Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(3): 237-245

Received: 10-03-2020
Accepted: 12-04-2020

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# Traditional agricultural practices as a tool for management of insects and nematode pests of crops: An overview

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**Abstract**
Indigenous Technical Knowledge (ITK) refers to the unique traditional local knowledge existing within and developed around the specific conditions by women and men indigenous to a particular geographic area. This indigenous technical knowledge that people in a given community have developed over time and continue to develop it, is based on human experiences on mass scale, dynamic and changing, tested in most cases over centuries of use, endowed with highest possible adaptability to local culture and environment and put greater weight age on minimizing risks rather than maximizing profit. The indigenous technical knowledge (ITK) covers a wide range of subjects, *viz.* crop production, livestock rearing, natural resource management, food preparation, healthcare, insect pest management and many others. The use of non-chemical methods for pest control and crop protection is already gaining importance in several countries including India. The integrated pest management strategies developed and promoted by the Governments is now based on the use of plants extracts. If an effort is made towards production of Indigenous Technical Knowledge (ITK) based products on cottage scale, it can be an economically viable option for sustainable development of ecofriendly pesticides/insecticides.

**Keywords:** Indigenous, insects, management, nematodes, traditional

## Introduction
The ITK is an explicit or "codified" knowledge that is transmittable in formal, systematic language. On the other hand, ITK is a tacit knowledge of the local or indigenous people, which is personal, content-specific, and therefore hard to formalize and communicate. Local or indigenous people acquire knowledge by actively creating and organizing their own experiences. Thus, the traditional knowledge that can be expressed in words and numbers represents only the "tip of the iceberg" of the entire body of knowledge possessed by indigenous people. As we puts it, "We can know more than we can tell". India is home to hundreds of ITKs thanks to the ancient civilization and the localized way of cultivating crops and rearing of fish as well as livestock [65]. These ITKs play significant role in agricultural production, as [17, 18] observed that 'the enhancement of the quality of life of the Indians who in great majority live in and depend on agricultural production systems would be impossible by keeping this rich tradition of ITK aside'. ITK as Indigenous Knowledge functions within the given socio-economic and spatial boundaries of the society and plays an active part in the culture of population concerned being preserved, communicated and used by its members to serve some purpose in relation to productive activity within the society. Scientist compiled the ITKs practiced in agriculture in India. They found 1998 ITKs being practiced by the farmers in the area of veterinary and animal sciences, pest and disease management in crops, grain/seed storage, horticultural crops, and cropping systems and fisheries. Indigenous knowledge is effective, locally available, relatively cheap and less destructive to local environments [17]. A majority of farmers in most developing countries are small-scale farmers and their knowledge systems have never been recorded systematically in written form; hence they are not easily accessible to agricultural researchers, extension workers, and development practitioners [88].

## ITK in India
India over several millenniums had been the treasure of biological wealth, intellectual knowledge and spiritual wisdom. The importance of indigenous technology and practice to sustainability is being brought through pooling of traditional knowledge, short listing and evaluating them in the context of modern scientific and technological environment and

harnessing it for sustainable agriculture growth. The capital and technological skill requirements in the use of traditional technologies are generally low and their adoption often requires little restructure of the traditional societies. Indigenous practices in agriculture are organic in nature; never causes any damage to the air, water and soil, free from environmental pollution and safe to mankind. These practices are dynamic, region specific, depending upon soil type, rainfall, topography etc., and are often modified by the local farmers. Indigenous knowledge is unique, traditional, local knowledge existing within and developed around the specific condition of women and men indigenous to a particular geographic area [25].

**Role of ITK in Agriculture**

Present Indian agriculture is facing incalculable problems like instability of production, exhaustion of natural resources, inadequacy in controlling pests and diseases etc. Due to constant use of chemical inputs, the fertility is lost and also pest and diseases became resistant to chemical inputs. This has made to look back for ITK's which has the ability to solve such problems in a cost-effective manner. ITK's provides us prophylactic and curative measures for managing many problems. Since, ITK's are developed by people based on experience and continuous refinement through informal experimentation over centuries; blending ITK's with modern technology is the need of the day to maintain sustainable agriculture.

**Knowledge level of respondents on indigenous cultivation practices**

The findings on overall knowledge level of respondents on indigenous cultivation practices were presented in Table

**Table 1:** Distribution of respondents according to their overall knowledge level on indigenous cultivation practices.

| S. No. | Category | Number | Per cent (%) |
|---|---|---|---|
| 1 | Low | 20 | 16.66 |
| 2 | Medium | 68 | 56.67 |
| 3 | High | 32 | 26.67 |

*Total observations =120

It is observed from the data in Table, about more than half of the respondents (56.67 per cent) had medium level of knowledge followed by high (26.67 per cent) and low (16.66 per cent) levels of knowledge on indigenous cultivation practices. Knowledge being a pillar to every understanding, majority of the respondent might have possessed medium to high knowledge level, which are passed from their ancestors.

**ITK and Insect-Pest Control**

The application of chemicals for pest control leads to food poisoning, soil, water and
environmental pollution. These chemicals create ecological imbalance and allow insect-pest to develop resistance. At these moments, an indigenous knowledge related to plant protection in agriculture would play vital role

**Cultural practices**

Generally cultural practices enhance the "belowground biodiversity" which concurrently contribute to "aboveground biodiversity" and make the habitat more diverse for sustenance of natural enemies. The cultural practices (field sanitation; proper seed and variety selection; proper seedbed preparation; planting date; row spacing; seeding rate; fertilization; water management; crop rotation; planting of trap crops and hedge rows; companion planting; and intercropping) contribute to prevent, suppress, or eradicate pest build-up by disrupting the normal relationship between the pest and the host plant and thus make the pest less likely to survive, grow, or reproduce. Most of these practices are well experimented and practiced by the farmers. However, some strategies to grow ground cover crop and windbreaks are required to reduce dust because dust can interfere with natural enemies and may cause outbreaks of pests such as spider mites. Similarly there is a need to avoid excess fertilization and irrigation, which can cause phloem-feeding pests such as aphids to reproduce more rapidly than natural enemies.

**Physical and mechanical control**

It includes proper land preparation; hoeing; weeding, bagging of fruits; baits and traps; row covers; mulching; handpicking; and pruning, etc. Among the above practices traps and baits can be indigenously prepared using locally available resource for better monitoring and control of insect pests. A few examples are cited below

**Trapping of Insects**

**Defoliators**

A mud pot with three quarters of it is to be filled with water and to this 250 g of powdered castor cake is added. The pot is then buried in the soil with its mouth in level with the soil. The smell of the cake attracts the beetles which fall into the water. Just 2-3 such pots in one hectare of plantation can clear beetles from the area. Slices of pine apple are also used to attract RB. In a cylindrical plastic container 2 slices of pineapple are taken and an exit hole is made to allow the rain water to drain. The trap is hung near the crown of the coconut tree. The beetles are attracted to wards the pineapple and get trapped [31].

The mid rib of coconut leaf is cut into small pieces and crushed, place it in an earthen pot either with 1 lit of water 100 g jaggery and 10 g tobacco powder or with sugarcane molasses 2.5 kg or toddy 2.5 liters, acetic acid 5 ml and yeast 5 g. Another pot with hole at its bottom is placed over it. This arrangement is made at 3-4 corners of the coconut orchard to attract and trap the beetles. The mixture of jaggery, tobacco and water is to be added once in a month in case the former bait is choosen. Blue containers, filled with water with little detergent are claimed to attract blister beetles.

**Sucking insect pests**

Bright yellow sticky traps are used for monitoring/controlling aphids, thrips and whiteflies. While, bright blue traps can exclusively be used for monitoring thrips and bright white sticky traps for flea beetles [10]. Set up sticky traps for monitoring whitefly, thrips etc. @ 10 traps per ha. Locally available empty tins can be painted yellow / coated with white grease / vaseline / castor oil. Place traps near the plants, preferably 25 cm away from the plant to ensure that the leaves will not stick to the board, but not facing direct sunlight. Position the traps at 50-75 cm above the plants. Alternatively, yellow water pan traps also proved useful for simple population counts of alate aphids based upon which insecticidal control can be initiated. Mix 500ml of aloe extract 1 kg of castor cake and add latex as adhesive. Put this mixture in a wide opened disposable container. Place in strategic locations of the field @12 / ha [10].

**Fruit flies**

Fruit fly (*Dacus dorsalis*) incidence is normally seen in mango and cucurbits. A low-cost fruit fly trap to combat this insect pest can be made as follows;

Twenty gram of *Ocimum sanctum* (holy basil) leaves are crushed and the extract along with the crushed leaves are placed inside a coconut shell, which is then filled with 100 ml water. To increase the keeping quality of the extract, 0.5 g citric acid is added and the extract is then poisoned by mixing 0.5 g carbofuran 3G. The traps are suspended from mango tree branches at a rate of 4 traps per tree. The fruit flies feed on the ocimum extract and are killed. Make a trap using a 2-liter disposable water bottle: Two holes at a height of 5cm from the bottom of bottle are made and for hanging the trap, use a string which is pushed through a hole drilled in the centre of the cap from inside. The attractant mixture for fruit flies is then prepared by mixing 1 cup of vinegar, 2 cups of water and 1 tablespoon of honey and shakes this well before use. Fill the trap with this mixture up to the level of holes and hang the container about 5 feet high. Flies will enter the container and fall into the attractant

**Slugs**

Set the rinds of grapes with a little pulp left inside with upside down (like an igloo-style) in kitchen garden. The slugs will hide underneath the grapefruit and die.

**Mechanical control practices**

**1. Attracting birds**

Erection of bird perches @ 25/ha facilitates predation of larval stages of insects.

**Bait for Ant**

Ants often protect honeydew producing organisms such as aphids, mealybugs, and scales from attack by natural enemies. Sometimes ants move these honeydew-producing insects from plant to plant. Control of ants often leads to more effective biological control of sucking pests. The bait can be made by dissolving 1 teaspoon powdered boric acid and 10 teaspoons sugar into 2 cups of water; this mixture can then be absorbed into cotton balls which are left near ant trails.

**Gundhi bugs in rice**

Fix dead crabs, frogs or even pieces of jackfruit (*Artocarpus heterophyllas*) to bamboo sticks and place them in rice fields before milky stage. This will attract gundhi bugs and keep them busy till the dough stage is over.

**Rats**

Boil 10 kg of wheat seeds in water with two large pieces of the bark from the Gliricidia tree. Then use the boiled wheat seeds in the field or in stores where rat menace exist. Mexican farmers grind the bark or leaves, mix it with wet wheat seeds or smear it on banana slice and use it for rat killing purpose. In Panama, a mixture of cereals and ground leaves of Gliricidia is allowed to ferment and then this is used as a rat killer. Gliricidia is a rat killer as it contains coumarin which gets converted to anticoagulant dicoumerol by bacterial fermentation. This reduces the protein Prothrombin to cause death in rats due to internal bleeding. Fruits of *Mucuna pruriencs* Back (Fam: Papilionaceae) are kept in the active rat burrows. When the rodent enters into the hole, it collides against the hairy fruits with irritating hairs and leaf the spot with irritation. A mixture containing 90% sesame or g.nut or niger flour with 5% thick sugar crystals and 5% powdered bulb or tube is placed in a bowl near rat holes and when rats feed this mixtures they die within a week. Inserting 10 – 12 inches long fresh pieces of stem of Jatropha plant into active rat holes makes the field rat free [32].

**Use of botanicals**

Botanicals are readily available than commercial products as they grow in the local environment. Reviving and modernizing age-old farmer practice through the optimization of ethnobotanicals has shown that farmers are more comfortable using plant materials than commercial synthetics and those botanicals can offer a similar level of control when certain guidelines are followed to their use [8]. Aloe (*Aloe barbadensis*; Fam: Aloeaceae) vitex (*Vitex negundo*; Fam: Verbenaceae) extract: Soak vitex leaves (5kg) in 10 liters water. After boiling for 30 minutes cool the extract and then strain. Remove the outer part of the aloe leaves (2 kg) and grind in water to get the extract. Mix the two extracts and dilute in 50-60 liters of water to cover 0.4 ha area. Add 50-60 ml soap in the mixture and spray early in the morning or late in the afternoon. This Aloe vitex extract is reported to control armyworm, hairy caterpillar, rice leaf folder, rice stem borer, semi-looper, bacterial and fungal diseases [10].

**Marigold and chilli extract**

Chop 500 g of whole plant and 10 hot chilli pods; Soak them overnight in 15 liters of water. Dilute the filtrate with water at 1:2 ratios and add soap @ 1tsp per liter of extract. This controls most agricultural pests [10]. Turmeric (Curcuma domestica): Soak shredded rhizome (20g) in 200ml cow urine. Dilute the mixture with 2-3 liters of water and add soap (8-12 ml) and spray. The extract controls aphids, caterpillars, red spider mites and powdery mildew [13]. Indian privet tree (*Vitex negundo*; Verbenaceae): Soak 2kg vitex leaves overnight in 5 liters of water and boil the mixture for 30 minutes. Add 10 liters of water and soap (10ml) and spray. This controls DBM, hairy caterpillars, rice leaf folder, rice stem borer and semilooper [15].

**Neem leaf extract**

Pound 1kg neem leaves and place it in a pot with 2liters of water.Cover the mouth with cloth and leave it as such for 3 days. Dilute the extract at 1:9 with water and add 100 ml of soap before spraying. This controls aphids, grasshoppers, leaf hoppers, plant hoppers scales thrips weevils and beetles [22].

**Other pest control formulations based on ITK**

**Fermented curd water** – In some parts of central India fermented curd water (butter milk) is used for the management of white fly, jassids, aphids, *etc.* Cow milk: Cow's milk was reported to acts as an excellent sticker and spreader due to presence of casein protein has excellent spreader and sticker property. It can be used @ 10% aqueous suspension for effectively controlling powdery mildew. Milk spraysinduced systematically acquired resistance in chilli against leaf curl, a viral disease [5].

**Cow urine and dung**

Cow urine diluted with water in ratio of 1: 20 is not only effective in the management of pathogens and insects, but also acts as a growth promoter of crops [74]. Cow urine have been found effective against mealy bugs, thrips and mites [9] and against post flowering insect pests of cowpea [51].Crush 5

kg neem leaves in water, add 5lit cow urine and 2 kg cow dung ferment for 24 hrs with intermittent stirring, filter the extract and dilute it in 100 lit of water for spraying over one acre. This extract is useful against sucking pests and mealy bugs.In brinjal, application of cow urine10% starch 1% [59] either alone or alternatively with chlorantraniliprole 18.5 SC [71] was found to be cost effective.

**Botanicals fermented in cow urine/cow dung**

The cow urine decoctions of botanicals have been reported as effective against the various insect pests without noticeable detrimental effect on their natural enemies [26], [58] .Cow urine 5% with neem seed kernel extract 5% and cow dung 5% showed anti-feedent and anti-ovipositional effects against *Helicoverpa armigera* [11],[70]. Among 14 cow urine mixed botanical extracts tested *Lantana camara* Linn. and *Vitex trifolia* were reported effective against aphid, *Lipaphis erysimi*[75].

Crude extract of *Datura alba* (20%) cow urine (20%) was effective against stem borer and leaf folder in Basmati rice [6]. The effectiveness of cow urine along with various botanicals viz., NSKE, Pongamia, Vitex and *Aloe vera* against *S. litura* and H. *armigera* in groundnut and chickpea, respectively [7]. Combination of cow urine with NSKE and Vitex reduced the shoot fly infestation in sorghum [46],[86].Cow urine fermented karanj leaves (10%) / neem leaves (10%) were ideal in respect of marketable fruit yield (135.5-141.7 q / ha) and benefit: cost ratio (38.20:1 – 42.68:1) despite of their ineffectiveness against the shoot and fruit borer in brinjal [74].

**Ash**

A thick layer of ash is either spread on the soil around plants or sprinkled on foliage to protect it against a variety of pests. Besides acting as a physical poison ash on crop foliage interferes in the chemical signals emanating from the host plants thus obstructing the initial host location by pests. Ashes from burnt palm frond and bunches have been traditionally used in the eastern parts of Nigeria to dust the leaves of okra to protect against leaf eating beetles, Podagrica spp [51]. Application of ash @50kg/ha kerosene5% and spinosad 45SC generated maximum benefit cost ratio of 4.8:1in brinjal [71].

**Kerosene**

It is readily available with the farmers and can be used with soap instantly to suppress the insect pests at the beginning of outbreak situation and subsequently the desired/recommended strategies may be followed. The use of Kerosene-soap-water emulsion has earlier been reported as a contact insecticide for piercing and sucking insects [14]. Similarly, the usefulness of this emulsion against scale insects, bugs, mites, aphids and leaf miners has been documented [84]. The effectiveness of SABRUKA (a mixture of soap, water and kerosene) against insect pests of cowpea in the northern Guinea Savanna [52]. Kerosene exhibits phytotoxicity at higher concentrations and therefore, its use as foliar spray should be restricted up to 1 or 2%. Prepare a 4 lit. stock solution of soap kerosene mixture in the below given proportion. Oils may also repel some pests, but the problem of phytotoxicity can not be ignored. Visible leaf damage, or more subtly reduction in yield could be possible. Bi-weekly oil applications reduced whitefly counts on tomato leaves by two thirds, but yield on the oil-treated plants was also reduced compared to untreated plants [81]. Five oil sprays controlled powdery mildew in grapes but reduced sugar levels [49]. Indian farming, which is going through a transition phase, is slowly but surely adopting the ways and means of pest management for sustainable agriculture [19]. Adoption of ITK based crop protection measures as an alternative to pesticides might help in restoring the biodiversity of natural enemies, but as IPM is a knowledge-based and farmer driven approach, education of farmers on alternatives to pesticides must be given a priority.

**Disease Management**

Tribal farmers use fermented solution of 5 kg of cow dung, 5 litre of cow urine, 150 gm lime + 100 litre of water to control khaira disease in rice, bacterial and viral diseases in paddy. To control the papaha disease (tip burn) of paddy, farmers drain out the standing water from the field. Cowdung is mixed with water thoroughly and kept for 3-4 hours till the course materials settle down. The solution on top is filtered and sprayed on paddy leaf for control of bacterial blight. Bactericidal action of cowdung helps reduce the population of the bacteria (*Xanthomonas sp*.) To control blight disease, mahua (*Madhuka indica*) cake (100 g) is mixed with 1 litre of water. The extract is mixed with washing powder and spraying is done. Smoke of mahua is also used for bacterial blight. About 3% neem oil extract and 3% mahua cake @ 1:1 ratio is also prepared and sprayed for control of pests [29].

**Weed Management**

Nirai or godai method is used by the tribal farmers. In this method, they use khurpi for removal of weeds from field. Deep summer ploughing also known as Khurra-Bakhroni (ploughing) in summer or after rabi also exposes the weed seeds to sun and destroy them. Farmers of the research area use ploughing in standing crop. This is the most common method in low land paddy. Ploughing in the standing paddy crop of one fourth to one and a half month after transplanting is done in the water filled field. A narrow desi plough kud nagar is used for this purpose by which paddy crop is ploughed and it falls on field. Weeds are uprooted and get decomposed in soil. In some crops especially in kharif season, farmers use hand weeding as a method by uprooting the seeds from soil. Farmers of the area manually separate the weed seeds from the crop seeds/grain [16].

**Nematodes Managements by Traditional Practices**

The qualitative and quantitative damage to crops caused by plant-parasitic nematodes is directly dependent on their initial population density in the field. The nematodes population in the field is fluctuated by nature of prevailing the biotic and abiotic stress factors. In the traditional farming system, several agronomic practices are used to keep the nematodes population below the threshold level to safeguard crops against nematodes infestation [12]. The manipulation of existing environmental conditions in the crop production site would further help to lower the damage by nematodes at the same time negates the uses of nematicides [3].

Traditional practices to overcome phytonematodes problem in the field

- The uses of nematode free planting material which negates the addition of fresh inoculum and prevent further migration of nematodes
- Adaptation of profitable crop rotation tactics with non-host crops to suppress the existing population of nematodes by starvation
- Addition of locally available organic amendments to enhance the multiplication of biocontrol agents

antagonistic to nematodes
- Uses of nematode-resistant planting material
- The adjustment of time for crop sowing and spacing in the field helps in escaping the most infecting stages of phytonematodes
- Maintain the crop diversity in the field to hinder the specific preference of nematodes towards a particular crop

**Crop wise Traditional practices to prevent nematodes infestation in the field**

**Pairing in a banana**

Banana is a rich source of Carbohydrates and vitamins. Banana is grown at a large scale in the world as a staple food crop. The major thwarting nematodes of banana include burrowing nematode *Radopholus similis* and lesion nematode *Pratylenchus coffeae*. Traditionally in the African and Asian countries, the infested part corm and sucker of banana are manually removed by cutting with a knife before planting in the field. The technique is known as pairing which prevents further inoculum in the field.

**Tuber cutting in Yam**

The yam crop suffers huge losses by the attack of nematode *Scutellonema bradys* and *Pratylenchus coffeae* [2]. Upon infestation these nematodes produce dry rot lesion on the surfaces of the tuber. The farmers traditionally adopted to remove unhealthy or rotten tissue from tuber before planting in the field [1].

**Corm thinning in Taro**

Taro is scientifically known as *Colocasia esculenta* is infested by nematode *Hirschmanniella miticausa* which develops the miti-miti disease on the plant [13]. This disease of Taro is mainly prevalent in the Pacific island nations where Taro is a staple food crop. The farmers in this region remove most of the infected tissue of corm with a knife to remove all the nematodes before planting in the field.

**Heating of Banana corm in water-filled drum**

In many African countries, the corm of banana are heated in water inside a drum. The corms left submerged in water for 10 to 15 minutes in the water-filled drum. The most effective temperature range to kill nematode is 50 to 55oC in range, which does not cause any negative harm to plant material.

**Seed dipping of groundnut in hot water**

The groundnut testa nematode *Aphelenchoides arachidis* in African nations can effectively be controlled by dipping the seed material in hot water for 5 minutes at 60oC temperature before planting.

**Burring of husks above the nursery seedbed:**

The nematode free nursery site is the primary requirement for the farmers to prevent the spread of nematode in the main field for transplanted crops. The nursery bed site is laid with rice husks, wheat straws, and other dry litter material. The burning of these materials raises the temperature of the nursery bed and kills nematodes, pathogen and weed seeds simultaneously.

**Dipping of wheat seeds in the brine solution**

The wheat seed gall nematode *Anguina tritici* is the major nematode that infests the wheat crop and forms seed galls. These seed galls get mixed with the healthy seed and spread nematodes if used for sowing. The seeds of wheat are dipped in salty brine solution inside a bucket and floating seeds are removed before planting. This method is the best-suited method to overcome the problem of wheat seed gall nematode problem.

**Plants with nematicidal properties and their specific parts against nematodes**

Many plants available in nature have tremendous potential to suppress plant-parasitic nematodes. These plants with nematicidal properties kill nematodes with a synergistic mechanism. The addition of these plants and their plant parts in the soil as an organic amendment enhances the population of antagonistic microbes. These microbes decompose the organic material and release toxic gasses inside the soil environment [21]. The accumulation of toxic gasses kills nematodes by suffocation. Some to the plants like crucifers exhibit directly interfere with the activities of nematodes by producing various allelochemicals. Decomposition of these plants also enhances the soil fertility apart from killing the nematodes (Table1).

**Table 1:** The plants and their parts in management of plant parasitic nematodes

| S. No. | Botanical | Material Used | Target Nematode | References |
|---|---|---|---|---|
| 1 | Pineapple | Leaves | *Meloidogyne spp.* | [12, 13] |
| 2 | Castor | Oilcake<br>Leaves Powder | *Meloidogyne javanica*<br>*Heterodera schachtii*<br>*Tylenchulus semipenetrans* | [15, 22, 27] |
| 3 | Pumpkin | Plant Residues | *Hoplolaimus tylenchiformis* | [40] |
| 4 | Cabbage | Chopped Leaves | *Heteroderamajor* | [75] |
| 5 | Cotton<br>Lucerne | Crop Waste &Hay | *Tylenchulus semipenetrans* | [30] |
| 6 | White Pine | Sawdust | *Pratylenchus penetrans* | [2] |
| 7 | Yellow sweet clover | Green Manures | *Meloidogyne* spp. | [3] |
| 8 | karanj | Leaves | *Meloidogyne javanica* | [31] |
| 9 | Paper<br>White Pine | Sawdust | *Heterodera fabacum* | [44] |
| 10 | Salwood | Sawdust | *Meloidogyne javanica* | [44] |
| 11 | Soybean<br>Corn | Meal | *Pratylenchus penetrans* | [2, 3] |
| 12 | Buttonbush | Leaves | *Meloidogyne* spp. | [2, 3] |
| 13 | Alfalfa | Green Manure | *Meloidogyne incognita*spp. | [21] |
| 14 | Alfalfa and Cotton | Seed Meals | *Pratylenchus penetrans* | [66] |

| | | | | |
|---|---|---|---|---|
| 15 | Neem | Chopped Leaves<br>Cakes<br>Seed Cake | *Meloidogyne* spp.<br>*Rotylenchulus reniformis* | [9] |
| 16 | Subabul | Leaves | *Meloidogyne javanica* | [24] |
| 17 | Karanj | Leaves | *Meloidogyne incognita* | [24] |
| 18 | Guava | Dried Leaves | *Rotylenchulus reniformis* | [76, 80] |
| 19 | Crepe ginger | Dried Rhizome Powder | *Meloidogyne incognita* | [29] |
| 20 | Groundnut | Oilcake | *Meloidogyne* spp. | [28] |
| 21 | Oak<br>Datura | Dry & Fresh Leaves | *Pratylenchus coffeae* | [64] |
| 22 | Crown flower | Leaves | *Meloidogyne* spp. | |
| 23 | Flower plant<br>*Parkia javanica* | Dry Powder of Leaves & Flowers | *Meloidogyne incognita* | [33] |
| 24 | Water Hyacinth | Leaves & Compost | *Hirschmaniella oyazae* | [16] |
| 25 | Ornamentals Chrysanthemum *Callistemon* sp. *Dandelion* sp. | Leaf Extracts | *Meloidogyne incognita* | [31] |
| 26 | Groundnut | Oilcakes & Leaves | *Meloidogyne incognita* | [28, 32] |
| 27 | Siam weed<br>Lemon grass | Root Extracts | *Meloidogyne incognita* | [16, 32] |
| 28 | Papaya | Plant Parts Extract | *Meloidogyne incognita* | [15] |
| 29 | Marigold | Aquous Extracts Of Plant Parts | *Meloidogyne incognita* | [47] |
| 30 | Tea | Compost | *Meloidogyne hapla* | [21] |
| 31 | *Lantana camara* | Leaf Extracts | *Meloidogyne incognita* | [16] |
| 32 | Garlic | Aqueous Extracts of Plant Parts | *Meloidogyne incognita* | [22] |
| 33 | Chrysanthemum | Flowers | *Meloidogyne incognita* | [47] |
| 34 | Jatropha | Leaves | *Meloidogyne incognita* | [25] |
| 35 | Datura | Plant Part Extracts | *Meloidogyne incognita* | [15] |
| 36 | Peppermint<br>Tarragon Marjoram | Plant Parts | *Meloidogyne incognita* | [15] |
| 37 | Bead tree<br>Hops<br>Elderberry<br>Poison hemlock | Plant Part Extracts | *Meloidogyne incognita* | [15] |
| 38 | Nilakkumil | Leaf Extracts | *Meloidogyne incognita* | [37] |

## Conclusion

Indigenous technical knowledge provides valuable inputs to make efficient use of natural resources and extends relevant support for sustainable development. Indigenous techniques used in different component of farming system are mostly organic, eco-friendly, sustainable, viable and cost effective. But, there is a need to explore, verify, modify and scientifically validate these practices for their wider use and application.

## References


1. Adegbite AA, Adesiyan SO, Agbaje GO, Omoloye AA. Host suitability of crops under Yam intercrop to root-knot nematode (*Meloidogyne incognita* Race 2) in South-Western Nigeria. Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS). 2005; 106(2):113-8.
2. Adesiyan SO, Adeniji MO. Studies on some aspects of yam nematode (*Scutellonema bradys*). Ghana journal of agricultural science. 1976; 9(2):131-6.
3. Akhtar M, Alam MM. Utilization of waste materials in nematode control: A review. Bioresource Technology. 1993; 45(1):1-7.
4. Alsayed AA, Ahmed SS, Abd-El-Hameed SH. Influence of decomposing dry leaf powders on *Rotylenchulus reniformis* reproduction and growth response of soybean. Annals of Agricultural Science, Moshtohor (Egypt), 1992.
5. Kumar A, Raj Bhansali R, Mali PC. Response of bio-control agents in relation to acquired resistance against leaf curl virus in chilli. In Proceedings of Asian Congress of mycology plant pathology, Mysore 2002, 1-4.
6. Aswal JS, Kumar J, Shah B. Evaluation of biopesticides and plant products against rice stem borer and leaf folder. Journal of Eco-friendly Agriculture. 2010; 5(1):59-61.
7. Barapatre A, Lingappa S. Larvicidal and antifeedant activity of indigenous plant protection practices for *Helicoverpa armigera* (Hub.). Proc. Nation. Symp. Fronterier Areas Ent. Res., 2003, I.A.R.I., New Delhi.
8. Belmain, Steven R. Optimising the indigenous use of botanicals in Ghana. In: Final Technical Report, Natural Resources Institute, Chatham, Kent ME4 4TB, UK. 2002, 58. (Website: http: // www. fao. Org /docs / eims / upload / agrotech / 1952/R7373 _FTR_pt1.pdf retrieved on 20.01.12)
9. Bhattacharya D, Goswami BK. Comparative efficacy of neem and groundnut oil-cakes with aldicarb against MeZuidugyne incognita in tomato. Revue Nématol. 1987; 10(4):467-70.
10. Bissdorf JK. In: How to Grow Crops without Endosulfan – Field Guide to Non-chemical Pest Management, (Ed: Carina Webber), Pesticide Action Network (PAN), Hamburg, Germany: 2008, 71.
11. Boomathi N, Sivasubramanian P, Raguraman S. Biological activities of cow excreta with neem seed kernel extract against *Helicoverpa armigera* (Hübner). Annals of Plant Protection Sciences. 2006; 14(1):11-6.
12. Bridge J. Nematode management in sustainable and subsistence agriculture. Annual Review of Phytopathology. 1996; 34(1):201-225.

13. Bridge J, Mortimer JJ, Jackson GV. *Hirschmanniella miticausa* n. sp. (Nematoda: Pratylenchidae) and its pathogenicity on taro (*Colocasia esculenta*). Revue de nématologie. 1983; 6(2):285-90.
14. Celsia and Janarthanan, "Indigenous technology knowledge of rice. International Journal of Current Research. 2019; 11(03):1810-1811.
15. Chabra HK, Grewal PS, Singh A. Efficacy of some plant extracts on root knot nematode (*Meloidogyne incognita*). J Tree Sci. 1988; 7:24-5.
16. Chaudhary KK, Haile A, Ayresea ZG, Semereab G, Weldegergish T. Nematicidal activity of Eritrean weed plants against the root-knot nematode Meloidogyne incognita. Nematropica. 2013; 43(2).
17. Das P, Das SK, Arya HPS, Subba Reddy G, Mishra A. Inventory of ITK in Agriculture. NATP Mission mode project on collection, documentation and validation of Indigenous Technical Knowledge. Indian Council of Agricultural Research, Document I, 2002, 5.
18. Dhandapani N, Shelkar UR, Murugan M. Bio-intensive pest management (BIPM) in major vegetable crops: an Indian perspective Food, Agriculture and Environment 2003; 1(2):333-339.
19. Duddington CL, Everard CO, Duthoit CM. Effect of green manuring and a predacious fungus on cereal root eelworm in oats. Plant Pathology. 1961; 10(3):108-9.
20. Edwards CA, Arancon NQ, Emerson E, Pulliam R. Suppressing plant parasitic nematodes and arthropod pests with vermicompost teas. Biocycle. 2007; 48(12):38-9.
21. El-Nagdi WM, Youssef MM. Comparative efficacy of garlic clove and castor seed aqueous extracts against the root-knot nematode, Meloidogyne incognita infecting tomato plants. Journal of Plant Protection Research. 2013; 53(3):285-8.
22. Formulations as Protectants of Cowpea against Field Pests. Journal of Entomology. 3(2):130-135.
23. Govindaiah SN, Sharma DD, Gargi. Effect of mulching of green leaves for the control of root-knot nematode in mulberry. Indian J. Nematology. 1989; 19(1):25-8.
24. Gupta MP. Efficacy of Neem in combination with cow urine against mustard aphid and its effect on coccinellid predators. Natural Product Radiance. 2005; 4(2):102-106.
25. Hafez SL, Sundararaj P. Concomitant interaction of *Meloidogyne chitwoodi* and *Pratylenchus neglectus* in a potato cropping system. Nematologia Mediterranea. 2000; 28(1):89-92.
26. Haroon SA, Hassan BA, Hamad FM. The efficiency of some natural alternatives in root-knot nematode control. Adv Plants Agric Res. 2018; 8(4):355-62.
27. Hutchinson MT, Reed JP, Pramer D. Observations on the effects of decaying vegetable matter on nematode populations. Plant Disease Reporter. 1960; 44(6):400-1.
28. IIPR. Recording and using indigenous knowledge: A manual, International Institute of Rural Reconstructions, 1996.
29. Joymati L, Romoni H, Dhanachand C. Effect of *Parkia javanica* Merr. against root-knot nematodes Meloidogyne incognita on *Vieia faba* Linn. Indian Journal of Nematology. 2004; 34(1):102-4.
30. Kanojia AK, Singh RV, Bambawale OM, Trivedi TP. (Edr) In: Explored Indigenous Technical Knowledge in Pest Management: NCIPM, New Delhi, 2005.
31. Kayani MZ, Sarwar G, Muhammad S. Control of root-knot nematode (*Meloidogyne incognita*) on tomato plants by using root extracts of plants. Journal of Agriculture in the Tropics and Subtropics. 2001; 102(2):143-6.
32. Khan AM, Alam MM, Siddiqi ZA, Saxena SJ. Effect of different oil cakes on hatching of larva and development of root-knot caused by *Meloidogyne incognita*. In International Symposium Plant Pathology, IARI, New Delhi 1967, 37.
33. Khan AM, Alam MM, Siddiqi ZA, Saxena SJ. Effect of different oil cakes on hatching of larva and development of root-knot caused by Meloidogyne incognita. In International Symposium Plant Pathology, IARI, New Delhi 1967, 37.
34. Khan AM, Khan MW, Saxena SK. Effect of organic amendments on the population of nematodes and fungi in the rhizosphere of eggplant (*Solanum melongena*). In All India Nematol. Symp 1969, 67-8.
35. Khan ML, Rathi N. Effect of organic amendments and carbofuran on *Meloidogyne incognita* population and yield in tomato. Indian Journal of Nematology. 2001; 31(1):83-4.
36. Khan MR, Khan MW. Effects of the root-knot nematode, *Meloidogyne incognita*, on the sensitivity of tomato to sulfur dioxide and ozone. Environmental and experimental botany. 1997; 38(2):117-30.
37. Lall SB, Hameed SF. Studies on the biology of the root-knot nematodes, *Meloidogyne* spp. with special reference to host resistance and manuring. In First all India nematological symposium. IARI, New Delhi 1969, 6.
38. Lear B. Application of castor pomace and cropping of castor beans to soil to reduce nematode populations. Plant Dis. Reptr. 1959; 43(4):459-60.
39. Linford MB, Oliveira JM. Potential agents of biological control of plant-parasitic nematodes. Phytopathology. 1938; 28:14.
40. Linford MB. Stimulated activity of natural enemies of nematodes. Science. 1937; 85(2196):123-4.
41. Mankau R, Minteer RJ. Reduction of soil populations of the citrus nematode by the addition of organic materials. Plant Dis. Rep. 1962; 46:375-8.
42. Miller PM, Edgington LV. Effects of paper and sawdust soil amendments on meadow nematodes and subsequent Verticillium wilt of tomatoes. Plant Dis. Rep. 1962; 46:745-7.
43. Miller PM, Taylor GS, Wihrheim SE. Effects of cellulosic soil amendments and fertilizers on *Heterodera tabacum*. Plant Dis. Rep. 1968; 52:441-5.
44. Mudigourdra S, Shekharappa, Balikai RA. Evaluation of plant products in combination with cow urine and panchagavya against sorghum shoot fly, *Atherigona soccata* Rondani Karnataka Journal of Agricultural Science. 2009; 22(3):618-620.
45. Natarajan N, Cork A, Boomathi N, Pandi R, Velavan S, Dhakshnamoorthy G. Cold aqueous extracts of African marigold, *Tagetes erecta* for control tomato root knot nematode, Meloidogyne incognita. Crop Protection. 2006; 25(11):1210-3.
46. Nayak N, Sharma JL. Evaluation of brinjal (*Solanum melongena*) varieties for resistance to root–knot nematode (*Meloidogyne incognita*). Global J. Bio-Sci. Biotehnology. 2013; 2(4):560-2.
47. Northover J. Optimum timing of Stylet oil for control of powdery mildew and European red mite without affecting juice sugars in Canadian grapes. pp. 402-408 In Spray

Oils Beyond 2000 (edited by G. Beattie *et al*.). Univ. of Western Sydney Press, 2002.
48. Omer EA, Hendawy SF, El-Deen AM, Zaki FN, Abd-Elgawad MM, Kandeel AM *et al*. Some biological activities of Tageteslucida plant cultivated in Egypt. Advances in Environmental Biology. 2015; 15:82-9.
49. Oparaeke AM, Dike MC, Amatobi CI. Fermented cow dung: a home produced insecticide against post flowering insect pests of cowpea, *Vigna unguiculata* (L.) Walp. Samaru Journal of Agriculture. 2003; 19:121-125.
50. Oparaeke AM, Dike MC, Amatobi CI. Insecticidal Efficacy of SABRUKA
51. Padhi NN, Misra RP. Control of Rotylenchulusreniformis on French bean (*Phaseolus vulgaris* L.). Indian Journal of Nematology. 1987; 17(1):130-1.
52. Pandey PC, Joshi Nirmala, Pokharia Dev Singh. Kumaon Himalaya ke Paramparagatpraudyogiki – Lok Vidha (In Hindi). Nilambar Joshi Smriti Sansthan, Almora, Uttarakhand, India, 2006.
53. Pant H, Pandey G. Use of Trichoderma harzianum and neem cake alone and in combination on *Meloidogyne incognita* galls in chickpea. Annals of Plant Protection Sciences. 2002; 10(1):175.
54. Paruthi IJ, Jain RK, Gupta DC. A note on reaction of some spices to root knot nematode (*Meloidogyne javanica*). Haryana J Hortic Sci. 1987; 16:154-5.
55. Patel RM, Desai MV. A possible biological control of root-knot nematodes. Plant Disease Reports; 1964; 48:167-8.
56. Poonam C. Effectiveness of cow urine and its decoctions against insect pests of soybean. M. Sc. Thesis, G.B.P.U.A.T., Pantnagar, 2003, 95.
57. Prasad JS, Kumar RM, Rao LV. Role of manures and fertilizers in the management of the root Nematode (*Hirschmanniella oryzae*) in rice (*Oryza sativa* L.). Indian Journal of Nematology. 2004; 34(1):1-4
58. Radhakrishnan T, Anandaraja M, Ramasubramanian M, Nirmala, Israel Thomas M. Traditional agricultural practices- applications and technical implements. New India Publishing Agency, New Delhi, 2009.
59. Radwan MA, El-Maadawy EK, Kassem SI, Abu-Elamayem MM. Oil cakes soil amendment effects on *Meloidogyne incognita*, root-knot nematode infecting tomato. Archives of Phytopathology and Plant Protection. 2009; 42(1):58-64.
60. Rajagopalan CR. Indigenous knowledge/CFS experience. Indian Journal of Traditional knowledge, 2003; 2(4):313-320.
61. Rajendran G, Saritha V. Effect of plant extracts and their potentized doses against root-knot nematode, *Meloidogyne incognita* on tomato. Indian Journal of Nematology. 2005; 35(1):28-31.
62. Devi R, Saha B, Pandit A, Kashyap D. Assessment of applicability of Indigenous Technical Knowledge (ITK) in aquaculture as perceived by fish farmers in Assam. Indian J Fish. 2014; 61(3):104-10.
63. Randhawa N, Sakhuja PK, Singh I. Management of root-knot nematode *Meloidogyne incognita* in *Abelmoschus esculentus* through botanical extracts and organic amendments. Indian Journal of Nematology. 2002; 32(2):129-31.
64. Rehman B, Ahmad F, Babalola OO, Ganai MA, Parihar K, Siddiqui MA. Usages of botanical extracts for the management of root-knot nematode, *Meloidogyne incognita* in chickpea. Journal of Pure and Applied Microbiology. 2013; 7(3):2385-8.
65. Rizvi R, Ansari RA, Iqbal A, Ansari S, Sumbul A, Mahmood I *et al*. Dynamic role of organic matter and bioagent for the management of *Meloidogyne incognita*–*Rhizoctonia solani* disease complex on tomato in relation to some growth attributes. Cogent Food & Agriculture. 2015; 1(1):1068523.
66. Roldi M, Dias-Arieira CR, Severino JJ, de Melo Santana S, Dadazio TS, Marini PM *et al*. Use of organic amendments to control *Meloidogyne incognita* on tomatoes. Nematropica. 2013; 43(1).
67. Sadawarte AK, Sarode SV. Efficacy of neem seed extract, cow-dung, and cow-urine, alone and in combination, against the pod-borer complex of pigeonpea. International chickpea and pigeonpea Newsletter. 1997; 4:36-7.
68. Sakhinetipalli A. Field testing of ITK and insecticide based strategies for the control of brinjal fruit and shoot borer, *Leucinodes arbonalis* Guenee in brinjal. M. Sc(Ag) thesis submitted to OUAT, Bhubaneswar, during, 2012.
69. Saxena R. Biotoxicity of some ornamental leaf extracts against *Meloidogyne incognita*. Indian Journal of Nematology. 2005; 35(2):145-7.
70. Scholte K, Vos J. Effects of potential trap crops and planting date on soil infestation with potato cyst nematodes and root-knot nematodes. Annals of Applied Biology. 2000; 137(2):153-64.
71. Shailaja B, Patnaik HP, Mukherjee SK. Assessment of botanicals fermented in cow urine alone and along with panchagavya against brinjal shoot and fruit borer. Journal of Eco-Friendly Agriculture. 2012; 7(1):24-8.
72. Shreth CN, Singh KI, William SJ. Laboratory evaluation of certain cow urine extract of indigenous plants against mustard aphid, *Lipaphis erysimi* (Kaltenbach) infesting cabbage. Hexapoda. 2009; 16(1):11-13.
73. Singh RS, Sitaramaiah K. Control of plant parasitic nematodes with organic soil amendments. PANS Pest Articles & News Summaries. 1970; 16(2):287-97.
74. Singh RS, Sitaramaiah K. Control of root knot through organic and inorganic amendments of soil--effect of oil cakes and sawdust. Indian journal of mycology and plant pathology, 1971.
75. Singh RS, Sitaramaiah K. Effect of decomposing green leaves, sawdust and urea on the incidence of root-knot of okra and tomato. Indian Phytopath. 1967; 20:349-55.
76. Singh RS, Sitaramaiah K. Incidence of root knot of okra and tomatoes in oil-cake amended soil. Plant Disease Reporter. 1966; 50(9):668-72.
77. Singh S, Singh B, Singh AP. Nematodes: A threat to sustainability of agriculture. Procedia Environ. Sci. 2015; 29:215-6.
78. Stansly PA, Liu TX, Schuster DJ. Effects of horticultural mineral oils on a polyphagous whitefly, its plant hosts and its natural enemies. In Spray Oils Beyond 2000 (edited by G. Beattie *et al*.). Univ. of Western Sydney Press. 2002, 120-133
79. Sundararaju P, Padmanaban B, Sathiamoorthy S. Efficacy of certain botanicals against root-lesion nematode, Pratylenchus coffeae in banana.
80. Vaitheeswaran M, Ibrahim SM, Kumar KS. Carbohydrate metabolism in a host plant, *Hibiscus cannabinus* infected by Meloidogyne incognita. Indian Journal of

Nematology. 2005; 35(2):205-6.
81. Van der Werf E. Pest Management in Ecological Agriculture. AME Foundation, Groenekan/Holland. Vijayalakshmi, K., Subhashini, B. and Shivani, V. K., (1999). In: Plant in Pest Control - Garlic and Onion, Centre for Indian Knowledge System, Chennai, 1985, 1-20.
82. Vijayalakshmi K, Subhashini B, Koil S. Plants in pest control: Custard apple, vitex, sweet flag and poison nu. Centre for Indian Knowledge System (CIKS). Chennai: 1998, 15.
83. Vijayakshmi K, Subhashini B, Koul S. Plant in pests control: Garlic and onion. Centre for Indian knowledge system, Chennai, India. 1999, 123.
84. Walker JT, Specht CH, Mavrodineau S. Reduction of lesion nematodes in soybean meal and oil-amended soils. Plant Disease Reports. 1967; 51:1021-4.
85. YU Kawasaki I, Lim Y, Oh WS, Paik YK, Shim YH. Inhibition of developmental processes by flavone in Caenorhabditis elegans and its application to the pinewood nematode, *Bursaphelenchus xylophilus*. Molecules & Cells (Springer Science & Business Media BV). 2008; 26(2).