Application of Indigenous Technological Knowledge (ITK) for Plant Disease management in Tamil Nadu, India

ABSTRACT

Most of the farmers in our country highly depend on chemical pesticides and fungicides to control pests and diseases in agriculture and horticultural crops. Abundant usage of these pesticides in crop fields causes harmful effects to human beings as well as to other living organisms. The harmful effects of these chemicals brings the emergency call for ecofriendly and hazard free sustainable agriculture. Indigenous technological knowledge (ITK) originates from local, rural communities and it can play an important role in organic agriculture. The ITKs are eco-friendly and compatible with various agricultural management practices particularly pest and disease management. Application of ITK in crop management, contributing towards chemical residue-free agricultural products. The farmers of Tamil Nadu state in India profusely use the chemical pesticides and fungicides to control crop pests and diseases even though most districts in Tamil Nadu havetheir own ITK practices with respect to location specificity. Hence, an attempt has been made to document some of the significant and effective ITKs followed by the farmers in Tamil Nadu for the management of crop diseases. This paper contains an overview of Indigenous Knowledge in Plant diseases management to help researchers in the future.

Keywords: Botanicals, Indigenous technological knowledge, Panchakavya, Plant diseases

1. INTRODUCTION

Indigenous Technical Knowledge (ITK) is the local knowledge that is unique to a given culture or society and its knowledge passes from generation to generation. It is the knowledge that people have gained through inheritance from their ancestors. Wang [1] defined “ITK as “the sum total knowledge and practices which are based on peoples accumulated experiences in dealing with situations and problems in various aspects of life and such knowledge and practices are special to a particular culture.” ITK is stored in people's memories and activities, and is expressed in the form of stories, songs, folklore, proverbs, dances, myths, cultural values, beliefs, rituals, community laws, local language and taxonomy, agricultural practices, equipment, materials, plant species and animal breeds”. “ITK is shared and communicated orally, by specific examples and through culture. Indigenous agricultural practices are an unwritten body of knowledge. There is no systematic record to describe what they are, what they do and how they do what they do, how they can be changed, their operations, their boundaries and their applications. It is held in different brains, languages and skills in as many groups, cultures and environments as are available today. Hence, there is immense pressure on the people of India to collect, preserve, validate and adopt Indigenous agricultural practices so as to reduce dependence on external inputs, to reduce the cost of cultivation and to propagate eco-friendly agriculture” [2]

“ITKs are practical in nature and optimize local thinking in the field of agriculture, fisheries, health, livestock and forestry” [3]. “Agricultural scientists believed that ITKs can play a significant role in solving issues related to modern agriculture and environment” [4]. “The scientific community accepted that the assessment of ITKs is an indispensable part of the introduction of new agricultural technology. It is recognized that the knowledge of farmers must be taken into account before any new technology is developed and disseminated”. [4]The integration of scientific and traditional knowledge would help to

develop technologies which are need based, better problem solving, locally available, easily acceptable, cost effective, convincing and credible to the agricultural farmers. Recent scenario has aroused interest in indigenous technical knowledge (ITK). These ITKs are based on experiences which gathered momentum through generations and are being developed and improved through informal experimentation. Indigenous technology is used by the native inhabitants of a country or region and it constitutes an important part of its cultural heritage.

"In India, the chemical pesticides are largely being used by the farmers to control different pests and diseases of crops. Some of the pesticides do pose a potential risk to human and other life forms and unwanted side effects to the environment. The world-wide deaths and chronic diseases due to pesticide poisoning is about one million per year" [5]. "These detrimental effects of chemical pesticides bring the urgent need of organic agriculture. Therefore, it is important to develop holistic methods of managing pests and diseases of agricultural crops to make it more eco-friendly, economically viable and socially acceptable for the farmers" [6]. "In recent years, the importance of organic agriculture has been recognized and emphasized in those areas especially which are rich in biodiversity such as north eastern region of India" [6]

Application of ITK in pest and disease management of different crops has been practiced for a long time. The ITKs are eco-friendly and compatible with other management practices as well. Since chemical pesticides do pose a serious threat to the soil, environment, plant, animal and human health, scientists are constantly working on alternative methods of pest and disease control in agriculture. Present study attempts to document ITKs followed by farmers of different localities for management of pest and diseases of crops. The ITKs documented may serve as basic knowledge for doing research to develop ecofriendly technology capsule.

2. MATERIALS AND METHODS

The traditional knowledge on plant disease management was collected in various districts of Tamil Nadu through personal interviews and focus group discussions. Karur, Tiruchirappalli, Villupuram, Thiruvarur, Thanjavur and Nilgris districts of Tamil Nadu were chosen for this study. A structured interview schedule for data collection was developed by the investigator to assess the traditional and Indigenous Technical Knowledge (ITK) practices in plant disease management in the selected districts of Tamil Nadu. The online literature search was also performed via Google Scholar, Science Direct and Scopus using combinations of the keywords for searching research articles, proceedings, newsletters, and reports with respect to the scientific validation of the identified traditional practices. The villagers of the selected districts were approached and asked about the traditional practices for the management of plant diseases. The information received from the villagers have been categorized into different sub-headings and presented in this article.

3. RESULTS AND DISCUSSION

3.1 Chillies leaf curl disease management using buttermilk

Leaf curl disease in thechilli plant is caused mainly by the *Chillies leaf curl virus* (ChiLCV) ChiLCV shows a widespread occurrence in most of the chilli(*Capsicum annuum*)growing regions.In Trichy district of Tamilnadu foliar spray of buttermilk is done in chillies for the management of leaf curl disease. "The formulation, prepared in buttermilk, was tested against the plant virus and found effective. The use of buttermilk for its antimicrobial activity in humans and plants has been a traditional practice. Many milk proteins are known to have shown antiviral activity by inhibiting reverse transcriptase enzyme of viruses. Buttermilk base alone could reduce virus concentration but was more effective when used in combination with Bacillus formulations"[7].

3.2 Fungal disease management using neem seed kernal extract

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Fungi constitute the largest number of plant pathogens and are responsible for a range of serious plant diseases. Most vegetable diseases *viz*., wilt, root rot, leaf spot, leaf blight are caused by fungi. In Trichy district of TamilnaduNSKE (Neem Seed Kernal Extract) 25 kg of neem seed kernel was soaked in 500 liters of water for 8 hours. "Spraying with 5% NSKE controlled rice sheath rot, Blackgram powdery mildew, and green leaf hopper (vector of rtv) at 2 sprays at 15 days interval. Neem Seed Kernal Extractextract has fungistatic and fungicidal effects against plant pathogenic fungi like *Alternaria solani*, *Curvularialunata*, *Fusarium oxysporum*, *Helminthosporium* spp. and *Sclerotium rolfsii* (Natarajan, 2002)[8]. A range of fungal infections including *Candida albicans*, *Aspergillus fumigatus*, *Aspergillus flavus*, *Aspergillus niger*, *Microsporumgypseum*, *Microsporumcanis*, *T. mentagrophytes*, *T. rubrum*, *Cladosporium* spp., *F. oxysporum*, *Penicillium notatum*, and *Penicillium citrinum* can also be treated using neem oil" [8,9,10]

3.3 Seed borne diseases management using mint leaf extract

Seed borne diseases such as leaf stripe,*Fusarium*, and loose smut are largely controlled by the use of certified seed and seed treatments. In Karur districtof Tamilnadumint leaf extract was prepared by soaking 100 g of mint leaves in one liter of water for one hour. Soaking seeds in mint leaf extract would prevent the seeds from seed borne diseases. Hafedh*et al*, [11] conducted "a study to investigate the efficiency of the combined effect of hot water leaf extracts of horse-mint (*Menthe longifolia*L. Hands) against six pathogenic fungi associated with legume seeds: *Aschochta fabae, Macrophominaphaseolina, Alternaria alternata, Dreschsleraspecifera, Fusarium solani*and*Curvularialunata*. All tested concentrations of the leaf extracts were found to significantly reduce mycelium growth and spore germination of pathogenic fungi associated with legume seeds. The concentrations of 20 and 30g/l were effective in suppressing the radial growth of *A. alternate, A. fabae, M. phaseolina* and *F. solani"*

3.4 Blast Management Using *Prosopis juliflora* Leaf Extract

"The rice blast fungus attacks the crop at all stages of crop growth from seedling to late tailoring and the ear-heading stage. The disease is favored by long periods of free moisture, high humidity, little or no wind at night, and night timetemperatures between 63 and 73°F.In Karur districtofTamilnadu20Kg of *Prosopis* leaves were soaked in 200 liters of water to get a 10% extract. This *Prosopis* extract is sprayed in paddy for management of paddy blast disease.*Prosopis juliflora*leaves and fruit extracts had their antimicrobial activities evaluated against the growth of selected bacteria and yeast, and against mycelial growth and conidial germination of selected mycotoxins-producing fungi. *P. juliflora*water-soluble leaf ethanolic extract with its novel extraction method showed the strongest antibacterial activity. Antimicrobial tests showed total inhibition of *Botrytis cinerea*, *Alternaria alternata*, *Bacillussubtilis*, *Staphylococcus aureus* and *Candida albicans.* Percent inhibition of mycelial growth of the extract was also determined against seven other fungal strains with highest value against *Geotrichumcandidum*(66.2%). Even the least affected fungal strain showed alterations in their hyphae and spores exposed to extract when observed using a scanning electron microscope (SEM)" [12].

3.5 Management of bacterial and viral diseases using Papaya leaf extract

"In Karur district of Tamilnadu10Kg of papaya leaves were soaked in 200 liters of water to get 10% extract. Papaya leaf extract is sprayed on all types of crops for the management of bacterial and viral diseases. Particularly, for the management of brown spot disease in rice, farmers used to prepare asolution from 2 kg fresh papaya leaves in 3-4 liters of water. That solution is need to be kept overnight. After that solution is filtered by using a cloth. Then, that is diluted in 50-60 liters of water. In that solution 250 ml of soap solution can be added as a sticker or surfactant" [13,14]."The active compounds contained in seed extract and papaya leaves are flavonoids, alkaloids, tannins, steroids, and saponins. Extracts isolated from papaya plants had gram-positive antibacterial activity greater than that gram-negative bacteria" [15].

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3.6 Antimicrobial activity of Herbal extract

"Indiscriminate use of most of the synthetic fungicides has created different types of environmental and toxicological problems. Recently, in different parts of the world, attention has been paid to the exploitation of higher plant products as novel chemotherapeutants in plant protection. The popularity of botanical pesticides is once again increasing and some plant products are being used globally as green pesticides. In Thiruvarur district of TamilnaduSpraying of leaf extracts of different indigenous plant species viz., notchi, adathoda and datura sprayed in black gram and green gram as plant protection measure to protect the plant from pest and disease.*Vitex negundo* has strong inhibitory effect against *Rhizoctonia solani* and *Xanthomonas oryzae*pv.*oryzae* under *in vitro* and *in vivo"*[16].

"Adathodavasica leaf extract significantly reduced the bacterial leaf blight pathogen, X. oryzaepv. oryzae (Xoo) *in vitro*. Seed treatment was found to be effective in reducing the incidence of the disease under greenhouse condition. Physiological observation of Adathodavasicatreated plants indicated that restriction of pathogen colonization or disease development in plant tissue was correlated with the pronounced increase of peroxidase, PAL, β -1, 3-glucanase polyphenol oxidase and phenol activity after challenge inoculation with the target pathogen"[17]

*"Datura metel*themember of the Solanaceae family is famous due to its herbicidal, antibacterial & anti-fungal activity"[18]. In *Datura metel* plant extract twelve phyto-constituents viz. eugenol, 2-pentadecanone 6,10,14 trimethyl, pentadecanoic acid, pentadecanoic acid, 1 4-methyl- methyl ester, phytol, 9,12,15-octadecatrienoic acid, heptacosane, *n*-hexadecanoic, 6-octadecanoic acid, 9, 12 octadecanoic acid, dodecanoic &tetradecanoic acids were identified. The presence of these bioactive constituents make*D. metel*as an effective antifungal agent against *R. solani*.

3.7 Pulses root rot management using Calotropis

Mungbean [*Vigna radiata* (L.) Wilczek] is an important pulse crop globally. This imperative crop is severely affected by charcoal rot disease caused by *Macrophominaphaseolina*. In Pudukottai district Spraying of the leaf extract of calotropis against pulse crop disease management is practiced. The higher concentration of methanolic leaf extract of Calotropis *procera* (7%) caused maximum inhibition in the diameter of *M. phaseolina* i.e. 38%. The *n*-hexane fraction of methanolic leaf extract was found to be the most effective against *M. phaseolina*. Seven compounds belonging to classes of chlorocarbon, aromatic hydrocarbon, azocompounds, aromatic carboxylic acids and fatty acids were identified in GC-MS analysis of n-hexane fraction. Antifungal activity of the methanolic leaf extract of *C. procera* might be due to the presence of the identified compounds in the n-hexane fraction of methanolic leaf extract.

3.8 Paddy khaira disease (Zinc deficiency) management using Tamarind extract

Khaira disease (Zinc deficiency)is a common disease in rice caused by zinc deficiency. It leads to the formation of dusty brown patches on leaves and causes necrosis. In Thanjavur district tamarind extract is used for the management of khaira disease. Five hundred g of tamarind leaf were chopped and homogenized in a mixer after adding 200 ml of water. The homogenate was initially filtered through a layer of muslin cloth. The final volume of the extract was made to 500 ml with water to form 100% extract. This extract was diluted to 10% concentration and sprayed over paddy leaves to check khaira disease.

Jacob*et al* [19]evaluated"the influence of tamarind leaf extract (5,10,15,25 and 50%) on the growth of certain polypathogenic fungi (*Phytopthora*, *Colletotrichum gleosporioides*, *Alternaria solani*, *Fusarium solani*, *Rhizoctonia bataticola*, *Sclerotium rolfsii*, *Pellicularia filamentosa* and *Macrophominaphaseolina*). Tamarind leaf extract suppressed the growth of all the fungi spp. at 3 days after inoculation. The tamarind leaf extract offers great opportunity for use as an antifungal botanical to control seed, soil and air borne phytopathogenic fungi".

3.9 Panchagavya for disease management

In Trichy district for Rice, Banana and vegetables Spraying of Panchakavya @ 3% without external chemical inputs is practiced for plant protection measures and to get higher yield. Panchagavya is mixture of eight products namely cow dung,urine,milk,ghee etc. It promotes plant growth, yield and immunity and it also an organic pesticide. It is mainly used in organic farming. “Panchagavya contains a significant proportion of macronutrients like Nitrogen, Phosphorus and Potassium as well as micronutrients like Zinc, Magnesium, Calcium, Copper, Manganese that are required for the growth and development of plants.Hence Panchagavya boosts immunity and promote plant growth. *Panchgavya* in agricultural fields dramatically influences the growth and crop yield by promoting the beneficial soil microorganisms around the roots” [20]

There is a wide scope to find the spectrum of panchagavya in inhibiting the several soil-borne and seed-borne fungal plant pathogens. The previous research provides evidence about panchagavya as soil fertility agent, insect repellant and plant growth promote. These distinguished features of panchagavya can make it best suite for integrated pest, disease, and nutrient management programmes.

4. CONCLUSION

It is concluded that our farming society in Tamil Nadu, which is going through a transition phase,is gradually adopting the ways and means of traditional disease management for sustainable agriculture. It has been proven that various diseases can be controlled by using natural products with different formulations. Adoption of ITK-based crop protection measures as an alternative to chemical fungicides might help in avoiding the residual effect as well as restoring the biodiversity of natural enemies. Tamil Nadu is experiencing the revival of traditional and indigenous practices in agriculture and allied activities. Hence, it is the right time to disseminate good agricultural practices that are rich in ancient wisdom and a proper coalition between the traditional and modern knowledge and technology systems has vast potential for the benefit of the farming community.

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