the ground for 3 months. After 3 months the pot is taken out and boiled till the residue remains one fourth of the original followed by filtration through a 18 mesh sieve. Nearly 100 ml of the filtrate is mixed in 2.5 liters of water along with 5 ml of emulsifier and filled in a jar for spraying over the agricultural crops preferably in the later afternoon. Since this preparation needs a high quantity of neem leaves, hence such pesticides can be used in the nurseries and kitchen gardens. It is highly effective against leaf-eating caterpillars, grubs, locusts, grasshoppers, etc. as reported by *Tang (2002)*.

Preparation of Neem cake pesticide: Neem cake is the by-product obtained from the extraction of the neem oil during the process of cold-pressing of neem tree fruits and kernels. Nearly 100 grams of neem cake is placed in muslin cloth and soaked in 1 liters of water for overnight. It is then filtered and emulsifier @1ml in 1 liter of filtrate is added in it and spraying is performed over the agricultural crops preferably in the later afternoon. It is also a potential source of organic manure and acts as nitrification inhibitor which prolongs the availability of nitrogen to both short and long duration crops. Neem cake organic manure protects plant roots from nematodes, soil grubs and white ants. It was also reported by *Kimaru et al (2004)*.

Preparation of Neem oil pesticide: Neem oil is a vegetable oil extracted by cold-pressing of neem tree fruits and kernels. It is generally red as blood, and has a rather strong odour similar to the odours of peanut and garlic. It comprises mainly triglycerides and large amounts of triterpenoid compounds, which are responsible for its bitter taste. The azadirachtin content in the neem oil varies from 300ppm to over 2500ppm depending on the extraction technology and quality of the neem seeds crushed. It is hydrophobic in nature, hence before spraying it is necessary to add surfactants @ 3 ml per liter of water. It is necessary to stirr well the mixture of oil and water and should be used immediately through a knapsack sprayer, otherwise oil droplets will start floating. Similar was also reported by *Lababidi (2002)*.

METHODOLOGY

This study was carried out in five villages of Etmadpur block in Agra district of Uttar Pradesh with the objective to study the adoption pattern of neem as an organic biopesticide in various agricultural operations. All the selected farmers perform agricultural farming on their own lands. The farmers were provided practical training once a week for one month duration regarding the preparation and application of bio-pesticide in their fields. Initially the farmers of the village were communicated a pre-designed message in Hindi regarding advantages of neem as a pesticide, its preparation and its procedure of application on various types of agricultural crops. After proper exposure among the farmers, the adoption pattern of neem bio-pesticide was studied under various socio-personal parameters

in field conditions at an interval nearly 6 months. Twenty five farmers were selected from each village thus comprising a total of one hundred twenty five farmers for the study. Data was gathered from these farmers using stratified random sampling procedure with the help of a questionnaire to study the adoption behaviour of neem based bio-pesticide preparations as well as its correlation with their socio-personal variables. However in order to identify the adoption as well as its application and preparation of neem bio-pesticide, the adoption behaviour was studied at an interval 3 and 6 months on several parameters. Statistical tests involving percentage, correlation, F-test and t-test were applied for proper interpretation of the data.

RESULTS AND DISCUSSION

Adoption of agricultural technologies in developing countries are influenced by a wide range of economic and social factors as well as physical and technical aspects of farming and risk attitudes of farmers *(Kebede et al, 1990)*. The suitability of an innovation depends on the potentialities of the farmers, i.e., their personal attributes like attitude, values, beliefs, farm size, education, extension contact, communication behaviour and so on. The farmers always differ in their socio-economic status as well as in personal traits. Hence there is possibility that different categories of farmers might adopt the technologies to different extent *(Singh et al, 1993)*. The impact of training on adoption of neem based bio-pesticide was studied after exposing the farmers continuously for four weeks, regarding its preparation and application. Thereafter its adoption behaviour among farmers was studied under various socio-personal variables and other adoption parameters.

Adoption behaviour according to various socio-personal variables: Age of farmers is the most frequently reached personal characteristics which influence the adoption behaviour. The findings of the study presented in Table 1 reveal that the relationship between the age of farmers and their adoption behaviour is somewhat inconsistent. Nearly 68.8% of farmers between the age group of 26-40 years have adopted the neem pesticidal preparation in their fields followed by farmers between the age group of 41-55 years and above 55 years shows the adoption percentage as 16% and 9.6% respectively. It shows that the youth are more keen to adopt such bio-pesticidal preparations which was mainly due to high sale price of their crops/ vegetables in the market, less cost input, less complex in preparation, eco-friendliness preparation, etc.

Table 1. Adoption behaviour of Neem bio-pesticide among various socio-personal variables

Adoption Behaviour in different Parameters	No.	%
Age		
Upto 25 years	7	5.6
26-40 years	86	68.8
41-55	20	16.0
Above 55 years	12	9.6
Education		
Illiterate	3	2.4
Primary School	8	6.4
Middle School	62	49.6
Secondary School	27	21.6
Higher Secondary School	15	12
Graduation & above	10	8.0
Occupation		
Agriculture	102	81.6
Government service	7	5.6
Others	16	12.8
Land Holding size		
Upto 1.0 hectares	86	68.8
1.1 – 2.5 hectares	22	17.6
2.6 – 4.0 hectares	12	9.6
4.0 hectares and above	5	4.0

It is a universal fact that education plays a very important role in determining the adoption rate of farmers. The table further reveals that 49.6% farmers educated upto middle level of school have adopted neem based biopesticidal preparations as compared to just 2.4% illiterates. It was also revealed that 21.6% farmers have also adopted it having educational level upto secondary level followed by adoption pattern of 12%, 8% and 6.4% having educational level upto higher secondary school; graduation and above and primary school. This reveals that diffusion of the economic practice was more prevalent among farmers with less educational status and practicing agriculture as the main source of occupation.

However in respect to adoption behaviour in terms of occupation the findings shows that majority (81.6%) of the farmers who have adopted bio-pesticidal preparation have agriculture as their main occupation, followed by 12.8% and 5.6% farmers who have other occupation and government service respectively. Thus a larger proportion adoption by the agricultural farmers reveals availability of effective market price of their

Table 2. Adoption behaviour of farmers in various time durations

Adoption of Neem bio-pesticide	Time Duration				'r' value	'F' value	't' Value
	3 months		6 months				
	No.	%	No.	%			
Number of farmers prepared neem bio-pesticide after demonstration	25	20.0	84	67.2	0.3493	0.0756	1.5503
Number of farmers prepared neem oil bio-pesticide	7	5.6	19	15.2	0.5752	1.0932	0.0128
Number of farmers applied bio-pesticide on the field	23	18.4	82	65.6	0.3439	0.0246	1.0942
Number of subject found technology effective	15	12.0	72	57.6	0.3172	4.3462	1.0132
Number of subject repeatedly made bio-pesticides	12	9.6	69	55.2	0.3326	3.1652	2.5310
Number of subject adopted technology	12	9.6	64	51.2	0.3032	7.6302	1.1582
Number of subject adopted technology as an enterprise	2	1.6	10	8.0	0.4324	2.5211	0.0179

products, less competition with their peer farmers, more economic returns, less cost of pesticides, labour savings, etc. as factors responsible for high adoption of bio-pesticides.

The results further reveals that 68.8% farmers having land holding size upto 1.0 hectares have adopted the bio-pesticidal preparation more frequently followed by 17.6%, 9.6% and 4.0% farmers having land holdings of 1.0-2.5 hectares, 2.6-4.0 hectares and 4.0 hectares and above respectively. This reveals that farmers with low resources, i.e., less land holding size are more prone to adopt bio-pesticide preparations due to low cost in preparation, easy application without instruments, more profit from sale of organic products, local availability of bio-raw materials, etc.

Adoption behaviour of farmers in various Time Durations : The results in Table 2 further reveal the drastic change in the adoption behaviour of neem bio-pesticide at time interval of nearly 3 and 6 months after exposure to the message. It was found that after 6 months, 67.2% of farmers have started preparing neem bio-pesticidal preparations, which was comparatively higher as compared to 20.0% in the initial 3 months. This high adoption may be due to the beneficial effects on productivity as compared to their neighbours using chemical preparations. This increase in adoption percentage may also be due to motivation received from other farmers who reported a sharp drop in pests and simultaneously increased productivity in their fields as well as rise in income from sale of bio-pesticide crops in the market. Similarly 65.6% farmers have applied neem bio-pesticidal preparations in their fields after an interval of 6 months, which was also higher as compared to 18.4% adoption in 3 months. It was also revealed that only 12.0% farmers have found technology highly effective in the initial 3 months, which was elevated to 57.6% farmers after 6 months. It was further pointed out that only 9.6% farmers repeatedly prepared the bio-pesticide for its application in the fields but the figure was enhanced to 55.2% farmers after 6 months. The study further revealed that after 6 months nearly 51.2% farmers wish to adopt the application of bio-pesticide in their fields on a regular basis in their fields, which was just 9.6% after 3 months. Such increase in adoption percentage and increase in pesticidal preparation as well as its adoption may be due to sale of their product at higher prices in the local market, since consumers are ready to pay higher prices for organically produced products, which in turn is further a motivation for farmers to adopt such biopesticidal practices.

It was also found that preparation of neem oil based bio-pesticide was adopted by only 5.6% farmers after 3 months, which was slightly raised to 15.2% farmers after 6 months duration. Such lower adoption was due to difficult extraction and the adoption behaviour was found only in those farmers having facilities of extraction as well as of spraying. It was also further revealed that only 1.6% farmers wish to adopt this technology as an enterprise, which was also slightly raised to 8.0% farmers after 6 months. However a larger proportion farmer do not want to engage themselves in entrepreneurial activity for the preparation of neem bio-pesticide in larger quantities and selling it to neighbor and surrounding village farmers.

CONCLUSION

Thus we may say that neem leaves and its seed extracts shall be used as bio-pesticidal preparations in various agricultural farming practices. Such preparations tend to reduce the feeding tendency of pests as well as

reduce their reproductive capacity or ability of laying eggs. Such preparations do not have harmful or toxic side effects for human and livestock as well as pests do not develop resistance. These preparations control harmful pests but does not harm farmer-friendly insects like earthworm, bees, spider, mites, dragon flies, etc.

The Government of India is also promoting research, production, registration and adoption of bio-pesticides with open hands through various rules, regulations, policies and schemes. The Department of Biotechnology (DBT) spearheads the promotion of bio-pesticides, especially research, funding and production and it supports nearly 22 bio-control production units, while Indian Council of Agricultural Research (ICAR) supports nearly 35 units. The National Centre for Integrated Pest Management (NCIPM) looks after plant protection needs in various agro-climatic zones of the country and runs nearly 40 State Bio-Control Labs (SBCL's) across the country engaged in production and distribution of natural predators and parasites to farmers. *The National Farmers Policy, 2007* also recommended support and promotion of bio-pesticides.

Today in order to emphasize the benefits of bio-pesticide for future agriculture sustainability, it is the need of the hour for framing the Bio-pesticidal Promotion and Regulation Policy, which will enable motivational training programmes on multiplication and scaling-up of such bio-pesticidal and bio-control agents as per protocol and techniques developed at National institutes. There is also a need for massive awareness campaign for all the stakeholders for promotion and adoption of eco-friendly technologies as well as to develop entrepreneurship skills among them.

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