

Department of Agriculture Development &  
Farmers' Welfare  
Farm Information Bureau



NOVEMBER 2022  
VOLUME - 10  
ISSUE - 05

# KERALA KARSHAKAN

*English journal*

The First English farm journal from the house of Kerala Karshakan

## POKKALI

AN EXQUISITE  
CLIMATE RESILIENT  
AND ORGANIC  
RICE - PRAWN  
PRODUCTION SYSTEM  
FOR FUTURE



## The First English farm journal from the house of Kerala Karshakan

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# POKKALI

## AN EXQUISITE CLIMATE RESILIENT AND ORGANIC RICE-PRAWN PRODUCTION SYSTEM FOR FUTURE

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The globe is facing faster climatic changes in the 21st century than in the past. The world's average temperature is rising and is accompanied by flooding, drought, and erratic rainfalls. The change in soil and water salinity is a peripheral impact of this utmost weather conditions. These climatic changes have a significant effect on agricultural production, making



climate-adaptive crops extremely valuable at this time. Pokkali is the oldest indigenous rice variety that has 3000 years of organic cultivation and climate resilience history. The journey of Pokkali rice began from a flood, where earlier Pokkali was wild rice that was seen in the western ghats of India and was carried by the flood to low-lying coastal saline areas. All the climatic stress was overcome in this great journey and it developed resistance to flood and salinity. It is grown in the water-logged, coastal regions of Ernakulam, Thrissur, and Alappuzha districts in Kerala and is well known for its flood, saline tolerance, and high nutritional value. The rice got its name Pokkali, because of its notable height, which can grow up to 6 feet. In Malayalam, Pokkali is a term used to describe someone who dominates in height over others. Pokkali rice cultivation alternated with extensive aquaculture is known as Pokkali farming.

In Kerala, when the southwest monsoons wash the salinity of the tiny soil mounds made in the fields, is the ideal time to start Pokkali paddy cultivation, it is carried out over 4 months which begins in June and ends in September, which is the 1st season. In the second season, which runs from November to May, prawns/fish are produced in the same field. During harvest, panicles are cut, and the remaining parts are left in the field, where they eventually serve as feed for



Avifauna of pokkali fields 2

Photo: Netto Peter

prawns in the next season. The entire farming is organic, since no fertilizers and pesticides are used, and the soil is well fertile with prawns, fish excrement, and other remnants.

**SIGNIFICANCE OF POKKALI RICE**

In 2018 Kerala experienced a severe flood that destroyed much agriculture and bought up losses for the farmers, while majority of the Pokkali fields were able to withstand the heavy

wind, soil erosion, and flooded water that entered the fields. The rapid climatic changes and the rising sea levels across the world have encouraged the search for saline-resistant varieties, hence Pokkali which can also grow in saline water will have a great future. Some of the major salt tolerant rice varieties in the world are listed in Table 1.

The traditional way of Pokkali transplantation enables the plant to survive underwater

for more than a week. It is widely used as a donor for developing new breeds and in salt tolerant crop research.

Pokkali rice got its Geographical Identification tag (GI Tag) in 2008-2009, by the Geographical Indications Registry Office, Chennai, also making it the first product in Kerala to receive the tag. Most importantly, this farming is eco-friendly without exploiting natural resources and biodiversity.

**Table 1. Major salt-tolerant varieties in the world**

India	Cheruviruppu, Nona Bokra, Getu, Damodar, SR26B, Vikas, Kuthiru, Korgut, Karekagga, Sathi, Bhurarata, Picha neelu, Kalundai samba
Bangladesh	BRI, BR203-26-2, Sail
Russia	VNIIR8207 and Fontan
South Korea	Dongjinbyeo, Seomjimbyeo, Ganchukbyeo, Gyehwabyeo, Nonganbyeo Ilpumbyeo, and
Thailand	FL530
Japan	Mantaro rice, Lansheng, Kanto 51, Chikushiqing, Hama Minoru
United States	American rice





Avifauna of pokkali fields 1

Photo: Netto Peter

## **NUTRITIONAL AND MEDICINAL VALUES**

The Pokkali rice varieties are abundant in protein, fiber, and antioxidants. The grain contains tocopherol, oryzanol, and tocotrienol antioxidants that are essential for immunity. Pokkali rice has the lowest concentration of carbohydrates making it suitable for diabetic patients and is also enriched with micronutrients such as iron, boron, sulphur, and vitamin E. However, polishing of grain can result in the loss of nutritional and health benefits. Polished rice is deficient in minerals such as manganese, sulphur, potassium, and phosphorus.

## **FIELD PREPARATION**

Rice cultivation is done during low salinity, while aquaculture is carried out during high salinity. By mid-April the soil mounds are dried and after April 14, sluices (water gates) are installed in the field to regulate water flow during tidal changes. Water channels and dikes are made followed by ploughing. The field is suitable for sowing once the monsoon has removed salt from the soil.

## **SEED PREPARATION**

For sowing, sprouted seeds are used. Baskets made

of Teak, arrow roots, or coconut, leaves that can hold 10 kg seeds are used to submerge seeds in water for 12 to 18 hours without sun exposure. Within 6-8 days the seed germinates. When the weather is favorable, sowing is done. Before sowing; the seed baskets are again soaked in water for 6 hours. If the monsoon gets delayed, sowing is postponed. But two times water dipped seeds should be sown within 2-3 days.

## **FARMING PRACTICES**

On the fifth day after sowing, shoots of saplings are visible, which is known as Panchakanam in Malayalam. Later on, on the 28<sup>th</sup> day weeds are removed from the paddy before transplantation, in Malayalam, this process is termed as Valaymatheerna divasam by the ancestors. After 100 days, rice spikes will be visible and in the next 20 days, the grain ripens to a golden color and is ready for harvest. Harvesting is done in the Malayalam month of Thulam.

## **CURRENT SCENARIO AND CHALLENGES**

According to the Pokkali Land Development Agency (PLDA), a few decades ago 25,000 ha of land was there under Pokkali farming. It got reduced

to 8,500 ha, in which only 5,500 ha are cultivating paddy, the remaining is unused or under prawn farming. According to the latest data, Pokkali cultivation is done in only 967 ha in Kerala. Although Pokkali production requires no fertilizer or pesticides, farmers are not keen on it. They tend to switch to monoculture of Prawns due to the poor market price of Pokkali rice. Quality and taste of the pokkali paddy are its attractions, whereas there is no premium market for the Pokkali paddy products. The loss in paddy is generally compensated by Shrimp farming, whereas due to the widespread attack of White spot syndrome (WSS) viral infection, Shrimp farming also turned un-profitable. Lack of farm hands and excessive labor costs are the other problems faced by farmers in this sector. Large amount of labour is required for Pokkali land preparation, bund forming, planting, harvesting, transportation, whereas no specialized equipment or machinery is available for the marshy Pokkali fields to replace human labour. Since Pokkali farming is climate dependent, constant attention is required at each phase of the paddy/ shrimp cultivation. Even then,



Pokkali paddy harvesting. Photo: Dr.Vikas P.A

the production is unpredictable. Industries in the nearby area are a threat to this cultivation, as the toxic substances emitted by them contaminate the backwaters. Major Pokkali fields are being utilized for large-scale industrial projects, bridges, residential, and road construction, these have disturbed the tidal flow of backwaters to the Pokkali fields. The current social and economic practices are making it difficult for this traditional farming to survive and the rate of Pokkali farming is alarmingly declining.

### **THE NEED FOR POKKALI FARMING**

#### **For wetland conservation:**

Kerala is well known for wetlands and one-fifth of the state's total landmass is wetlands. Thousands of people rely on wetlands for their livelihood, well-being and poverty mitigation.

Wetlands can act like a sponge to hold water during flooding, storms, or whenever the water levels are high, which helps in maintaining normal river levels and filtration and purification of surface water. When the water levels are low, it releases water. Wetlands are the home for many plants, fishes, and wildlife. It also avails in the migration and reproduction of animals that live in other habitats. But urbanization, and development activities are demolishing wetlands and their vegetation. Industrial pollution and improper sewage management have resulted in a decrement in biota, fish mortality, and ammonia accretion in water.

#### **To Save avifauna habitat:**

The wetland ecosystem is an Important Bird Area (IBA) that serves as a habitat for

avifauna and a stopover area for migratory birds. They utilize wetland ecosystems for breeding, feeding, roosting, nesting, and rearing chicks. Water birds are salient indicators of ecological wellness, productivity, and contamination of wetlands. The depletion in Pokkali farming has induced the diminishing of avian fauna.

#### **To Escalate Rice production:**

Rice is the staple meal of Kerala, still, there is not enough Pokkali rice being produced to meet demand. In this current era where organic farming acquiring social, political, and scientific acceptance for its contribution to sustainable agriculture, promoting rice production for stress-prone areas in a purely organic system like Pokkali, is vital to attain an evergreen revolution in rice.



**H**oney bees and fruits of its toil are familiar to man since the prehistoric time. Honey bees are the social insects with remarkable degree of social instincts and division of labour. In India, they are known mainly for the production of honey and to some extent as wax producers. Other valuable bee hive products are pollen, royal jelly, bee venom and propolis. Apart from these rewards, they play an important role in pollination.

*Apis cerana indica* Fab., the Indian honey bee is the popular honey bee species used for commercial beekeeping in Kerala.

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# PROBIOTICS: AN AMELIORATE OF BEE HEALTH





Maintaining these bee colonies in a healthy state throughout the year is one of the main concerns of beekeepers. The bees are affected by a number of biotic and abiotic factors which affect honey bee health and productivity. Some of the factors such as farmer practices, climate change, habitat loss and pathogen are becoming equally crucial for beehive integrity.

In the dearth season,

sugar syrup is used as the artificial feed for honey bees. Sugar can harm the honey bees by means of the impurities present in commercial sugar (Roy, 1977). According to Doung (2014), raw sugar has a sucrose level of 99.50 per cent with an ash content of 0.2 per cent which can cause digestive issues to the honey bees.

Honey bees, the eusocial beneficial insects are reported to have many diseases.

According to Gilliam (1997), there is a large diversity of disease causing microorganisms associated with honey bees. Recently, beekeeping in Kerala faced a serious threat when brood diseases resulted in great economic losses throughout the state. The disease incidence was reported as 5.4 to 63.63 per cent (Amritha et al., 2014). Joseph (2018) also reported the occurrence of similar bacterial brood disease from southern

districts of Kerala. Honey bees are exposed to pesticides while collecting pollen and nectar from flowers, resins from various flora, drinking water from rivers or lakes or ponds etc., breathing and during flight (if the pesticides are airborne) (Mullin et al., 2010). These pesticides are brought back unintentionally into the colony where its level sets concentrated further in the waxy comb (Gregorc and Ellis, 2011).

Scientists are researching on the role of bee gut microbiota in health status so that the use of chemicals in managing pathogens can be reduced which in turn improve the bee health. Generally lactic acid bacteria (LAB) are proved to be important inhabitants of animal and human intestinal tracts as they have a multifaceted, antimicrobial potential (Audisio and Benítez-Ahrendts, 2015).

### **Honey bee and its gut microbes**

There is a distinctive gut bacterial community, which consists of nine dominant groups, comprising over ninety-

five percentage of the whole community. They belong to mainly three phylum Proteobacterium, Actinobacterium and Firmicutes. They are *Gilliamella apicola*, *Frischella perrara* and *Snodgrassella alvi* of phylum Proteobacterium. Firmicutes includes clades, Lactobacillus Firm-4 and Firm-5, and phylum Actinobacterium includes Bifidobacterium. The distribution of these beneficial microbes varies in the alimentary canal. A few bacteria are found in the crop and midgut, while the hindgut is lined with a stable layer of cuticle that accounts for more than ninety-nine percentage of the bacteria in adult worker bees. The young honey bee larvae are devoid of bacteria, but are fed by workers throughout their development. The transmission of microbes is mainly of three ways – oral trophallaxis, from hive material and faecal- oral route. The most important one is faecal– oral route, since, almost all the microbiota are harboring in the distal part of the gut (Kwong and Moran, 2016).

### **Benefits of microorganisms in their host**

The microbes help to digest food and provide essential nutrients, detoxifying harmful molecules, protect from pathogens & parasites and thus modulate the immunity. The microbes essentially provide nutritional and immunity support to the host. They improve the energy uptake (Newton et al. 2013), helps in lignin breakdown (Rokop et al. 2015), pectin breakdown (Engel and Moran, 2013) and trehalose degradation (Milani et al., 2015). The microorganisms play a role in host protection either by directly stimulating the bee's immune system or by directly inhibiting pathogens through antimicrobial compound production (Evans et al., 2005).

### **Probiotics concept in bees**

According to WHO, 2002, probiotics are live microorganisms that, when administered in adequate amounts, confer a health benefit on the host. There is a mutualistic dependence between the Lactic





Acid Bacteria and honey bees. The LAB flora obtain a niche abundant in nutrients, while the honey bees in turn are protected from harmful organisms (Olofsson and Vasquez, 2008).

**Histomorphology of Indian bee (*Apis cerana indica* Fab.) supplemented with probiotics**

A study was conducted at AICRP on Honey bees and Pollinators, Department of Agricultural Entomology, College of Agriculture, Vellayani, Thiruvananthapuram in 2019. The main objective was to assess the histomorphology of Indian bee's (*Apis cerana indica* Fab.) midgut suffering from various stressors (pathogens and insecticides) and, after being fed with probiotics.

Purposive sampling was conducted at

Thiruvananthapuram, Kollam, Pathanamthitta and Idukki districts for the present study. Twelve larvae each from naturally occurring feral colony, domesticated colonies which were fed with and without sugar syrup (artificial feed), naturally infected ones with bacterial brood disease as well as larvae fed with insecticide (Thiamethoxam 25% WG) amended royal jelly were collected and subjected to histomorphological evaluation. Apart from these, the effect of probiotics on larvae under different stress conditions were also evaluated. The study mainly focused on the variations in the midgut histology of the larvae.

**Histology of feral colony and domesticated colony larvae fed without sugar**

The midgut of the honey bee larvae from feral colony

had high epithelial integrity, well defined brush bordered microvilli which probably helps in the easy absorption of nutrients, prominent regenerative cells that is responsible for epithelial cell replacement and copious secretion of peritrophic membrane that are intended for the protection of the midgut from abrasive food particles, pathogen and toxins (Plate 1A). The larvae of the colonies which were not fed with artificial feed also had similar histology. The midgut of such larvae had homogeneously arranged characteristic columnar shaped epithelial cells, uniformly arranged brush bordered microvilli and triangular shaped minute regenerative cells

**Histology of domesticated colony larvae fed with sugar**

Histomorphological

studies of honey bee larvae fed with sugar syrup, revealed an adverse effect of sugar on midgut cells viz., absence of microvilli, reduced number of regenerative cells and uneven peritrophic membrane secretion. Apart from these, the cytoplasmic granulation was comparably more than that of the normal cells. Though peritrophic membrane was present, its secretion and distribution over the epithelial cells was uneven.

### **Histology of colony infected with bacterial brood disease and larvae fed with insecticide**

Studies on the midgut histomorphology of bacterial brood disease infected larvae indicated necrosis with picnotic or karyorrhectic nuclei, moderately vacuolated cytoplasm, inconspicuous microvilli and distorted peritrophic membrane. Only occasional regenerative cells were apparent (Plate 1B). The midgut epithelial cells of the larvae fed with insecticide, Thiamethoxam 25% WG @ 0.05g L<sup>-1</sup> exhibited only the presence of vacuoles of variable sizes.

### **Histology of domesticated colony fed with probiotic**

The midgut histomorphology of honey bee larvae treated with the probiotic, Darolac @ 1.2 g L<sup>-1</sup> at weekly intervals for a period of four weeks was also evaluated. An increased cell activity which was indicated by the prominent aposematic secretion towards the gut lumen in those larvae supplemented with probiotics when compared

with that of the normal larvae from feral colony. Apart from these, enhanced integrity of the epithelial columnar cell, even distribution of microvilli and augmentation in the secretion of peritrophic membrane was also recorded when the probiotic was fed to bacterial brood disease infected larvae (Plate 1C).

Hence a balanced gut microbiota improves the resistance of indigenous microorganisms against colonization of pathogens. Being the dietary supplement, the probiotics maintains or restores beneficial bacteria to the digestive tract. Thus, they stimulate the intestinal defense mechanism in the host body. So probiotics can be regarded as a natural tool to protect honey bee from pathogens

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Cassava is the most widely cultivated root crop in the tropics and because of long growth season (8–24 months), its production is limited to the tropical and subtropical regions in the world. Cassava is a perennial shrub belonging to the family Euphorbiaceae. Cassava originated in South America and subsequently was distributed to tropical and subtropical regions of Africa and Asia. Cassava plays an important role as staple food for more people in the world due to its high carbohydrate content. The production and consumption

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# Value added products from Cassava





of cassava attaches a significant importance in support of the rural food security. Compared with other cereals, cassava has the potential to produce the highest yield in terms of carbohydrates or calories.

Once harvested, tubers are more perishable than grains as they are high-moisture vegetables (60- 90%) so that they have poor post-harvest storage qualities. Tubers are primarily affected by two types of postharvest deterioration i.e., physiological deterioration and microbial spoilage which results loss of market acceptability. As well as direct physical loss of the crop, postharvest deterioration causes a reduction in quality that results in price discounts and so contributes to economic losses. The most important and primary



CASSAVA SNACKS



CASSAVA BREAD

operation in processing roots and tubers is drying which converts the perishable tuber crops to powdery secondary food products or flours that satisfy the needs of traditional patterns of food utilization. The major processed products from tubers are starch, dried chips, sago, bread, sauce, flours, noodles etc.

#### **Cassava starch**

Cassava starch is a very good raw material in the food industry. It can be processed by peeling and washing of the

roots, grating and sieving to remove the fibre. The mash is allowed to sediment then followed by decanting to collect the starch. The starch has a low gelatinization temperature, high water-binding capacity (thus, a good stabilizer of food) and high viscosity and it does not retrograde easily. The lipid, protein, ash and phosphorous content are generally low, but its carbohydrate content ranges between 73.5 and 84.9%. Both the modified and unmodified starch are used as raw materials

in food industries, either directly as starch food in form of custard or as a thickener in baby foods and gravies and as a binder for products during cooking to prevent drying out.

#### **Cassava Chips and Pellets**

Cassava chips are dried irregular slices of roots, which vary in size but should not exceed 5 cm in length. The method of processing chips consists of peeling, washing, chipping the cassava roots, and then sun drying the slices. Pellet is similar to chips but has lower moisture





**Roasted-Special (CS)**



**Roasted-Best (CB)**



**Roasted-Milky white (CM)**



**Steamed-Ceylon (NC)**



CASSAVA PAPPAD

content of about 9 % compared to chips. Hence, pellets have longer storage life compared to chips.

Pellet is cylindrical in shape, dry and hard with length of about 2– 3 cm and diameter about 0.4 and 0.8 cm. Pellets can be processed either from the root or leaves but also be from the peels of the root and it involves milling and extrusion, resulting in gelatinized products which become hardened on cooling. Pellet is recommended for shipment purposes because it has less storage weight and the ability to retain the quality after long distance of travel due to the low moisture content.

### **Cassava Flour**

Cassava flour is white, smooth and odourless flour which also known as high quality cassava flour (HQCF) and can be

used as composite flour. It was processed by sorting, peeling, washing and grating. The grated pulp is then dewatered (using rock to compress the sack bags) and pounded with pestle and mortar; this process contributes to soften the tuber. The mash is then sun dried and pounded again and then sieved and finally packed for further use in the food industries.

### **Cassava Bread**

Cassava bread is a fermented product prepared from the combination of wheat flour and cassava flour in the ratio of 5:1. In this method, cassava flour is processed into dry flour by drying at temperature of about 50°C to ensure that flour retains its creamy colour after drying. It helps to improve the use of cassava flour as composite flour in bakery industries.

### **Fermented Cassava Starch**

This is used for frying and baking of cheese bread in some countries such as Brazil. It involves steeping already peeled and grated cassava roots in a tank of water for a period of 20 to 70 days to allow fermentation. This steeping process in adequate water helps in separating the starch granules from the fibre and other soluble compound. After fermentation, the obtained starch is dried to produce a powdered product.

### **Cassava Fufu**

Fufu is a common traditional food for the West African countries. Fufu is an acid-fermented cassava product that is processed through the submerged fermentation of peeled roots in water. But its shelf life is short because it is processed as a wet paste with moisture content of about 50 % so it will not be useful to be suitable for large-scale and commercial purposes.

### **Garri**

Garri is creamy-white, pregelatinized granular and high-calorie food with slightly sour taste. It is processed from fresh cassava roots following very tedious operation of peeling, grating into mash. The grated pulp is put in sacks (Jute or polypropylene) and placed under heavy stones or pressed between wooden platforms for 3-4 days to dewater the pulp and allow fermentation to take place. Garri is regarded as precooked convenient food which can be eaten as a snack and the long

period of roasting contributes greatly to its longer shelf life.

### **Agbelima**

Agbelima is a traditional food of the West African especially in Ghana, Togo and Benin. It involves grating and fermentation of the cassava tuber with inoculums. The fermentation process in agbelima promotes detoxification of cassava root and gives a peculiar organoleptic quality such as souring taste and soften texture.

### **Sago (Sabudana)**

Sago (sabudana) is a processed edible starch marketed in the form of small globules or pearls. It is easily digestible, rich in carbohydrate and its size generally ranges from 2 to 4.5 mm. When cooked, sago turns from opaque white colour to translucent and becomes soft and spongy. Sago is very heat sensitive, if it is subjected to fry, it will turn into a sticky, gluey mass, which is nearly impossible to separate.

It is a traditional processed food product of India and commonly used as a food (known as khichadi) during festive season and fasting in western and central part of India (Maharashtra and Madhya Pradesh) and used as baby food (West Bengal). It is also used as a food thickener in several food preparations and in South India, it is used to make Kheer by adding milk. The flowchart of the unit operations followed for sago production is shown.

Fresh tubers →Peeling

& washing →Starch extraction →Conditioning →Sizing →Roasting →Drying →Polishing →Bagging →Sago

Sago is generally classified into two types viz. Roasted sago (commercial sago) and Steamed sago (Nylon sago) based on the type of heat treatment after globulation. They are further divided into different grades viz., Commercial (special, best, milky white) and Nylon (ceylon, pearl). Nylon sago is glassy and has more transparency in its raw appearance, whereas roasted sago has no transparency. The colour of the two grades are also different as nylon sago becomes a glowing transparent cream-yellow colour when cooked, whereas roasted sago retains the original natural white colour like a milk.

### **Cassava Pakkavada**

This is a hot snack food having good texture and taste made out of cassava flour. The other ingredients include maida, bengal gram flour, salt, chilli powder, asafoetida, baking soda and oil. The ingredients are thoroughly mixed and made into dough with hot water (50°C), proofed for 1h and then extruded through hand extruder having flat rectangular holes, into hot oil.

### **Cassava Nutrichips**

This is a high protein snack food made out of cassava flour by mixing with other ingredients like maida, groundnut paste, egg, salt, sugar, sesame, coconut milk, baking soda and oil. After

mixing the ingredients, hot water is added and mixed to form smooth dough. The dough after proofing is made into small balls which are then spread into sheets of 0.2cm thickness. This is then cut into diamond shape using a sharp knife and deep fried in oil.

### **Cassava Crisps**

This is a soft and good textured crispy snack food made from cassava flour, maida, rice flour, bengal gram flour, salt, baking soda, turmeric powder and oil. The dough made with hot water is proofed for 1h and then extruded through the small pore size die having round holes. The deep fried material is mixed with fried nuts, curry leaves etc. before packing.

### **Cassava Rava**

Cassava rava is a pre-gelatinized granular product similar to wheat semolina and finds use as a breakfast recipe product. For the preparation of cassava rava, the tubers are peeled and sliced into round chips. It is then partially cooked by boiling in water for 5 min, decanting the steep water, sun-drying the parboiled pieces and powdering coarsely in a hammer mill. This is then sieved through fine sieve to separate out the finest fraction which can be converted to porridge powder by flavoring with cardamom and fried powdered cashew nuts. The residue is sieved through larger mesh size sieve to obtain rava. The uneven large pieces are again powdered to recover the rava.



# MAJOR INFECTIOUS DISEASES IN GOATS TO BE PREVENTED BY VACCINATION

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**G**oats also known as Poor man's cow is gaining popularity in Kerala among progressive farmers, youth entrepreneurs. They are the main meat-producing animals, whose meat (chevon) is one of the choicest meats and has a huge demand. Goats efficiently convert low quality grazing matter that is less preferred by other livestock into quality lean meat. Also Goat farming needs relatively small area, limited demand for resources but fetches better returns. Diseases in

Goats is a worrying factor that pulls back farmers from Goat Husbandry. But many of the diseases can be prevented by proper and timely vaccinations and disease control measures by way of practicing hygienic practices. This in addition to scientific feeding and housing is a sure way of making Goat rearing an attractive economic venture. Some major Infectious diseases affecting Goats include bacterial diseases like anthrax, enterotoxaemia, tetanus, caseous lymphadenitis, listeriosis, tuberculosis, Johne's disease, dermatophilosis, pasteurellosis, brucellosis, foot rot, contagious caprine pleuropneumonia, colibacillosis, salmonellosis, etc. Mastitis is also common due to bacteria belonging to E. coli, Staphylococcal and streptococcal category. Viral diseases like Foot and Mouth Disease (FMD), Peste des petits ruminants (PPR), Bluetongue disease etc can affect goats.

**Considering the incidence and outbreaks of infectious diseases in Kerala, vaccination against the following diseases is highly recommended as detailed below** **Peste des petits ruminants (PPR)** is an acute highly contagious fatal viral disease caused by Morbilli virus genus in the family Paramyxoviridae characterized by fever, necrotic stomatitis, gastroenteritis, pneumonia. High mortality is noticed. The vaccine against PPR is produced in 2 ml ampoules (50 doses) in Institute



of Animal Health and Veterinary Biologicals, Palode. The vaccine has to be reconstituted in 50 ml normal saline or 1 molar Magnesium sulphate solution. 1ml needs to be administered subcutaneously at neck region. Recommended age of first vaccination is 3 months of age. Immunity will last for more than 3 years(long immunity). The vaccine can be stored for 12 months at – 20°C

**Enterotoxemia**(overeating or pulpy kidney disease) is a bacterial infection caused by *Clostridium perfringens* type D. These bacteria are normally found in the soil and also as part of the normal microflora in the gastrointestinal tract of healthy goats. The disease occurs in

young kids due to abundant intake of milk, in adults while grazing on lush pastures during rainy season and also when fed high quantity and quality hays concentrates. This is one disease that can occur in well fed healthy animals. This toxin produced by this bacterium in an anaerobic conditions is absorbed through the intestinal wall and causes death suddenly. In many instances, deaths occur so quickly that no symptoms will be noticed. Affected goats and kids may show nervous signs such as trembling, stiff limbs, and convulsive movements. Sometimes the animal enters in to coma with death occurring quietly. Diarrhoea may be present in some cases . The

inactivated vaccine against Enterotoxaemia is produced in 100 ml bottles (40 doses) in Institute of Animal Health and Veterinary Biologicals, Palode (IAH & VB). The vaccine has to be administered as such. 2.5ml needs to be administered subcutaneously at neck region. Recommended age of first vaccination is 3 months of age. 2.5ml booster injection needs to be given after 2 weeks. Vaccination needs to be repeated every year. Immunity will last for one year. The vaccine can be stored for 12 months at + 4 °C

**Haemorrhagic Septicaemia** is a very common bacterial infection caused by *Pasteurella multocida* characterised by fever, laboured breathing, initially clear nasal discharge which can later turn to mucopurulent as the disease intensifies, salivation. Submandibular oedema spreading to the pectoral (brisket) region and even to the forelegs occur at later stages following which prognosis is poor. Goats die due to Pneumonia. The Oil Adjuvant inactivated vaccine against Haemorrhagic Septicaemia is produced in 300 ml bottles (150 doses) at IAH & VB, Palode. The vaccine has to be administered as such. 2 ml needs to be administered intramuscularly. Recommended age of first vaccination is 4 -6 months of age. Annual Vaccination needs to be done ideally one month before monsoon season. Immunity will last for 9 months. The vaccine can be stored for 12

months at + 4 °C

### **Goats are highly susceptible to tetanus.**

Tetanus is caused by a toxin produced by the bacteria *Clostridium tetani*. These bacteria live in the soil, in faeces and in dust on the goat's skin. When a penetrating wound occurs, tetanus bacteria may multiply in the wound and produce toxin. The incidence of tetanus is not uncommon. Tetanus toxoid is available as 0.5 ml ampoule and 0.5 ml needs to be administered intramuscular. Kids above 3 month needs to be given one injection, then booster injection after one month. Then annual injection needs to be repeated. Pregnant Goats needs to be given one injection at 4th month of pregnancy. In any situations that create deep wounds which favours an anaerobic condition is conducive for the disease to occur.

There are incidences of Contagious Caprine Pleuro Pneumonia being diagnosed but no vaccine is currently available in India. Foot and Mouth disease (FMD) is also reported in Goats although incidence is very less, vaccination against FMD is carried out along with the vaccination campaign for cattle. Goats are now suspected to be a potential carrier of FMD virus transmitting the disease to cattle, hence Goats can also be vaccinated in larger interest of controlling FMD in cattle. Ideally first vaccination against FMD in Goats needs to be given at 3rd month and then repeated

once in 4-6 months interval. Although Goats are susceptible to Anthrax and Black quarter, vaccines against these are produced at IAH & VB, Palode, regular vaccination is generally not recommended considering the negligible incidence being reported in Kerala and also considering the number of "must vaccinations" to be carried out as detailed above. Bluetongue disease is more common in sheep than in goats and incidences in Goats are not generally reported in Kerala

The vaccines produced by IAH & VB, Palode is given free of cost to farmers if approached or intended through Veterinary hospitals. The vaccine will be provided to district office of Animal Disease Control Project from IAH & VB, Palode for onward supply to Veterinary hospitals. A farmer can also purchase vaccine produced by IAH & VB, Palode directly by paying the cost of vaccine at IAH & VB, Palode sales counter fixed by Government from time to time. Since vaccines are available in multiple doses, it is ideal to conduct vaccinations in a camp mode in consultation with local self-government institution to avoid wastage of vaccine and more coverage of goats in a particular area.

Focus can be given to vaccinate goats against Peste des petits ruminants, Haemorrhagic Septicaemia, Foot and Mouth disease, Enterotoxaemia and Tetanus considering the infectious disease profile in Goats in Kerala.

# Neelakurinji

A Unique Bloom of Ecosystem

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## INTRODUCTION

Kurinji or Neelakurinji, scientifically known as *Strobilanthus kunsthaus* is a flower belongs to the genus *Strobilanthes* in the Acanthaceae family, which was found in the Western Ghats of South India's shola woods. 'Neela' literally translates to 'blue' and kurinji is the name given to it by the tribals of the area means 'blue flower' in Malayalam and Tamil language, Gurige in kannada. The name *Strobilanthesis* derived from the Latin words 'strobilos' meaning cone and 'anthos' meaning flower or shoot.







In the 19th century, Christian Gottfried Daniel Nees von Esenbeck first discovered and described the genus, *Strobilanthes*. For a tribal community in Munnar, the neelakurinji is the symbol of self-awakening of a woman. For the poets it is a symbol of longing for love and happiness, for tribal Kurinji, is the symbol of love and romance.

The genus has around 250 species, of which at least 46 are found in India. Native to Tropical Asia and Madagascar. Origin of the species is Asia. Most of these species show an unusual flowering behavior, varying

from annual to 16-year blooming cycles. The plant called after the Kunthi River, which runs through Kerala's Silent Valley National Park and is home to a large population of the plant. Located at an altitude of 1,300-2,400 meters and grows to a height of 30 to 60cm. Nilgiri Mountains got its name from the Neelakurinji flowers; Nilgiri: Blue Mountain.

### TAXONOMY

Division: Angiospermia  
Class: Eudicots  
Sub-class: Asterids  
Order: Lamiales  
Family: Acanthaceae  
Genus: Strobilanthe  
Botanical name: *Strobilanthes Kunthianus* Nees  
T Anders

Synonyms: *Strobilanthes nilgiriensis*,  
*Phlebophyllum kunthianus*, *Ruellia kunthiana*,  
*Phlebophyllum angustifolium*

### HABITAT AND DISTRIBUTION

- Neelakurinji is a tropical plant species native to Shola forests in Western Ghats. Grow on bare slopes, ravines and edges of moist

deciduous forests, etc.

- It is also seen in Shevroys Hills in Eastern Ghats, Anamalai hills and Agali hills in Kerala and Sanduru hills in Karnataka.
- Besides the Western Ghats, Neelakurinji is also seen in the Shevroy in the Eastern Ghats, Sanduru hills of Bellary district in Karnataka.

### SPECIES

- *Strobilanthes swightianus* is a species in the grassy downs of the Nilgiris. The plants can easily be recognised with a very rough and hairy shrub, 6 to 8 feet high at the edges of sholas. Sporadic flowering of this species can be seen almost every year in the Nilgiris.
- *Strobilanthes sessilis* and *S. reticulatus* were in flowers along the grassy slopes of Thadiyandamol hills in Coorg.
- *S. lanatus* is one of the species which is confined to the highest reaches in the Sisspara Ghat in the Nilgiris and Vellarimala.
- *Strobilanthes inegrifolius* is more frequent in the northern districts of Kerala and its distribution extends to Karnataka, Goa and Maharashtra. It seems to have a flowering periodicity of 6 to 7 years.

- *S. lupulinus*, *S. heyneanus* and *S. ciliatus* were found in the Chamakochi forest in the Kasaragod district in Kerala.
- *Strobilanthes consanguineus* can be seen on the Pulneys and Anamalais at about 1200m. Gamble says its period is about 12 years.
- *Strobilanthes callosus* (*Carvia callosa*) prominent in the grasslands of the northern part of the Western Ghats, probably from Chikmangalur and northwards.
- *Strobilanthes sainthomiana*, *S. malabaricus* and *S. kannani* are new species that were discovered from Vaithalmala in Kannur district, recently.
- *Strobilanthes agasthyamalana* is a new species located in the Agasthyamala region at the southern tip of the Western Ghats.
- Among the latest of discoveries is another species, *Strobilanthes jomyi*, that bloomed along the laterite stream sides near the coastal belt in Kasaragod district, Kerala, in October–November 2017.
- *Strobilanthes kunthianusm* (*Phlebophyllem kunthianum*) flowers gregariously once in 12 years turning the entire grasslands in the misty mountains of Nilgiris, Anamalais and Palnis into a blue sea.
- The flowering occurred mainly in the months of September and October. *S. homotropus*, *S.*

*gracilis*, *S. foliosus*, *S. pulneyensis*, *S. luridus*, *S. zenkerianus* and *S. urceolaris* were in full bloom in the sholas.

- *S. urceolaris* were seen along the shola edges in the open and among the bushes along the stream sides.
- *S. amabilis* flowered in the sholas on the Chembra peak in Wayanad

### MORPHOLOGY AND BOTANY

The wild flower grows at a height of 30 to 60 cm, beyond 180 cm under congenial conditions on hills slopes at an altitude of 1300 to 2400 meters where there is little or no tree forest. The plant of kurinji is a bushy shrub with hairless reddish branches. The leaves are hairless and have a leathery texture, elliptic in shape, the size of the leaves are 6 x 3 cm.

**Inflorescence:** The inflorescence spike branched or unbranched with many flowers. Spikes in upper axils and terminal, 3–10 cm long, uninterrupted, sometimes branched, white tomentose, subtended by leafy bracts.

The kurinji flower is a bright blue bell-shaped blossom with a bright color, grow in the cluster of 2-5 and have woolly texture. The flowers are hairy and grow in a linear pattern. The lance-shaped petals are almost 2.5 cm long and are attached to the spikes 3-5 cm long.

The flowers are hermaphrodite borne



on racemes, which are arranged compactly. On average, each plant produces  $82.5 \pm 62.5$  inflorescences and each inflorescence bears  $23.8 \pm 8.8$  flowers.

**Bract:** Bracts 1–1.5 cm long, elliptic-ovate, white villous, midrib not prominent.

**Corolla:** Corolla 2–3 cm long, somewhat campanulate, pale blue or pale lilac or mauve, nerves darker, pubescent outside, hairy inside at nectar guide area; lobes 5, orbicular or suborbicular, upper margin undulate.

**Androecium:** Staminal filaments not grooved, pilose hispid.

**Pollen:** Ellipsoidal,  $60\text{--}86 \times 40\text{--}53 \mu\text{m}$ , 3-zonoporate pseudocolpi 5 in each mesocolpium, ridges  $2.19 \mu\text{m}$  broad

**Gynoecium:** Ovary hairy at the apex, style 15 mm long, swollen areas absent.

**Fruits:** Capsules 1–2 cm long, narrowly ellipsoid; seeds 4, 1.5–2 mm across, orbicular, brownish, flattened, monocarpic species show dominance in the community.

## FLOWERING

The flower has no smell. Plants which bloom after long periods are known as Pletesials like kurunji. They are known to exhibit 'gregarious flowering habit', masting i.e. a mass seeding phenomena or synchronous production of seeds by plants after long intervals of time. These plants need a long time to prepare themselves for flowering. The period between two flowering season is known as Oscillatory period and is controlled by endogenous factors.

Each species of kurinji flower takes different time to mature. Flowers open within 9 am, they remain fresh up to the second day and senesced on the third day. Neelakurinji takes 12 years to grow and bloom gregariously. The red and maroon kurinji flowers are also available but it is the blue, azure neelakurinji that is widely popular and most-coveted.

The flowers are pollinated by honey bees, butterflies, eastern honeybees and insects love these nectar-filled blue flowers. The nectar collected by the honeybees is regarded to be superlative and healthier. This rarest honey can last for more than 15 years. The indigenous



tribe Paliyan harvests the honey from hives. The tribe calls it 'liquid gold' for its value. 'Kurinji then' is the name of the honey, which is derived from Neelakurinji flowers.

## UTILITY

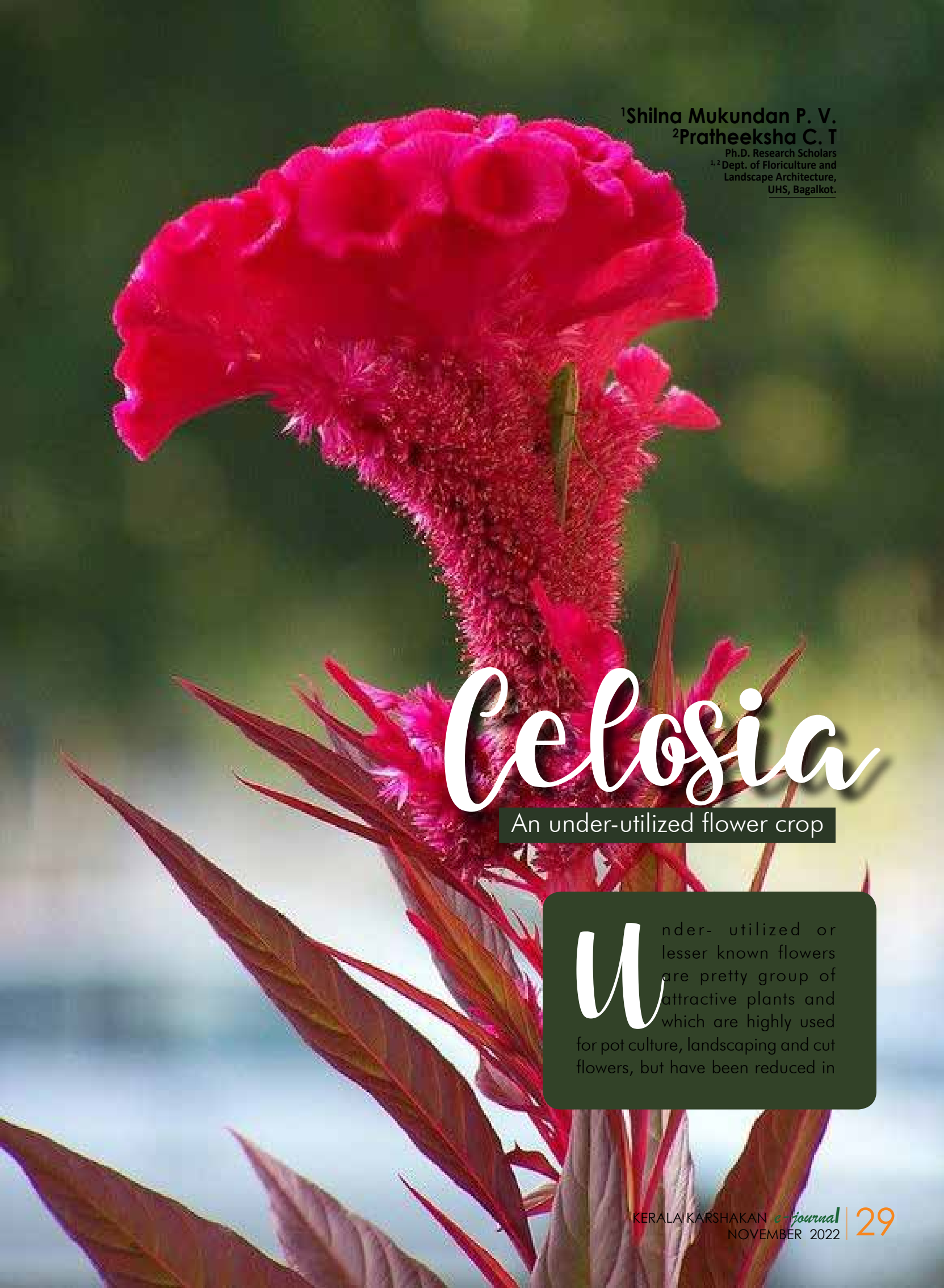
Possess many nutraceutical properties; Honey collected by these bees is very sweet, nutritious and has high medicinal value. It is transparent and a bit greenish-yellowish in colour. The taste is unique and so far. Honey is only available when the flowers bloom once in 12 years.

**Pharmacological:** antibacterial, antiviral, antifungal acute respiratory inflammation, stomach ailments, rheumatism, anxiolytic, anti-diabetic, laxative, anticancer, diuretic, anti-arthritis, anti-inflammatory properties.

## CONSERVATION

The year 2006 was when the Neelakurinji last bloomed in Kerala and Tamil Nadu, after a span of 12 years. The year was declared as the "Year of Kurinji" and a commemorative stamp was released in Kerala.

To save this natural wonder from going into extinction mode, the government has set up a sanctuary called, "Kurinjimala Sanctuary" in Vattavada and Kottakamboor villages of Idukki in 2006. This sanctuary spreads across 32 square km and organizes campaigns as well as programs to spread awareness regarding the conservation of the ecosystem. The locals have also dedicated a temple of Hindu God Kartikeya for the preservation of neelakurinji flowers.



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# Celosia

An under-utilized flower crop

**U**nder-utilized or lesser known flowers are pretty group of attractive plants and which are highly used for pot culture, landscaping and cut flowers, but have been reduced in



### Colour variations in *Celosia cristata* types

importance over time. Celosia is a flowering annual, which is one among them.

Celosia is commonly known as Cockscomb and Wool flower. They are called Lagos Spinach in Southeast Asia and Africa. They are also widespread in Mexico, where they are known as the velvet flower. In other areas like the West Indies, they

are grown as a wildflower for their nutritious leaves. In Nigeria, they are known as Soko Yokota and in Spain, they are known as the Rooster's Comb. Cockscomb (*Celosia cristata* L.) belongs to the family Amaranthaceae, is one of the most eye-catching dwarf annual bedding flowers of summer. Most common colors are dazzling red, yellow, cream, orange, rose, deep magenta and pink. The flowers are good for cutting and can be dried for table decoration as the dried

flower heads retain the colors for a long time. Celosia can range in size from dwarf varieties that only grow four to six inches high to vigorous types over three feet tall.

There are three types of Celosia which are easily distinguishable from each other. They are plumes, crests and



**Colour  
variations  
in Celosia  
plumosa  
types**



**Colour variations in Celosia spicata types**



## Other Uses of Celosia

Dry flower wreaths



Fresh flower wreaths



House plants



cones.

### 1) Plume/feathery celosia

(*Celosia plumosa*)

### 2) Crests/brain/fan celosia

(*Celosia cristata*)

### 3) Wheat/cones/spiked

celosia (*Celosia spicata*)

In plume types the flowers appear as feathery plumes and come in the shape of an arrowhead. The flower heads resemble the structures of a brain and in some varieties a rooster's comb. Hence the name cockscomb. It blooms in red, yellow, pink, white, and orange in crests types. The flower heads resemble a head of wheat or a bottle brush in wheat celosia. The flower colors are not as bright as with other types, but they come in rose-pink, white

and dark red varieties.

The dazzling flower can be used in various areas. Lets come to know one by one

#### a) As a bedding plant

It can be referred to as a temporary planting of fast-growing plants into flower beds to create colourful, temporary, seasonal displays, during spring, summer or winter. The wonderful colour variation in celosia makes this crop perfect for bedding purposes.

#### b) As a pot plant

Celosias make beautiful container plantings - alone, or combined with other plants. Among different types plumes and wheat types are more suitable for container planting. i.e. bushy or plants with height of less than 2 feet should consider for pot planting. And can be used as an excellent house plants also.

#### c) As a dry flower

Celosia can be preserved as an excellent dry flower, especially crests. For drying the

**Other  
Uses of  
Celosia**

Vase flower



Garland making



flower bouquet



Pressed dried flowers for greeting card making



flower heads, keep the flowers along with the stem upside down under the shade condition for fast drying and also this method will allow the air to circulate around the flower heads, stems and leaves, preventing mould and mildew. It will maintain the upright structure with rigid stem after drying. It will take almost 10-15 days for complete drying and again it will vary with the varieties used, atmospheric temperature, season preferred for drying etc.

When they dried properly they can last for up to six months before fading. Harvesting celosia for drying is very straightforward. Here's how it's done:

#### **Here's how it's done:**

- Wait until the flowers are fully open before cutting them.
- Cut early in the morning, after the dew has dried on the flowers.
- Cut the flower stems at ground level, and remove all leaves.
- Tie the stems together in small bundles, with about 6-8 stems to a bundle.
- Hang the bundles upside down somewhere warm, dark and well ventilated to dry. This process normally takes about a month.

#### **d) As a Cut flower**

Crested type flowers are available in variable colours with more than 30 cm stem length make it good for cut flower purpose. And the cut flowers can be used for decorative purpose, typical uses are in vase displays, bouquets, wreaths and garlands.

#### **e) As a food**

It can be grown as a nutritious leafy vegetable. The leaves, tender stems and even young flowers are combined with other vegetables in soups and stews. Celosia leaves can be boiled or steamed and eaten as a side dish as well. It is traditional fare in the countries of Central and West Africa, and is one of the leading leafy green vegetables in Nigeria, where it is known as 'soko yokoto', meaning "make husbands fat and happy".

Nutritionally, celosia containing protein, calcium, iron, phosphorous and vitamins A and C. The nutritional content of celosia is higher when the plant is young, before flowers begin to develop. Growing conditions also affect the nutritional content,

#### **f) As a value added product**

Some flower heads of cockscomb is used for making powder, which is called as cockscomb Mawal powder; is beneficial for diabetes.

It also helps in digestion and used as preservative for different kinds of food, its effects and results turn out excellent. It enhances the taste and color of various cuisines. Grinded and then sold as powder mainly in Kashmiri areas.

#### **g) Used for colour extraction**

It reports on the exploitation of a natural coloring material from *Celosia cristata* mainly betalains. Synthetic dyes are made in laboratory and they cause serious problems

like asthma and respiratory problems. The natural dyes are safer than the synthetic dyes, which results in increasing demand for natural dye products globally. *Celosia cristata* flowers are mostly red in colour. Dye extracted from *Celosia cristata* flower produces different colour shades. The dye have less affinity towards cotton so some mordant are used to increase the colour fastness properties of natural dye on fabrics.

#### **h) Medicinal properties**

It can be used to treat uterine bleeding, bloody stool, bleeding hemorrhoids and infections of the urinary tract. Their leaves are often used as vegetables and dressings for boils and sores and also utilized in Chinese medicine for the treatment of menstrual bleeding, inflammation and against worms. However the seeds have been used in the treatments of blurring of vision, bloodshot eyes, cataracts, hypertension and blood diseases.

#### **i) Other uses**

- 1) Used for garland making
- 2) Used for making flower bouquet

The *Celosia* symbolises courage, strength and success and is therefore perfect as a gift for home workers, graduates or anyone who needs a extra dose of luck and success.

During wedding ceremonies and all these bouquets can be used

- 3) Fresh and dry flower wreath making
- 4) Pressed dried flower used for greeting card making
- 5) Used as a house plant

# EMERGING PESTS OF **TROPICAL TUBER CROPS** AND THEIR MANAGEMENT STRATEGIES

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Spiralling whitefly



Papaya mealybug



Two-tailed mealybug



Cassava mealybug

**A**part from the common and well-known tuber crop pests, recently several other pests are emerging as big concern for the cultivation of tropical tuber crops in Kerala. Among them, different types of mealybugs and spiralling whitefly in cassava; vine borer and leaf miner in sweet potato; defoliator as well as wireworm



Symptoms of mealybug damage in cassava



Vine borer larva

attacking elephant foot yam; and plant parasitic nematode pests are most important.

### Mealybugs

Mealybugs cause considerable yield loss in cassava. In India there are three major types of mealybugs infest the crop. They are papaya mealybug (*Paracoccus marginatus*), two-tailed mealybug (*Ferrisia virgata*) and cassava mealybug (*Phenacoccus manihoti*). They are white and soft bodied insects, covered with mealy or waxy secretions. They affect all aerial parts of the plant and while sucking the sap, they inject a toxic substance into the feeding point, causing the deformation of terminal shoots, reduction of internodal length, stunted growth and subsequently the development of 'bunchy tops'. Honey dew excretion and the associated black sooty mold formation impair photosynthetic efficiency of the affected plants that often leads to heavy yield loss to a tune of 60-80 per cent.

## MANAGEMENT PRACTICES

### a. Cultural and Mechanical methods

It includes strategies like, monitoring and scouting to detect the infestation, pruning and burning of infested branches, removal of weeds/alternate host plants in and around cassava fields, avoiding the use of planting materials from infested cassava fields, destruction of ant colonies to prevent the spread of mealybugs and maintenance of field hygiene and sanitization of farm equipment.

### b. Biological method

Conservation of natural enemies like hymenopteran parasitoid, *Acerophagus papayae*, *Apoanagyrus lopezi* and lady beetle predators like *Cryptolaemus montrouzieri*, *Scymnus sp.* etc., lacewings and hover flies.

### c. Biopesticides/Chemical methods

Soaking of cassava setts in Dimethoate 30 EC @ 1% (10 ml/litre) for one hour

before planting and after the infestation starts spraying neem oil-soap solution (7:3) @ 1 to 1.5% twice at weekly intervals or fish oil rosin soap @ 25g/litre of water. In the case of chemical insecticides, spraying either Thiamethoxam 25 WG @ 0.6 g/litre or Imidacloprid 17.8 SL @ 0.6 ml/litre to cover lower surface of the leaves/infested portions of the plants. Drenching of Chlorpyrifos 20 EC @ 2 ml/litre may be done for the destruction of ant colonies-which are notorious for the insect spread.

### Spiralling whitefly

*Aleurodicus dispersus*, otherwise known as spiralling whitefly is a small (1-2 mm long) insect as other whiteflies and eggs are laid, along with deposits of waxy secretions, in a spiralling pattern, under leaves. Adult *A. dispersus* are white and coated with a fine dust-like waxy secretion. Like mealybug, this pest also is a predisposing agent for 'sooty mould' fungal growth in the plants, because of the production of honey dew.

Yellow sticky traps can be effectively used for controlling this pest. Neem oil and cotton seed oil at 1% (10 ml/litre) were found to cause considerable mortality of the different stages of the pest. Fish oil insecticidal soap at 2.5% (25g/litre) also deter the adults of the spiralling whitefly. Among chemical insecticides, Dimethoate 30 EC at 2 ml/litre and Profenofos 50 EC found to be very effective. Coccinellid

Leaf miner attack in leaves



Sweet potato leaf miner adult



Chrysomelid beetle



Shoot attack by elephant foot yam defoliator

predators-*Nephaspis oculatus*, *N. bicolor* and *Encarsia haitiensis* and two aphelinid parasitoids were found effective in suppressing the whitefly population.

**Sweet potato vine borer**

Vine borer, *Omphisa anastomosalis* is a serious emerging pest of sweet potato, which reduced the crop yield substantially for the past few years in several parts of India. As a result of the attack by larvae in collar region of the vines, bore holes become visible and they form tunnels inside the vines. Severe attack cause withering and wilting/drying of the plants. As most part of its lifecycle is inside the plant, traditional

management options are not effective against the pest. Spraying and drenching using Thiamethoxam 25 WG @ 1 g/litre or Imidacloprid 17.8 SL @ 1 ml/litre in collar region and in field at fortnightly intervals found to yield control.

**Sweet potato leaf miner**

Nowadays sweet potato leaves are heavily infested by a new emerging pest, *Bedellia somnulentella* (leaf miner). They attack sweet potato leaves in between upper and lower leaf surfaces, eat away leaf tissues, leaves become transparent and cause on an average 30 % leaf damage.

As leaf miners can become a potential pest in

later crop stages, it is important to manage them early. Since pupation of the pest is in soil, clean cultivation and weeding are important. Ploughing the field and raking of soil around the vines can kill the pupae. Mulching using plastic sheet is an effective management strategy against the pest. Also, application of spinosad 45% SC @ 0.3 ml/L at fortnightly intervals will be very effective in its control.

**Elephant Foot Yam (EFY) defoliator**

For the last 2-3 years, EFY shoots were attacked by the chrysomelid beetle, *Sphenoraia hopei* in many parts of Kerala. They feed on the shoots and also bore in them. If attack is severe the whole plant will be dried. The pest could reduce the crop yield substantially in the future, and become a menace to the farmers.

Like other pests, weeding and clean cultivation are important in its management. Study showed that, spraying and drenching of quinalphos 25% EC @2ml/Litre can control the pest.

**Wireworm**

In the last few years, wire worms/ click beetles found attacking EFY in Kerala by boring into collar region and tubers. It can drastically reduce crop yield and also market value.

Ploughing the field before planting and adequate irrigation can provide the desired effect against the pest. In the field



Attack by wireworms in amorphophallus



Nematode attack in amorphophallus

where the wireworms once came, further pest attack could be prevented by flooding the field for one week before planting. Drenching with Fipronil 5% @ 1.5 ml/Litre or Chlorpyrifos 20% EC @ 2 ml/Litre can manage the pest to some extent.

### Nematodes

Root knot nematode, *Meloidogyne spp.* and lesion nematode, *Pratylenchus spp.* are the two most devastating

nematodes and cause economic damage on elephant foot yam. Because of their endoparasitic nature, they cause severe root damage.

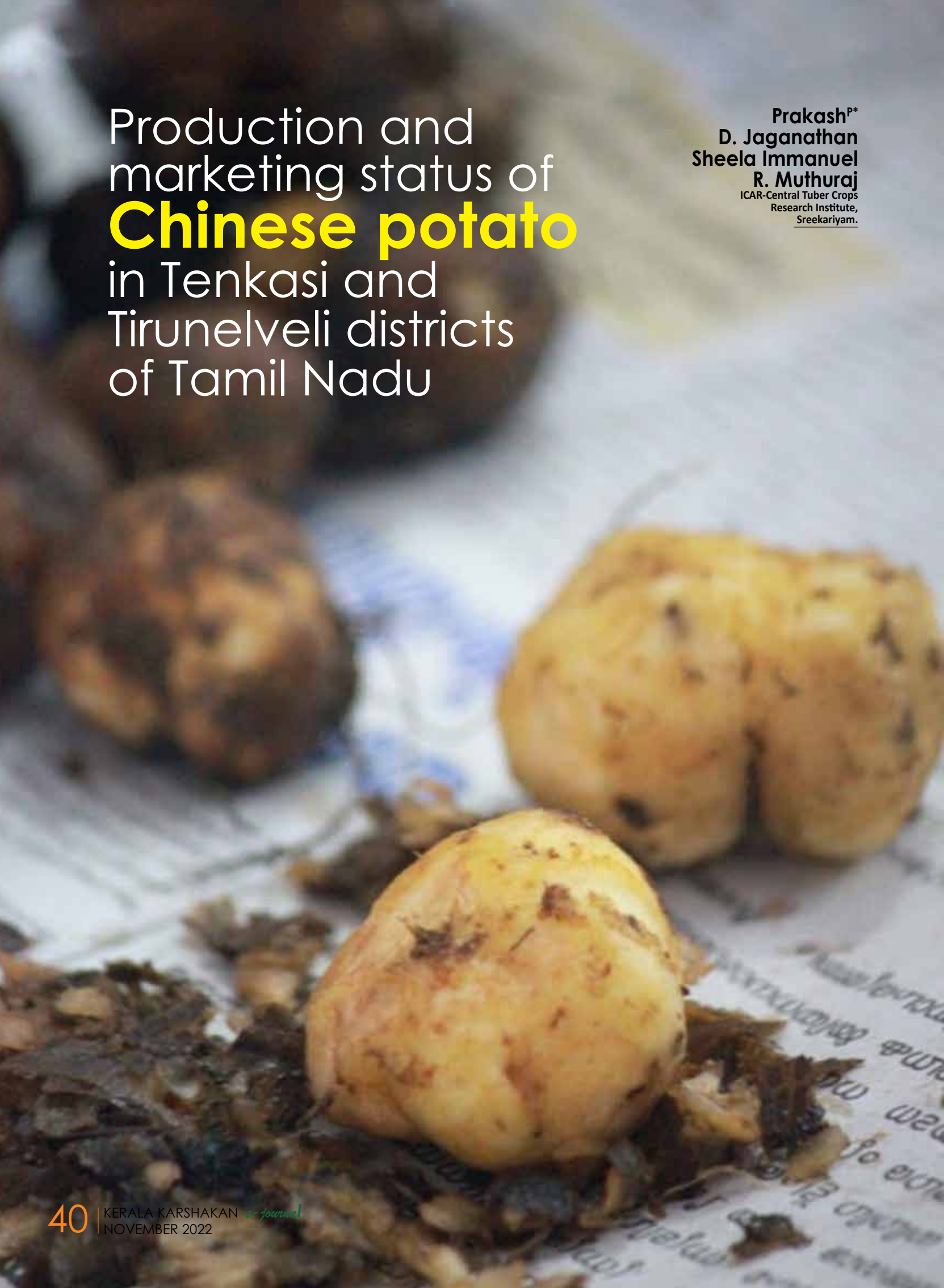
The aerial symptoms of nematode damage are generally not apparent. Most of the nematode damage in tubers is noticed only after harvesting. *Meloidogyne spp.* produces typical galls on the roots. In corms and cormels, infestation

leads to irregular projections. Under severe infestation, the tuber tissue gets discoloured and in corms the infested area dries up. The root knot nematode multiplies in the tuber after harvest during transport and in storage, causing more economic damage. Infestation by lesion nematode change tuber colour to black with cracks on the surface.

For the management of nematodes, if possible, field may be kept fallow for some time. Deep ploughing during hot summer months is very effective against the pest. Other strategies can be crop rotation, change the place of cultivation, grow trap crop like Sree Bhadra (Sweet potato) or marigold in the field, incorporation of cassava leaves in soil, apply farm yard manure (20-25 tonnes/ hectare) & neem cake enriched with *Trichoderma* (one tonne/ hectare).

### Conclusion

Regular monitoring, proper identification and understanding of important emerging pests which are infesting tropical tuber crops are very much required for adopting effective management options. Integration of various strategies like cultural modification, eco-friendly biopesticides, natural enemies and use of chemical pesticides with least environmental hazards as last resort can effectively control the pests before they cause significant economic damage.



Production and  
marketing status of  
**Chinese potato**  
in Tenkasi and  
Tirunelveli districts  
of Tamil Nadu

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## Introduction

Chinese potato (*Plectranthus rotundifolius* (Poir.) Spreng) is an important tropical tuber crop grown in Sri Lanka, Malaysia, Indonesia, India and parts of Africa, primarily for consumption. It is commonly referred as native or country potato in Africa and Chinese potato in India. In Africa, it is also called as Hausa potato or Sudan potato. The Chinese potato is a minor tuber crop and it is rich in calories and other essential nutrients. The plant produces a bunch of dark brown aromatic tubers at the base and in the lower parts of the stem. The tubers contain dry matter (31-33%) and starch (18-20%) with a characteristic flavour due to essential oils (0.05 to 0.12%). Chinese potato is a monsoon crop in India which is cultivated in irrigated and rain-fed production system. Though the Chinese

potato tubers are smaller in size, its unique taste and aroma makes the crop popular among farmers and consumers in the country. Data on the area, production and productivity of Chinese potato in different states of India are not available and hence data available from different sources were used to estimate the area in Tamil Nadu where the crop was commercially cultivated. In Tamil Nadu, the Chinese potato is cultivated approximately in an area of 425 hectares with a production and productivity of 5756 tons and 14 tons per hectare respectively. Kerala and Tamil Nadu are the leading states in India for Chinese potato production. It is known as Siru Kizhangu in Tamil Nadu and Koorka in Kerala. In Kerala, it is grown primarily in the districts of Thrissur, Palakkad and Malappuram, while in Tamil Nadu, it is mainly grown in the

districts of Tirunelveli, Tenkasi, Tuticorin and Virudhunagar.

The ICAR-Central Tuber Crops Research Institute (ICAR-CTCRI) has released an important variety of Chinese potato namely Sree Dhara with high yield, disease resistance and good keeping quality which is popular among farmers. In addition, this variety fetches a remunerative price in the market due to its aroma, flavour and desirable shape of the tubers. The ICAR-CTCRI has established frontline demonstrations-cum-seed villages during 2017-18 to 2021-2022 under Scheduled Caste Sub Plan (SCSP) programme for popularizing high-yielding Chinese potato variety in Tenkasi and Tirunelveli districts of Tamil Nadu as these districts have been the major producers of the crop for several decades. Planting materials and seed tubers of Chinese potato

Table 1. Improved varieties of Fig. 1. Cropping pattern in Tenkasi and Tirunelveli districts of Tamil Nadu

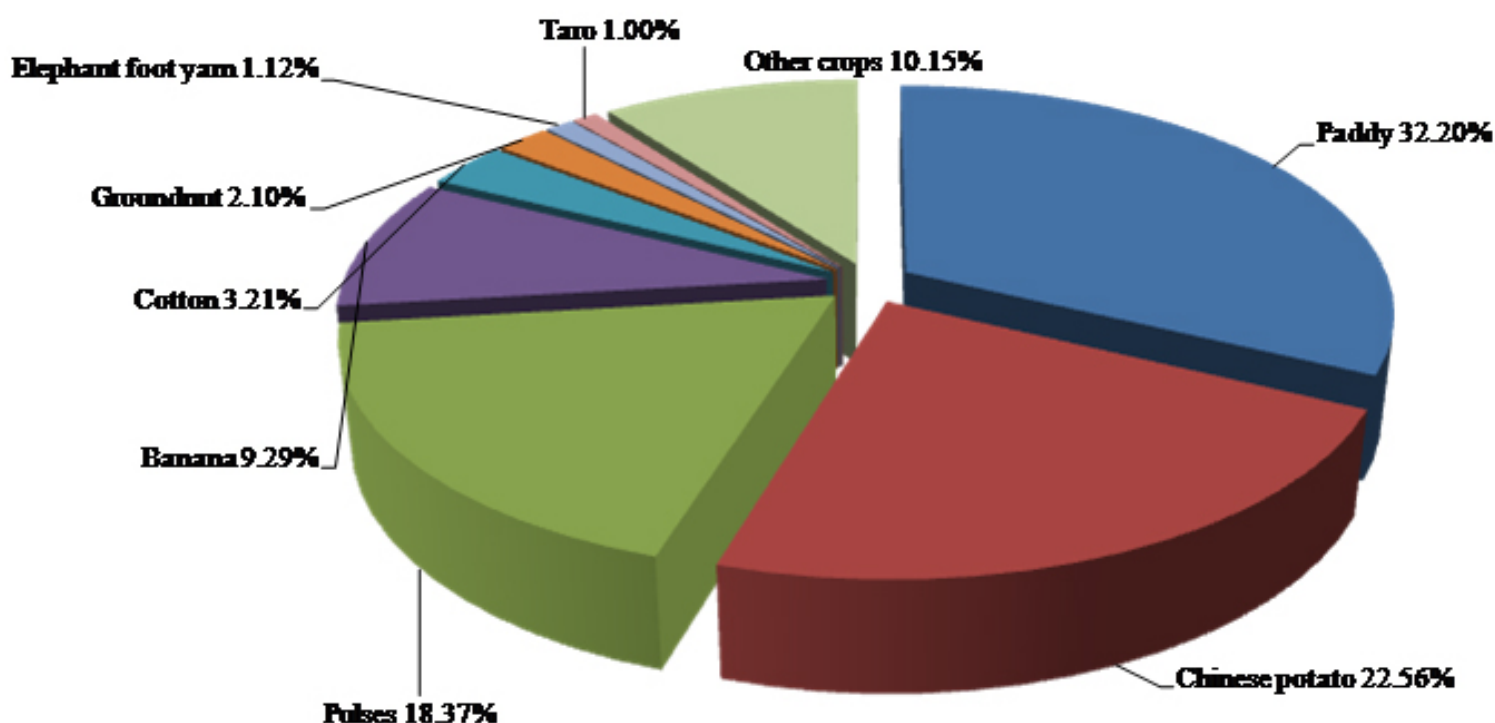


Fig.1 Improved varieties of Chinese potato and its features

Varieties	Duration (days)	Yield (tons/ha)	Year of release	Characteristics	Developed by
Sree Dhara	150	25	1993	First variety of Chinese potato; tuber shape round (2-5cm diameter); tuber skin colour dark brown; tuber flesh colour cream; tolerant to root knot nematode; suitable for Tamil Nadu and Kerala states	ICAR-CTCRI, Thiruvananthapuram
Nidhi	120-135	18-20	2001	Clonal selection from NBPGR accession CP 79; suitable for Kerala state	RARS, KAU, Pattambi
Suphala	120-140	15.96	2006	A tissue culture mutant derived from local cultivar suited for year round cultivation; suitable for Kerala state	KAU, Thrissur

Transplanting of Chinese potato



variety 'Sree Dhara' and inputs were provided to the farmers as part of the programme. Training and demonstrations were also conducted to the farmers to upgrade their knowledge and skills.

### **Cropping pattern**

Major crops grown in the study areas are paddy, Chinese potato, pulses, banana, cotton, groundnut, elephant foot yam and taro. The cropping pattern adopted in the study areas showed that paddy ranked first (32.20% of gross cropped area) followed by Chinese potato (22.56%), pulses (18.37%), banana (9.29%), cotton (2.10%), groundnut (2.10%), elephant foot yam (1.12%), taro (1%) and other crops (10.15%).

### **Chinese potato varieties**

Sree Dhara variety released by ICAR-CTCRI is cultivated in large areas and popular among farmers in Tamil Nadu and Kerala. About one

third of the farmers in the study areas are using Sree Dhara. The major varieties released by research institutes and state agricultural universities along with its characteristics are given in the table 1.

### **Chinese potato cultivation**

Chinese potato is cultivated in Tenkasi and Tirunelveli districts of Tamil Nadu during monsoon season as an irrigated and also rainfed crop. It is propagated by stem cuttings of 10-15 cm in length. The nursery preparation starts at two and half months prior to planting in the main field. Farmers raise nursery using seed tubers for multiplication. It is transplanted during June to August by following ridge and furrow method. Most of the farmers in the study area cultivated local varieties using farm inputs like fertilizers, manures, irrigation, pesticides etc. Farmers were doing two to three weedings

and one earthing-up in second month after planting. It is a labour-intensive technology; the demand of labour is more during transplanting, harvesting and grading. Root knot nematode is an important pest in the study area and the infested plants exhibit serious swellings or galls in the roots resulting in suppressed roots, stunted growth and wilting.

Chinese potato takes four to five months to attain maturity and the average yield of Chinese potato in the study area was estimated to be 13.56 tons per hectare. Chinese potato is a commercial crop in Tamil Nadu where farmers kept minimum tubers for household consumption, seed purpose for next crop season planting and the rest is marketed.

### **Chinese potato production technologies**

The technologies include improved Chinese potato variety

Chinese potato field



'Sree Dhara'; 75-100 kg seed tubers per hectare and stem cuttings of 10-15 cm long; mound or ridge and furrow method of land preparation; July-October are suitable planting season; horizontal or vertical planting; 45x30 cm of spacing; 10 tons per hectare of organic manures; 60:60:100 kg per hectare of NPK nutrients; weeding and earthing up at first and second month after planting; integrated nematode management (use of nematode free tubers or planting materials, deep ploughing after harvest and sweet potato variety 'Sree Bhadra' as a preceding crop in May-June) and harvesting at 4-5 months after planting.

### **Economic benefits of Chinese potato**

Chinese potato tubers fetches remunerative price in the market both for farmers and traders in comparison to other horticultural / cereals crops

grown in the study area. The total cost for cultivating Chinese potato production per hectare was estimated to be ₹184485 and the cost of production was ₹13065 per tons of tubers. The average yield of Chinese potato per hectare was estimated to be 13.56 tons and weighted average price was 24.09 per kg of tubers. Human labour and fertilizers including manures were the major expenditure which accounted 81% and 8% respectively. On an average, net income of ₹142176 was obtained from one hectare of Chinese potato cultivation and the benefit cost ratio was estimated to be 1.77:1.

### **Marketing of Chinese potato**

Chinese potato tubers are sold in different size based on grading such as small, medium, big and very big. These Chinese potato tubers are sold by farmers and aggregators in

the wholesale markets located in Tirunelveli and Tenkasi, where commission agents /traders play an important role in channelizing the produces between buyers and sellers. In wholesale markets tubers were auctioned to traders (wholesalers and retailers) which were transported to wholesale markets located in Tamil Nadu and Kerala through trucks for retailing. The prices of Chinese potato are determined by a number of factors based on demand in the market, tuber size, colour of the tuber, production time, festive season and consumer preferences.

### **Marketing channels of Chinese potato**

For the marketing of tubers, six types of marketing channels are being followed in Tamil Nadu. Most of the farmers in the study areas followed marketing channel II comprising Farmers-commission agents/traders at wholesale

Harvesting and grading of Chinese potato tubers





market – wholesalers – retailers – consumers, where farmers directly take their produce to the wholesale market and sell it to wholesalers and retailers. The buyers come from adjacent places mainly wholesalers for buying Chinese potato at wholesale market at Tenkasi and Tirunelveli.

Channel I and III which involve aggregators where aggregators take their produce to the wholesale market and sell it to wholesalers and retailers. Marketing channels IV and V where farmers take their produce to the market and sell it to retailers. Marketing channel VI where farmers are selling directly to the consumers.

### **Major challenges**

Incidence of pests and diseases such as root knot

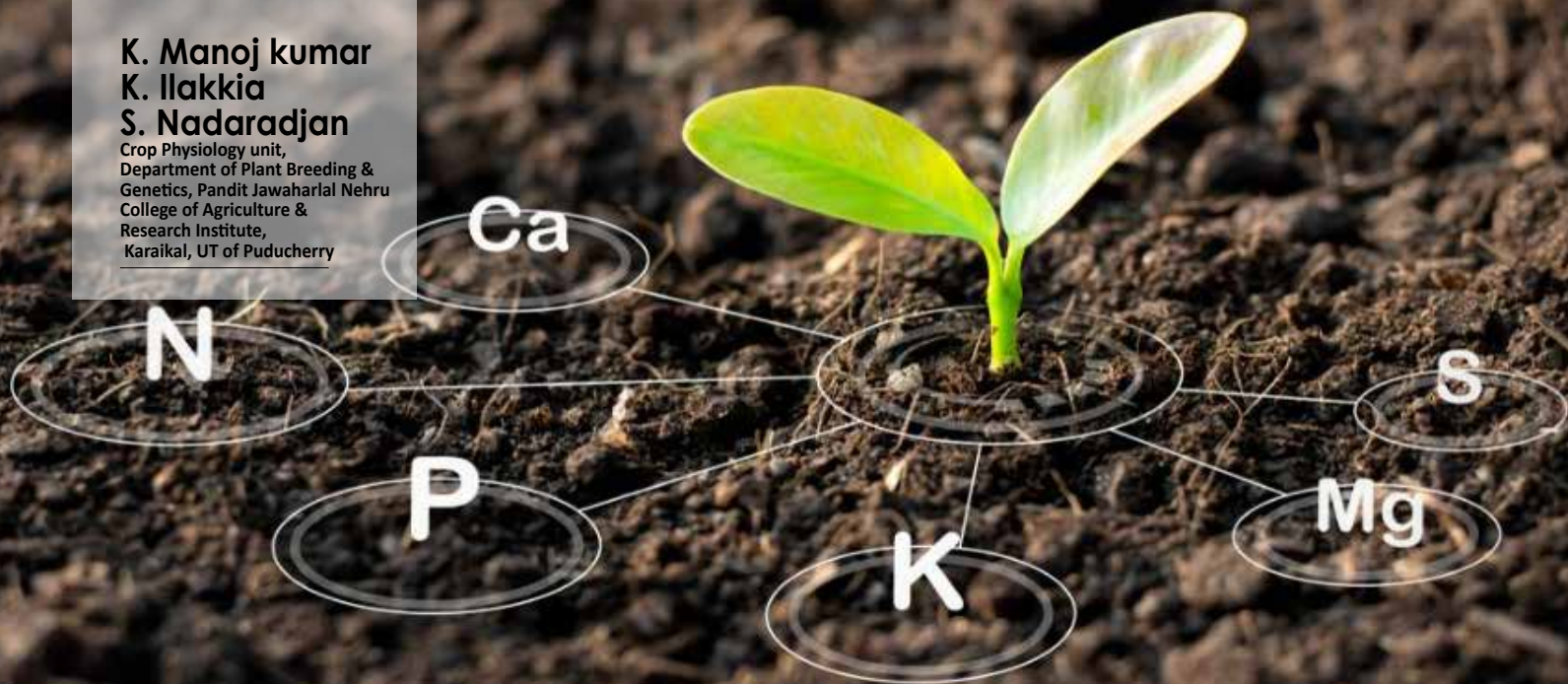
nematode and leaf blight, low price for the produce due to market/season glut, high commission fees charged by commission agents, inaccessibility to credit and crop insurance, difficulty in getting quality seed tubers, less yield due to heavy rainfall/water stagnation, long distance to market, lack of mechanization for harvesting and grading of tubers, shortage of labour during harvesting and grading and wild animals attack mainly by wild boar were the major challenges faced by the Chinese potato farmers. Major challenges faced by the traders (aggregators, commission agents, wholesalers and retailers) were high cost of transportation due to long distance and lack of storage facilities.

### **Way forward**

Development of short duration and high yielding varieties, establishment of seed villages for quality planting materials, strengthening Research- Extension- Farmer linkages, improving the accessibility to credit facilities and crop insurance scheme, exploration of alternative markets, establishment of post-harvest processing and storage facilities, development and popularization of Chinese potato harvesting/grading machine, rationalization of commission fees for marketing and capacity building on market intelligence and value chain mapping for the farmers and other stakeholders are warranted for the sustainable development of Chinese potato sector in the long run.

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# Trace elements Minor in terms of need: but major in terms of deeds

**P**lants apart from preparing their food by photosynthesis, absorb nutrients from soil for their growth and development. There are about 18 essential nutrients required for plant growth. Among these, certain elements are needed in larger quantities i.e major nutrients and some are needed in trace quantities i.e Trace elements or Micronutrients. Farmers are aware of these major nutrients such as Nitrogen, Phosphorus and Potassium and they are regularly applying for their crops. But apart from that, Micronutrients or Trace elements are essential for plant growth and development and to increase the yield and quality of crops. It includes Fe, Cu, Cl, Mn, B, Ni, Zn and Mo. The accumulation

of these micronutrients by plants generally follows the order of  $Mn > Fe > Zn > B > Cu > Mo$ . This order may change among plant species and growth conditions (e.g.; flooded rice). They are usually found in association with larger molecules such as cytochromes, chlorophyll and protein (usually enzymes). Micronutrients may be minor in terms of the amounts needed by the crop, but they can be major in terms of their impact on crop growth. Whenever the supply of one or more of these elements is inadequate, yields will be reduced and the quality of crop products impaired, but crop species and cultivars vary considerably in their susceptibility to deficiencies. They play a vital role in crop growth, crop productivity, soil fertility and

human nutrition (Chrysargyris et al., 2022).

The demand for increasing crop production requires a thorough knowledge of 'soil factors' that regulate the supply and availability of micronutrients in soils as soil-plant interrelations are dynamic and are affected by both inputs and losses. Nutrients are released into soil solution via weathering and solubilisation of soil minerals and through decomposition of organic matter (Choudhary and Suri, 2014). Due to the importance of micronutrients in crop productivity and quality, it is imperative that scientists, farming community and extension functionaries must recognise the factors that lead to micronutrient deficiencies and affect overall crop growth and development.

Optimum contents of micronutrients in plants create resistance towards various stresses including infectious pathogens (Huber and Wilhelm, 1988). Application of Cu as fungicide suppresses many soil-borne diseases; likewise, B sufficiency in plants reduces the incidence and severity of diseases, while B deficiency enhances them (Gupta, 1993). Further, optimum Mn concentrations in plant also decrease incidence of disease occurrence. Similarly, beneficial elements benefit the plant in terms of growth and resistance to diseases and environmental stresses (drought, salinity and nutrient toxicity or deficiency).

The key functions of essential trace elements were given below, which illustrates the physiological role of micronutrients in growth and development of plants and microorganisms. Further, micronutrients play a key role in disease control. The plants become susceptible to various diseases, if there is lack in the concentrations of Zn, B, Mn, Mo, Ni, Cu and Fe in plant tissues (Baligar et al. 1998).

### **Micronutrients Functions in higher plants**

#### **Zinc**

- Present in several dehydrogenase, proteinase and peptidase enzymes
- Promotes growth hormones and starch formation
- Promotes seed maturation and production
- Necessary for chlorophyll production
- Necessary for carbohydrate and starch formation

#### **Iron**

- Present in several peroxidase, catalase and cytochrome

oxidase enzymes

- Found in ferredoxin, which participates in oxidation–reduction reactions (e.g. NO<sub>3</sub><sup>-</sup> and SO<sub>4</sub><sup>-</sup> reduction, N fixation)
- Important in chlorophyll formation
- Acts as an oxygen carrier

#### **Copper**

- Present in laccase and several other oxidase enzymes
- Important in photosynthesis, protein and carbohydrate metabolism and probably N fixation
- Improves flavour of fruits and vegetable
- Indirect role in chlorophyll production

#### **Manganese**

- Activates decarboxylase, dehydrogenase and oxidase enzymes
- Important in photosynthesis, nitrogen metabolism and nitrogen assimilation
- Aids in chlorophyll synthesis

#### **Boron**

- Activates certain dehydrogenase enzymes
- Facilitates sugar translocation and synthesis of nucleic acids and plant hormones
- Essential for germination of pollen grains and growth of pollen tubes
- Essential for seed and cell wall formation
- Promotes maturity

#### **Molybdenum**

- Present in nitrogenase (nitrogen fixation) and nitrate reductase enzymes
- Essential for N fixation and assimilation
- Play an important role in plant nodulation
- Needed to convert inorganic phosphates to organic forms

in the plant

#### **Nickel**

- Benefited the growth of nitrogen-fixing species (nodule weight and seed yield (Bertrand and Wolf 1967)
- Component of nitrogen-fixing hydrogenase bacteria (Cammack 1995)
- Impart plant disease resistance
- Component of the plant urease (Dix et al. 1995)

#### **Chlorine**

- Turgor regulation (Stomatal regulation of water loss)
- Electrical charge balance
- Resisting diseases and photosynthesis reactions

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