DEPARTMENT OF AGRICULTURE DEVELOPMENT
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KERALA KARSHAKAN

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DECEMBER 2025
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DECEMBER 5
WORLD SOIL DAY

Healthy Soils for Healthy Cities

INSIDE

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Mail editorejournalkkfib@gmail.com Log on to www.fibkerala.gov.in Phone: 0471 2314358

THE FIRST ENGLISH FARM JOURNAL FROM THE HOUSE OF KERALA KARSHAKAN

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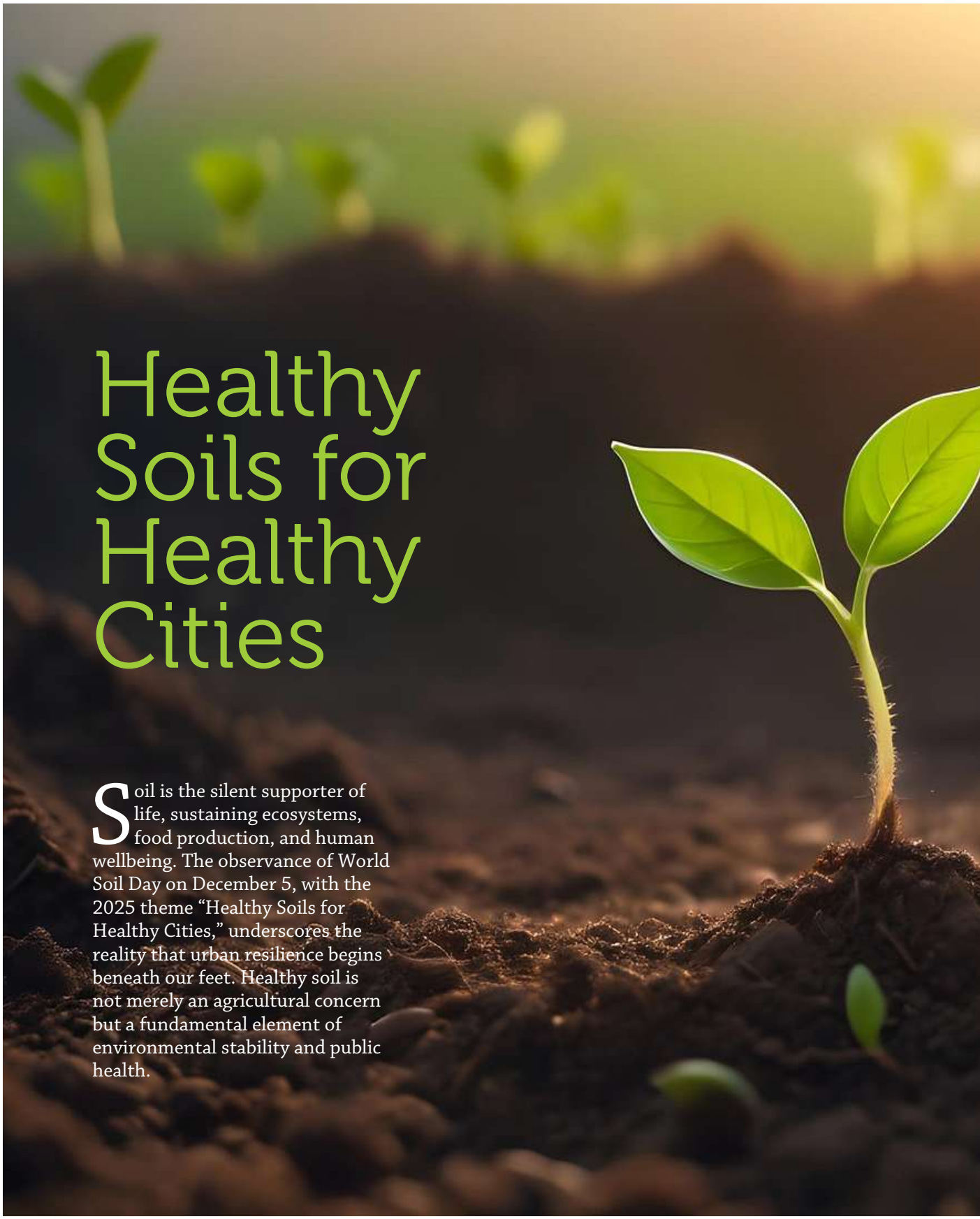
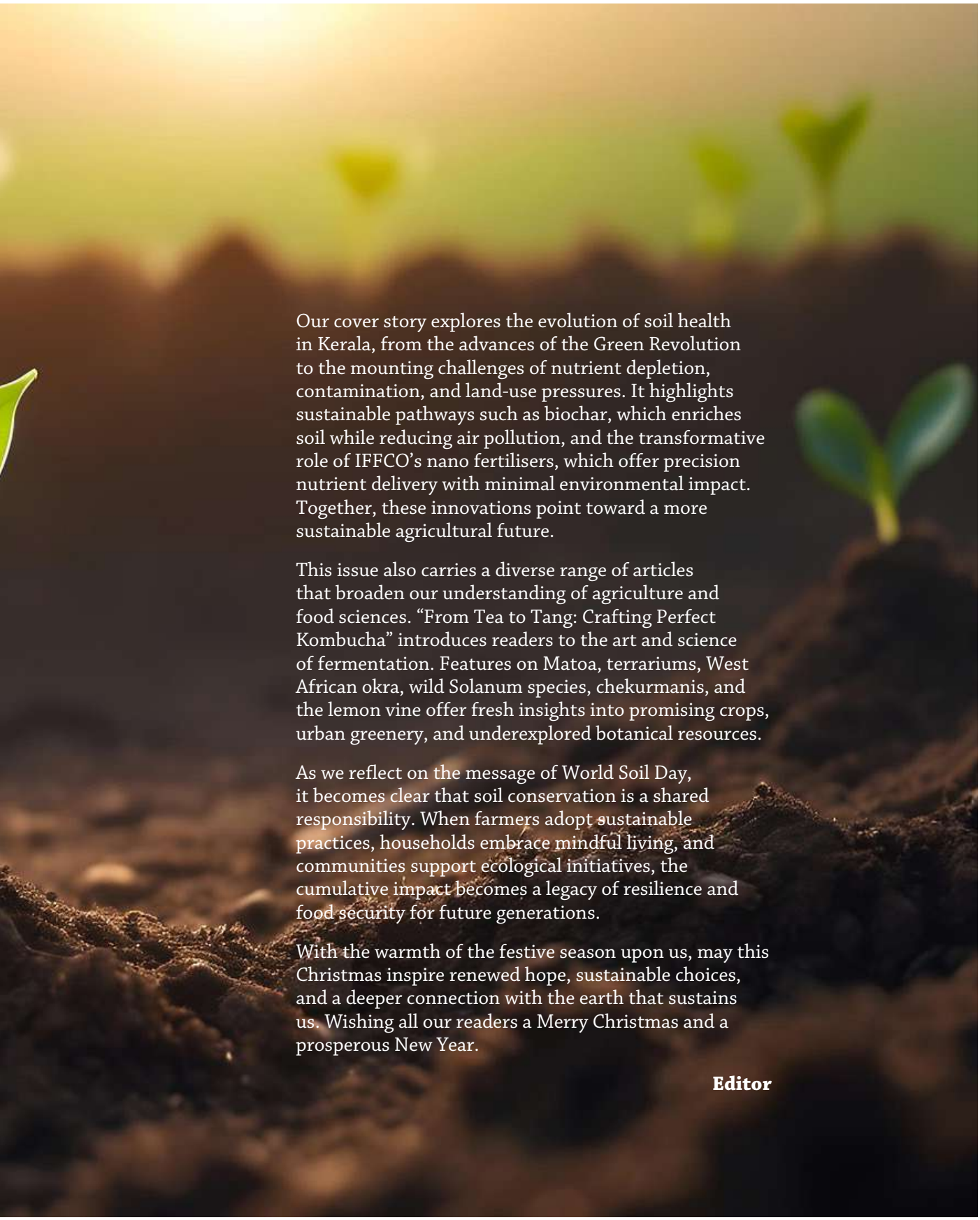


Healthy Soils for Healthy Cities

Soil is the silent supporter of life, sustaining ecosystems, food production, and human wellbeing. The observance of World Soil Day on December 5, with the 2025 theme "Healthy Soils for Healthy Cities," underscores the reality that urban resilience begins beneath our feet. Healthy soil is not merely an agricultural concern but a fundamental element of environmental stability and public health.



Our cover story explores the evolution of soil health in Kerala, from the advances of the Green Revolution to the mounting challenges of nutrient depletion, contamination, and land-use pressures. It highlights sustainable pathways such as biochar, which enriches soil while reducing air pollution, and the transformative role of IFFCO's nano fertilisers, which offer precision nutrient delivery with minimal environmental impact. Together, these innovations point toward a more sustainable agricultural future.

This issue also carries a diverse range of articles that broaden our understanding of agriculture and food sciences. "From Tea to Tang: Crafting Perfect Kombucha" introduces readers to the art and science of fermentation. Features on Matoa, terrariums, West African okra, wild Solanum species, chekurmanis, and the lemon vine offer fresh insights into promising crops, urban greenery, and underexplored botanical resources.

As we reflect on the message of World Soil Day, it becomes clear that soil conservation is a shared responsibility. When farmers adopt sustainable practices, households embrace mindful living, and communities support ecological initiatives, the cumulative impact becomes a legacy of resilience and food security for future generations.

With the warmth of the festive season upon us, may this Christmas inspire renewed hope, sustainable choices, and a deeper connection with the earth that sustains us. Wishing all our readers a Merry Christmas and a prosperous New Year.

Editor

SOIL HEALTH

Healthy Soils for Healthy Cities

Dr. P. SURESHKUMAR
Professor and Head (Retired)
Radiotracer Laboratory, Kerala Agricultural University

The World Soil Day (WSD) is being celebrated on 5th December since 2014 by FAO. The date of 5th December for WSD was chosen because it corresponds with the official birthday of H.M. King Bhumibol Adulyadej (Rama IX), the King of Thailand, who was responsible in recognising the importance of maintaining soil and its health. In 2016 this day was officially recognized in memory and with respect for this beloved monarch who passed away in October 2016 after seven decades as head of state. The year 2015 was celebrated as International Year of Soil with the main theme "Healthy Soils for a Healthy Life". The theme for World Soil Day 2025 is "Healthy Soils for Healthy Cities". A day dedicated for soil universally signifies the importance and essentiality of protecting the soil from being eroded and/or degraded due to a variety of reasons including anthropogenic. Improving soil health systematically and sustainably is mandatory for the survival of life in our mother earth because, the "SOIL" is the Source (or Soul?) Of Infinite Life.

Sustaining and improving soil health is so significant that soil undoubtedly is the central pillar of any eco-system. It is the reservoir of the food and nutritional components, water storage and ground water recharge, carbon sequestration and energy storage, climate resilience, pollution control,

bio- diversity as the list extends to any component of any ecosystem. Thus, a healthy soil has direct role in food security, nutritional security, water security, energy security, structural stability of infra-structural constructions like roads, buildings, bridges etc., pollution control, detoxification of toxic chemicals, holding heavy metals there by preventing their entry into food chain, controlling emission of green house gases, food and anchorage and favourable to the entire spectrum of organisms - single celled bacteria to plants animals including human. Hence it can be concluded that the soil is the central Pillar of any ecosystem.

The adverse and harmful effects due to deterioration of soil health are more intense and are quickly reflected in urban areas because of more constructions, industrialization, more vehicular emissions, hospital and other city wastes, poor ground water recharge, less plant population etc. The urban soil, often neglected component of city ecosystem plays a critical role in environmental sustainability, public health and climate resilience. This article tries to examine the biophysical properties of urban soils, the impact of anthropogenic activities, and evidence- based strategies for improving soil quality within urban landscapes. On emphasising the theme "Healthy Soils for Healthy Cities", it highlights how soil health directly influences air quality, hydrological balance, biodiversity and finally human well -being.

Soil as you know is a dynamic heterogenous natural body comprising of mineral and organic matter, micro and macro- organisms, gases and water. The functions of soil as the main component is often disrupted in urban environment

Sustaining and improving soil health is so significant that soil undoubtedly is the central pillar of any eco-system.

due to construction pressures, land sealing and pollution. Despite this fact, healthy urban soil is essential for ecological stability, carbon sequestration and functioning of green infrastructure. Ultimately the concept of "healthy cities" must therefore include a strong foundation of scientifically managed and sustained healthy soil.

Characteristics of Urban Soil

Urban soils differ significantly from natural soils due to mechanical, chemical and biological disturbances. These disturbances may be much more alarming than a cultivated or crop grown soil.

Physical Properties
Compaction

Use of Heavy machinery for construction make the soil compact reducing porosity, water infiltration and storage and root penetration and proper root growth. This may indirectly results in lack of drainage and unprecedented floods especially with areas having heavy rains.

Heterogeneity

Urban soils exhibit non uniform layering due to back filling, debris, waste materials from constructions. In a sense , the horizons formed are not due to any pedogenic process but mainly by anthropogenic interferences. Hence management requires location specific attention. Further artificial mixing of materials often increases coarse fractions which in turn reduced water holding capacity.

Chemical Properties
Elevated pH

Urban soils tend to be more alkaline due to concrete dust and residues from construction sites.

Heavy metal contamination

There is every possibility of

urban soils to be loaded and contaminated with heavy metals like lead, cadmium, arsenic, copper, and chromium from traffic, industries, paints and other urban wastes.

Nutrient imbalances

Low organic carbon reduces nitrogen mineralisation. Hard and inert resistant components like concrete wastes results in poor structure and reduced surface area which in turn can reduce cation exchange capacity. High pH and salinity can result in nutrient imbalances and unavailability of nutrients to plants.

Biological Properties

Reduces critically the population of beneficial microbes like Rhizobium, Azotobacter, mycorrhizal fungi due to toxic levels of pollutants. Lower microbial biomass carbon due to both low organic carbon and decline in microbial population is often noted in urban soils resulting in low enzymatic activity. Decline in macrofauna like earthworms due to pollution and compaction of soils is also observed. These undesirable alterations compromise soil ecosystem services adversely.

The ecosystem services of soil in urban ecosystems

Hydrological Regulations

Healthy soil increases infiltration, enhances groundwater recharge and reduces urban flooding. Soil with higher organic matter improves aggregate stability and structure, reducing erosion,and surface runoff.

Carbon Sequestration

Soil organic carbon on long term basis act as a carbon sink. Enhancing biological activity and minimizing disturbance can significantly contribute to carbon dioxide evolution to urban atmosphere.

Pollution attenuation

A healthy soil filters heavy metals, organic pollutants and microplastics through adsorption, precipitation, and microbial degradation. Degraded soils lack this filtering capacity, allowing contaminants to reach water bodies and food chains

Biodiversity support

Urban green spaces depend on

soil health for plant growth, habitat provision and nutrient cycling especially oxygen and hydrologic cycles. Biodiversity-rich soils also increase urban resilience to climatic extremes.

Major Threats to Urban Soil Health

Soil Sealing

Covering of the land with impermeable materials such as concrete and bitumen eliminates biological activity and disrupts natural hydrological and gas exchange processes.

Pollution and Toxic Accumulation

Vehicular emissions, industrial effluents, unscientific waste dumping and building materials contribute to accumulation of toxic elements altering the natural soil chemical and biological processes and profiles.

Organic Matter Depletion

Urban soils are often stripped of top soil, leading to depletion of organic carbon level, lack of addition of organic inputs, poor nutrient retention capacity and weakened structural stability.

Climate Stress

Higher surface temperatures and erratic rainfall patterns accelerate soil degradation and reduce microbial resilience

> Soil organic carbon on long term basis act as a carbon sink. Enhancing biological activity and minimizing disturbance can significantly contribute to carbon dioxide evolution to urban atmosphere.

Strategies for Restoring Urban Soil Health

Improving Organic Matter Status

Concerted effort to add organic matter in the form of compost, biochar, green manure must be followed to improve organic matter status of the soil leading to improvement of soil structure, microbial activity and nutrient availability.

Use of Permeable surfaces

Permeable pavements, bio-swales and infiltration trenches improve water percolation, and reduce surface runoff and floods.

Phytoremediation and Mycoremediation

Plants such as sunflower, vetiver, Calotropis can selectively accumulate heavy metals. Certain fungi degrade hydrocarbons and other pollutants restoring biochemical functioning of soil.

Soil Testing and Urban Soil Mapping

Assessment of soil pH, EC, organic carbon, available nutrients including micronutrients, pollutant elements in soil on a regular basis and preparing maps with GIS based overlays enables targeted soil management strategies and risk assessment for urban farming.

Green Infrastructure Planning

Establishing urban pocket forests, roof top gardens, bioshades, community gardens and bioparks improve biological activity while enhancing urban climate regulation and atmospheric purification.

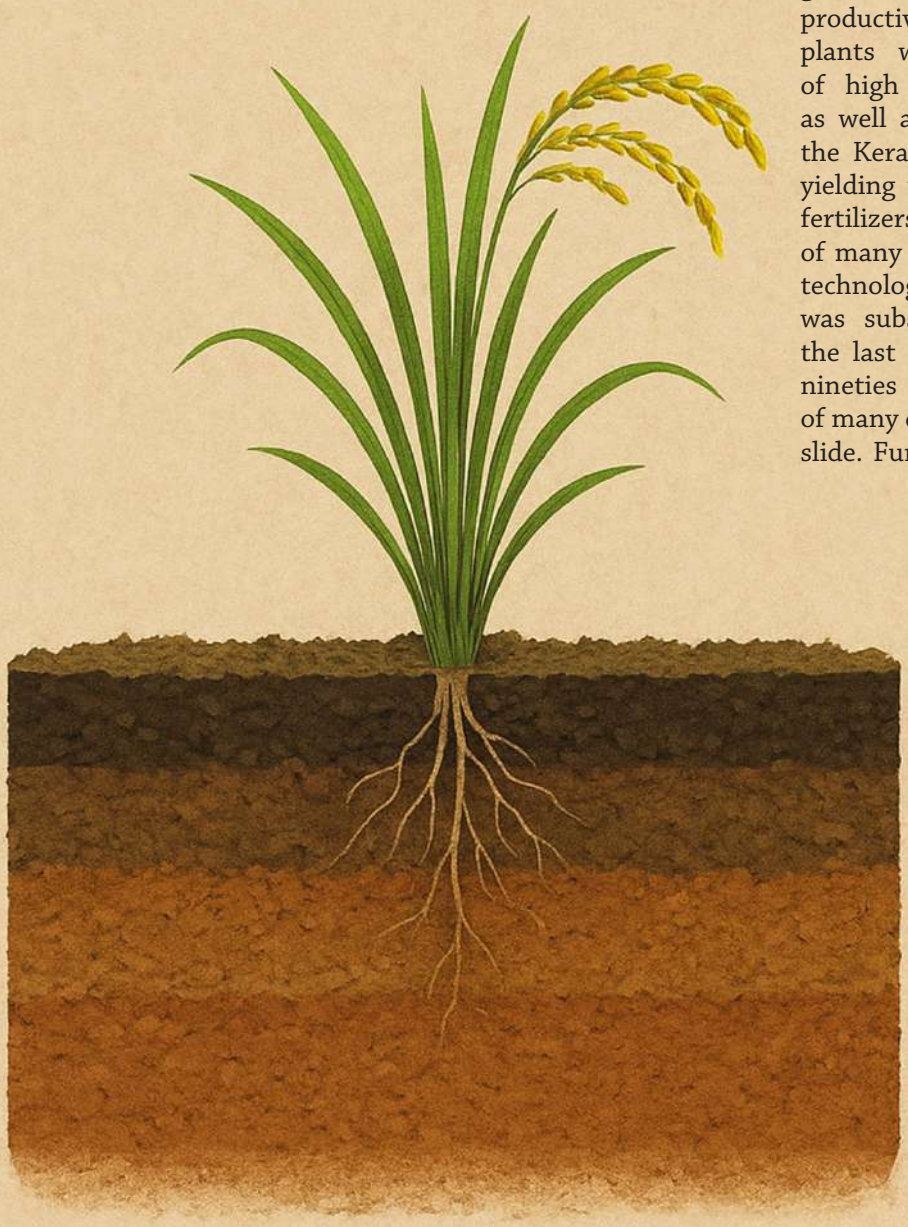
Conclusion

Healthy soil is a fundamental element of sustainable urban development. Scientific management of soil ensures improved hydrological processes, pollution control, biodiversity conservation and climate mitigation. As cities expand and urbanization progresses with a quick pace, incorporating soil health into policy frameworks and development plans is essential for building resilient and healthy cities. This healthy- soil based urban development only will sustain to accommodate healthy life in cities in the future.■

SOIL HEALTH

Fertility of Soils of Kerala

Dr. K. MADHUSOODHANAN NAIR
Former Principal Scientist, ICAR-NBSS & LUP, Bangalore



The green revolution in nineteen seventies led to substantial increase in crop productivity in the country and freed the population from hunger. The state of Kerala did not lag behind in adopting the green revolution model for enhancing crop productivity. Genetic improvement of crop plants was realised through introduction of high yielding varieties from elsewhere as well as thorough research carried out by the Kerala Agricultural University. The high yielding varieties and the external inputs of fertilizers and pesticides enhanced the yields of many crops. Extension of new agricultural technology and intensification of agriculture was substantial ineighties and nineties of the last century. However, by mid nineteen nineties the yield levels plateaued and yields of many crops in the state started a downward slide. Further improvements in crop genetics or increasing external input failed to reverse the trend. Added to that, the social changes in Kerala fueled waning interest in agriculture. The small size of holdings made farming an unviable proposition to ensure livelihood, if depended solely on. The higher level of literacy enabled population to migrate to other sectors, especially service sectors.

The decline in crop production was most visible in the case of annual crops. Best example is the area put to rice which declined to a third of its size four decades back. The plantation crop systems requiring less cultivation and management

rapidly gained in area and rubber is a good example. The land use changes, however, had seriously impaired the food security of the state. The state depends on neighboring states or imports to meet most of its requirements in grains, vegetables and fruits. The decline in productivity of crops like coconut and arecanut and spices like pepper and cardamom are also equally worrying. Coconut productivity around forty nuts per tree is far below the achievable yield.

The soils of the state developed under hot humid conditions of tropics are highly weathered and depleted off many plant nutrient elements, basically cations. The soils depleted of basic cations and silica and enriched with oxides of iron and aluminiumare locally known as laterite soils. The laterite soils cover 76 per cent of the land area of the state in midlands, foot hills and high lands. The nearly level coastal uplands have mainly sandy soils and in coastal lowlands clay soils. Together they cover around 13 per cent of land area of state. Nearly 7.4 per cent area distributed in Eastern Wayanad, Central and Eastern Palakkad and three panchayats of Idukki (Marayur, Kanthallur and Vattavada) have non-laterite, relatively fertile soils,well supplied with basic cations and many plant nutrients.The laterite and sandy soils are seriously constraining the state's crop production. The soil-relatedpotential and constraints are briefly described in the following sections.

Soil Reaction

Soils of the humid tropics are naturally acidic in reaction due to the intense leaching conditions and the consequent loss of basic cations. Under the natural vegetation of evergreen forest the surface soils are only moderately acid due to the return of the bases to the surface soil layers by the recycling of the plant nutrient elements by the deep-rootedvegetation. Conversion of the forested lands to crop production systems often leads to loss of the organic matter rich surface soils and the bases. Net result is the acidification of the soils put to crop production. The intensification of agriculture through high yielding crop varieties and external inputs of acid producing chemical fertilizers aggravated the problem of soil acidity. Strongly acid soils are stressed environment for plant growth. Soil acidity seriously impairs plant availability of nutrients and microbial processes responsible for organic matter decomposition and nitrogen fixation.In strongly acid soils (pH < 5.5) aluminium ion concentration in soil solution is high enough to seriously affect plant roots. Bacteria based bio-fertilizers are ineffective in strongly acid soils. In subsoils devoid of organic matter strong acid reaction produces enough Al ions to be toxic to roots. Roots shy away from subsoil layers with Al at toxic levels, thus impairing plant's ability to absorb nutrients and water subsoil layers. Subsoil Al toxicity is widespread in laterite soils of Central and Southern Kerala and sporadic elsewhere.

Soil acidification has assumed serious proportion in the state with ninety per cent of the land area with acid soil reaction. Out of this, fifty four per cent area has strong to very strong and extremely acid soil reaction (pH <5.5). The primary cause for development of strong acid condition in soils of the state is heavy input of fertilizers, without regular application of lime to neutralise the acidity generated. Application of liming materials based on soil test results is essential to improve crop productivity.

Available nitrogen in soil

Nitrogen is first among the major nutrients essential for plant growth. The sources of the nutrient to plants include precipitation, mineralization of organic matter and fixation of atmospheric nitrogen by soil micro-organisms. Estimates of plant available nitrogen in soils is often made by determining the organic carbon content of the soil. The soils of the state generally have medium to high levels of organic carbon.

Mineralisation of organic matter is constrained in acid soils. Hence it is necessary to correct soil acidity to benefit from high levels of organic matter. Again, mineralization proceeds at slow pace in reduced soil environment of rice paddies. Application of nitrogenous fertilizers to crops according to soil test is recommended. High levels of organic matter not only provide part of the nitrogen requirement of crop plants but also enhance nutrient and water retention capacity of soils and create favorable chemical and biological environment.

Available phosphorus in soil

Phosphorus is often described as the second limiting nutrient for crop production, after nitrogen. It is required by plants for energy transformation, photosynthesis and many other functions. There is considerable buildup of the nutrient, consequent to high input of the fertilizers containing phosphorus. This points to the possibility for reduction in the use of the costly phosphatic fertilizers. Again, correction of soil acidity through liming can lead to release of phosphorus fixed by soil constituents into the available pool. Hence it is recommended to get the soil tested regularly and apply fertilizers accordingly. In the

absence of soil test results apply only fifty per cent of the dose fixed for crops. High levels of phosphorusin soils can impair the uptake of many essential nutrients by plants, especially zinc and boron.

Available potassium in soil

Potassium is the third primary nutrient required in large quantities. The element plays a regulatory role in plant metabolism and development but is not a structural component. Deficiency symptoms of potassium develop first on older leaves: chlorosis along leaf margins followed by scorching and browning of tips of older leaves.

The highly weathered and leached laterite soils of Kerala, developed under humid tropics, do not have any significant amount of potassium bearing minerals. Cation exchange capacity of the low activity clay minerals in the soils (mainly kaolinite) does not permit retention of significant amounts of potassium in exchangeable form. Again, potassium is sparingly fixed by laterite soils unlike in the case of phosphorus. Thus, the nature of the soil and prevailing humid climate necessitates regular application of potassium fertilizers to crop plants in as many splits as feasible. Though the application of potassium fertilizers is a common practice for crop production in the state, soil sampling before or after crop often does not show it's in evidence in soil tests, due to the poor retention and rapid leaching loss of the element.

Approximately a third of the land area has medium and high levels of potassium. Potassium deficiency is more pronounced in coastal sandy soils. There is need for regular application of potassium fertilizers in as many splits as feasible, in doses recommended for crops by the package of practices of Kerala Agricultural University. No blanket reduction in dose is recommended. Soil test is the best guide on modification of potassium fertilizer doses. Maintenance of high levels of organic matter and abating soil acidity through liming can go a long way in regulating potassium nutrition of the plants in these soils.

Approximately a third of the land area has medium and high levels of potassium. Potassium deficiency is more pronounced in coastal sandy soils.

Available calcium in soils

Calcium is a secondary nutrient element required in comparatively small quantities. It is a structural component of cells and tissues. Calcium being immobile in the plant, deficiency appears in young leaves which are often distorted, small and abnormally green. Other symptoms include desiccation of terminal buds and weakening of stem structure.

The highly weathered tropical soils are generally low in availability of calcium and the minerals bearing the element. The secondary nutrient calcium is required in much lower quantities than the major nutrients. Calcium deficiency is serious in half the land area of Kerala, especially in laterite and sandy soils of central and southern Kerala. Application of liming materials to alleviate soil acidity shall ensure the supply of the nutrient wherever deficient.

Available magnesium in soil

Magnesium, another secondary nutrient is an important constituent of chlorophyll and hence indispensable for photosynthesis. The element is mobile within the plants, and the deficiencies first appear on older leaves: interveinal chlorosis, and, in acute deficiency, dry tip.

Magnesium, an essential secondary nutrient was deficient in three fourth land area of the state, especially in laterite and sandy soils.

Available sulphur in soil

In general, the available S is sufficient in soils of Kerala. Continuous application of S containing fertilizers like ammonium phosphate sulphate might have corrected the deficiency of sulphur.

Available zinc in soil

Zinc is required only in very small quantities. The element, besides being a constituent of many enzymes influences translocation and transport of phosphorus in plants. It plays a major role in many metabolic activities. Deficiency of the micro-nutrient zinc is negligible.

Available copper in soil

Copper too is required in very small quantities. It is a

component of many essential enzymes. Male flower sterility, delayed flowering and senescence are the important effects of copper deficiency. Chlorosis of younger shoot tissue, white tips, necrosis, leaf distortion and dieback are characteristic deficiency symptoms.The deficiency of micro-nutrient copper is negligible in soils of Kerala.

Available boron in soil

Boron is a micro-nutrient required in very miniscule quantities, though it plays vital role in physiology of the plants. It is responsible for cell wall formation and stabilization and lignification and xylem differentiation. It imparts drought tolerance and plays an important role in pollen germination. Boron deficiency symptoms are conspicuous on terminal buds or youngest leaves which become discolored and may die under acute deficiency. Internodes become shorter and give a bushy rosette appearance. Boron deficiency also induces calcium deficiency.

The acid, leaching environment of Kerala soil is not conducive for retention of this element. There is widespread deficiency of this essential nutrient.

Salient Findings

The soils of the state developed under hot humid climateare seriously constraining crop production in the state. The soil fertility related constraints to crop production are not many, but they are severe and extensive.

1. Soil acidification has reached alarming proportion, impairing the productivity of most crop plants. Ninety per cent of the land areasuffer from soil acidity and fifty per cent is strongly to extremely acid in reaction. The situation calls for immediate intervention to ensure application of liming materials on regular basis to bring the soils to near neutral reaction and restore the productivity of soils. Since strongly acid soils in the state are not only deficient in calcium but also magnesium, the application of dolomite (containing calcium and magnesium) is preferred over lime.
2. Indiscriminate application of phosphatic fertilizers over a long period had resulted in high levels of phosphorus in soils of Kerala. The high levels of the nutrient interfere with plant uptake of other essential nutrients by the crop plants. The application levels of the nutrient can be reduced by at least half.Since pH rises above 5.5 through liming of acid soils, the phosphatic fertilizer applied should be water soluble (like Factamphos), not insoluble rock phosphates.
3. Extensive deficiency of secondary nutrients, calcium and magnesium. The deficiency of calcium and magnesium can be alleviated by correction of soil acidity through dolomitic limestone powder. Regular application of magnesium sulphate at the rate of 80 kg per hectare is also recommended to ensure adequate levels of magnesium in the soils.
4. Among the micro-nutrients required by plants, the deficiency of boron only is significant and extensive, requiring immediate intervention. Boron deficiency can be alleviated by application of borax.

The soil fertility related constraints to crop production, though limited to four and solutions rather simple, the condition is severe, extensive and debilitating. Affirmative action to mitigate them can realise substantial improvements in productivity and profitability of all crop production systems in the state. Re-organisation of the soil testing services in the state, with the inclusion of secondary and micro-nutrients in the soil test programme, and focused extension activities to create awareness on soil-related constraints to the farmers needs to be immediately attended to. ■

SOIL HEALTH

The Biochar Solution

How by Strengthening Soil Health, We Can Ensure Quality Air

KRISHNAN RAJ, ASHIQ PARAMBIL-PEEDIKA, VIJESH V. KRISHNA
International Maize and Wheat Improvement Center (CIMMYT), Hyderabad

Every year in October and November, North India faces a sharp decline in air quality. Cities such as Delhi and Ludhiana are covered in thick smog that makes breathing difficult. Several sources contribute to this situation, including vehicular emissions, industrial fumes, construction dust, and the burning of crop residues in neighbouring states. Crop residue burning is often highlighted in the media as a key driver, and farmers are blamed for it, although studies show that residue burning contributes only about 10–20% of the total air pollution in New Delhi. Even if we debate how much residue burning contributes to metropolitan air pollution, the more important fact is that farmers and their families experience the harshest impacts.

The smoke polluting the air is only part of the story. The other part lies in the soil. When crop residues are burned, the soil loses much of its organic

Biochar

Mini or Village-Level Units

matter, depleting soil micro- and macro-organisms, soil quality and structure. Over time, this reduces soil productivity and increases dependence on fertilizers and irrigation. The burning, therefore, results in a double hazard: degraded soil on the farm and polluted air across villages and cities.

Just as residue burning creates this double hazard, there is also a solution that offers a double boon, benefiting both soil health and air quality. Biochar – a carbon-rich material produced through pyrolysis of biomass in anaerobic conditions, which locks carbon into a stable form and improves soil fertility while reducing emissions. By converting rice straw into biochar instead of burning it, farmers can prevent the release of smoke and harmful gases into the atmosphere. Furthermore, it can also enhance soil health as residues return biochar to soil for the decomposers to become a part of the nutrient cycling.

Industrial-Scale Pyrolysis Units

Biochar for Soil Renewal

Smoke is a visible hazard, but the loss of soil fertility from residue burning often remains unnoticed until yields begin to decline. Biochar offers a practical way to reverse this damage. Many studies show its positive effects on crop production. It increases soil organic matter, supports microbial life, improves soil structure, and helps the soil retain water and nutrients. These changes make crops more tolerant to heat and moisture stress. Biochar works well in most soil types, though its benefits are lower in soils that are already highly alkaline. At the same time, converting residues into biochar instead of burning avoids the release of particulate matter, methane, and black carbon. The stable, carbon-rich material stays in the soil for decades and plays a strong role in climate change mitigation.

In Northwest India, large volumes of paddy straw accumulate within a short harvesting window. If land preparation is delayed, the next crop – wheat – will be exposed to the terminal heat during the milking stage, which can lead to significant yield loss. This awareness prompts farmers to remove the large quantity of residue from the field as quickly as possible. Since paddy straw contains a high amount of silica, it is not much preferred as cattle fodder by farmers. Biochar provides productive use for this biomass, but paddy straw itself presents constraints. Its low bulk density and low stable carbon content mean that large quantities of straw are required to produce relatively small amounts of biochar. Transporting loose straw becomes expensive, and pyrolysis units need a continuous and bulky feedstock supply to operate efficiently. These factors reduce the financial viability of small units that lack strong aggregation systems. Adoption is further limited by the high cost of pyrolysis units, weak local markets for crop residues, and limited technical awareness among farmers. However, these challenges can be addressed if planned systematically. Decentralized collection, basic bailing or compacting equipment, targeted training, and well-designed incentives can make biochar production feasible for rural entrepreneurs, farmer cooperatives, and panchayats. By strengthening these systems, large volumes of low-density straw can be transformed into a valuable product that supports cleaner air, healthier soils, and broader climate action.

Biochar Production, Feedstock Options, and Carbon Market Potential

Biochar can be produced through different technological pathways, ranging from large industrial pyrolysis plants to

small village-level units. This flexibility allows regions to select systems that match residue availability, labour conditions, and local markets. The type of biomass used as feedstock (raw material) also plays an important role in determining the quality and stability of the final product. The composition of the feedstock strongly influences the characteristics of the biochar produced. Generally, crop residues have higher calorific value and lower ash content than many woody materials, making them suitable inputs.

In India, biochar can be produced from a wide range of feedstock, including paddy straw, maize stover and cobs, sugarcane trash, coconut shells, groundnut shells, food processing waste, and sawdust. This diversity ensures that biochar systems can operate across multiple cropping systems and regions. However, certain feedstocks bring specific challenges. Paddy straw, for example, has low bulk density and relatively low stable carbon concentration. Blending paddy straw with other biomass types or using compacting equipment can improve efficiency and reduce costs. Depending on the availability of feedstock, two types of biochar plants are feasible in rural India:

- Industrial-Scale Pyrolysis Units: Large pyrolysis plants can process several tonnes of biomass per day. They generate uniform-quality biochar with high carbon stability, making them attractive for carbon market certification. Monitoring and verification are easier in such centralized units, and their output meets the durability standards required for long-term carbon storage. These plants, however, require a steady supply of feedstock, skilled operators, and significant upfront investment. They also depend on strong aggregation systems

Smoke is a visible hazard, but the loss of soil fertility from residue burning often remains unnoticed until yields begin to decline. Biochar offers a practical way to reverse this damage.

Biochar Production Unit

because the low density of crop residues complicates transport. Industrial plants work best in regions with mixed feedstock sources or well-organized residue collection systems.

- Mini or Village-Level Units: Small pyrolysis units can operate at the village or panchayat level. These units reduce transport needs and keep residues within the local farming system. They create opportunities for rural entrepreneurs, farmer cooperatives and self-help groups, and produce biochar that can be applied directly on fields or sold locally. New digital monitoring methods now allow cluster-based carbon projects to include these small units, even when carbon content varies. Village-level systems support a circular model in which residues are converted into an eco-friendly product that strengthens soil health and reduces the pressure to burn.

Syngas, a mixture of combustible gases released during pyrolysis, is an important by-product in both industrial and village-level biochar systems. In large plants, syngas is usually captured and burned to generate heat or electricity, making the process more energy-efficient and increasing the overall emission reductions. In smaller village units, syngas is typically burned directly at the top of the reactor to maintain high temperatures and reduce smoke, as these systems do not include complex gas-handling equipment. When syngas is not utilized for energy, the process loses a potential climate benefit because it does not replace fossil fuel use, which means the carbon credits generated may be lower. Proper management of syngas, therefore, plays a key role in the environmental and economic performance of biochar systems.

Biochar and Carbon Markets: Biochar is one of the strongest nature-based carbon removal options because heating biomass in anaerobic conditions converts a large portion of its carbon into stable form of carbon that remains in soil for decades. This long-term permanence, combined with the fact that biochar is a physical and measurable product, makes it highly attractive in carbon markets. India has already issued more than twice as many biochar credits as other agricultural land management credits, highlighting its scalability. According to the carbon market specialist of CIMMYT, Dr Adeeth Cariappa, carbon in biochar is durable and verifiable, and because of this reason, these credits often command premium prices, often more than USD 100 per ton CO_2e. Global companies, including Google, have signed long-term agreements with Indian developers to secure biochar-based removals. Carbon finance can reduce the financial burden of setting up pyrolysis units by supporting collection

infrastructure, baling equipment, transport, and maintenance. With the right incentives and technical training, biochar can become a practical climate solution for both industrial- and village-scale projects.

Growing Market for Biochar as Soil Amendment: Besides carbon credits, a domestic market for biochar as a soil amendment or mulch is emerging. When applied to soil, biochar increases organic carbon, enhances microbial activity, improves water retention, and supports nutrient availability. These benefits are useful for vegetable plots, orchards, nurseries, and areas with degraded soils. Biochar is especially effective in acidic soils because its application helps increase soil pH, reduces aluminium toxicity, and improves the availability of key nutrients, leading to better crop response.

Biochar production and distribution can form promising opportunities for local supply chains and blended soil products. Village-level units can produce biochar for direct sale within the community, reducing dependence on chemical fertilizers and improving soil quality. This also increases affordability and accessibility. Compost–biochar or manure–biochar blends offer higher-value soil conditioners with consistent quality and easier application. Creating awareness of the benefits of biochar and building these markets will reduce dependence on carbon revenue alone and create a stable demand for biochar within farming systems. This strengthens the business case for decentralized pyrolysis units and supports a long-term shift away from residue burning.

Conclusion: Restoring Soils for Cleaner Air and Climate-Resilient Cities

Residue burning is not an isolated act but a symptom of a production system under strain. It creates a double hazard of gradual loss of soil health in farms and declining air quality across regions. Restoring soil fertility through the same residue is central to breaking this cycle. Healthier soils improve nutrient cycling, support microbial activity, and strengthen resilience against drought and heat stress. Practices such as residue incorporation, partial mulching, microbial treatments, crop diversification, and reduced tillage can rebuild soil structure over time. Biochar adds an important new opportunity because it improves soil fertility, reduces greenhouse gas emissions, and provides a durable carbon sink that qualifies for premium carbon markets. With the right investments in technology, training, and policy support, biochar can help shift residue management from a seasonal crisis to a long-term, climate-smart solution.

We may not face a residue-burning problem in Kerala, but the farming sector can still benefit from improving soil health and creating new income opportunities through better use of crop residues, thereby providing a successful model for the rest of the country. Kerala generates large volumes of rubber wood waste, coconut husk and shell residues, coffee byproducts, and other biomass materials that are well-suited for biochar production. These feedstocks have higher density and higher stable carbon content than paddy straw, making conversion more efficient and economical. Village-level pyrolysis units, possibly managed by self-help groups or farmer cooperatives, can turn these materials into valuable soil amendments for coconut gardens, homestead farms, vegetable plots, and agroforestry systems. Biochar is also highly relevant for urban farming because it improves soil structure, reduces the need for frequent watering, and enhances nutrient efficiency in terrace gardens, container gardens, and rooftop vegetable systems. With strong self-help groups, active panchayats, and growing interest in carbon markets, Kerala is well placed to build a local market for biochar and develop new livelihood opportunities around decentralized biomass production. Utilizing the efficient decentralized system of the local governments, even at the ward level, and the active women self-help groups, Kerala can write a success story in carbon markets and showcase a profitable biochar model utilizing agricultural waste. ■

Biochar and Carbon Markets: Biochar is one of the strongest nature-based carbon removal options because heating biomass in anaerobic conditions converts a large portion of its carbon into stable form of carbon that remains in soil for decades

IFFCO and its Pioneering Role in Nano Fertiliser Revolution

HARSHA. S. K, IFFCO ASD, KERALA

The Indian Farmers Fertiliser Cooperative Limited (IFFCO), established in 1967, is one of the world's largest cooperatives in the fertiliser sector, formed with the vision of empowering Indian farmers and ensuring the nation's food security. IFFCO today represents over 36,000 cooperative societies and serves more than 55 million farmers across India. IFFCO is not merely a fertiliser manufacturer; it is a pioneer in agricultural transformation, consistently driving innovation through sustainable, farmer-centric initiatives that enhance productivity and rural prosperity.

In line with India's vision of sustainable and efficient agriculture, IFFCO has developed a ground-breaking innovation, "Nano Fertilisers" - which represent a transformative leap in nutrient delivery technology. The IFFCO Nano Urea Plus, Nano DAP, Nano Zinc and Nano Copper are revolutionary liquid fertilisers formulated using advanced nanotechnology to improve nutrient use efficiency, reduce wastage, and enhance crop productivity.

Unlike conventional bulk fertilisers, IFFCO Nano fertilisers deliver nutrients directly to plant leaves in nano-sized form, allowing for the faster absorption and targeted action. Nano Urea Plus (20% N w/v) supplies nitrogen efficiently to support vigorous vegetative growth; Nano DAP (8% N, 16% P2O5 w/v) provides a balanced source of nitrogen and phosphorus essential for root development and flowering; Nano Zinc (1% Zn w/w) enhances enzymatic activities, chlorophyll synthesis, and resistance against diseases; while Nano Copper (0.8% Cu w/w) strengthens plant metabolism and improves tolerance to biotic and abiotic stresses.

NANO UREA PLUS (20% W/V)

IFFCO Nano Urea Plus is an innovative and eco-friendly liquid fertiliser developed by the Indian Farmers Fertiliser Cooperative Ltd (IFFCO) using advanced nanotechnology. It provides nitrogen, one of the most essential nutrients for plant growth, in nano form that can be easily absorbed through the leaves. Unlike conventional urea, which is often applied in bulk and results in significant wastage, Nano Urea Plus ensures targeted delivery and higher nutrient use efficiency. When sprayed on crops, it enhances photosynthesis, promotes greener and healthier plants, and strengthens root

development. It also helps in reducing environmental nitrogen losses such as leaching and volatilisation, thereby protecting soil and water quality. By adopting IFFCO Nano Urea Plus, farmers can reduce their dependency on traditional urea while achieving better yields, lower costs, and contributing to sustainable agricultural practices.

NANO DAP (8% N, 16% P205 W/V)

IFFCO Nano DAP (Di-Ammonium Phosphate) is a breakthrough innovation in plant nutrition developed by IFFCO using nanotechnology. It provides two vital macronutrients—Nitrogen and Phosphorus—in nano form, ensuring quick and efficient absorption by the plant leaves. Unlike conventional granular DAP, which often leads to nutrient losses in soil, Nano DAP delivers nutrients directly to the plant system, enhancing nutrient use efficiency and reducing wastage. Its application promotes vigorous root development, better flowering, and improved crop yield and quality. By replacing a significant portion of traditional DAP usage, IFFCO Nano DAP helps farmers reduce input costs while maintaining soil health and protecting the environment.

NANO ZINC (1% ZN W/W)

IFFCO Nano Zinc is an advanced liquid formulation developed through nanotechnology to provide zinc, an essential micronutrient required for plant growth and enzyme activation. It helps improve chlorophyll formation, photosynthesis, and grain filling, thereby enhancing overall crop productivity. The nano form of zinc ensures faster and more efficient absorption by plants compared to conventional zinc fertilisers, allowing better correction of zinc deficiency in crops. Regular use of IFFCO Nano Zinc supports balanced nutrition, stronger plant health, and sustained soil fertility, leading to higher yields and better-quality produce.

NANO COPPER (0.8% CU W/W)

IFFCO Nano Copper is a dual-purpose nano fertiliser that provides copper nutrition while also strengthening plants against diseases. Copper plays a vital role in photosynthesis, protein synthesis, and enzyme activity, and its nano form ensures rapid absorption and utilization by crops. When sprayed on plants, IFFCO Nano Copper enhances metabolic functions, improves stress tolerance, and offers protection against fungal and bacterial infections. By supporting both nutrition and plant defense, it contributes to healthy, resilient crops and promotes sustainable agricultural practices.

IFFCO's Nano technology not only enhances crop yield and soil health but also contributes to climate-smart agriculture, aligning with global goals of sustainability and resource efficiency. Field trials and large-scale demonstrations across India and several other countries have shown remarkable results in improving plant growth, yield quality, and resilience. Through its unwavering dedication to research, innovation, and farmer-centric solutions, IFFCO is shaping a new era of sustainable agriculture. The introduction of Nano Fertilisers signifies a transformative step towards enhanced nutrient efficiency, environmental conservation, and global food security. ■

Constraints of Crop Production in Acidic Soils of Kerala

SHAFNA S H, Project Assistant, ICAR-CTCRI, Sreekaryam

Healthy soil is the foundation of sustainable agriculture, but in Kerala, maintaining soil fertility is increasingly difficult due to widespread soil degradation and persistent acidity. Recent assessments reveal that about 76% of the state's soils are deficient in one or more essential plant nutrients, indicating a significant constraint to crop production. A large portion of Kerala's landscape is dominated by lateritic soils, which are naturally acidic and often prone to iron (Fe) and aluminium (Al) toxicity. High rainfall in Kerala increases the risk of leaching, a process in which water percolates through the soil and carries nutrients downward beyond the root zone. Micronutrients such as boron and molybdenum are

particularly susceptible because they become more soluble under acidic conditions, making them easier to wash away. As these essential trace elements are lost from the upper soil layers, plants face hidden deficiencies that can impair growth, even when the soil appears fertile.

Why Are Kerala Soils Highly Acidic?

Kerala's humid tropical climate, characterized by heavy and prolonged rainfall, plays a major role in determining soil properties. Intense rainfall promotes the leaching of basic cations such as calcium, magnesium, potassium, and sodium from the soil. As these nutrients are leached out, what remains are acidic oxides and silicates especially iron and aluminum compounds that gradually lower the soil's pH. Many of Kerala's dominant soil types, including the widespread laterite soils, originate from the weathering of rocks like granite, gneiss, and schist. These rocks are naturally low in basic minerals, meaning the soils that form from them are acidic right from the start. Certain regions of Kerala, such as the Kari and Kayal lands contain soils rich in organic matter. As this organic matter decomposes in the warm, humid climate, it releases organic acids and hydrogen ions (H^+), both of which contribute to increasing soil acidity.In low-lying coastal and wetland areas like Kuttanad, a special type of soil called acid sulphate soil is found. These soils are rich in pyrite (iron sulphide).

Fe toxicity in paddy, pic source:researchgate.in

When wetlands are drained or exposed to air, pyrite oxidizes to produce sulphuric acid, causing the soil pH to drop dramatically sometimes below 4.0, which is extremely acidic and harmful to crops.Continuous application of acid-forming fertilizers, such as ammonium sulphate and urea, without application of limecan further increase acidity over time.

The paradox of P richness and unavailability in Kerala soil

Recent analysis of Kerala soils indicates the richness of phosphorus in soil consequent to the application of high input of the fertilisers containing P. But this phosphorus pool is unavailable to plants.In Kerala, where lateritic and acid sulphate soils dominate, farmers commonly face the challenge of applied phosphorus rapidly becoming unavailable to crops. This problem known as phosphorus fixation significantly reduces fertilizer-use efficiency and limits agricultural productivity across the state. Under acidic conditions, iron (Fe) and aluminium (Al) become highly soluble and reactive. these ions exhibit strong affinity for negatively charged phosphate ions resulted in formation of highly insoluble Fe and Al phosphates. These compounds are chemically stable and thus unavailable for plant uptake.

High Fe and Al levels: a challenge for plant health

Fe and Al is an essential element for plant life cycle, but when in

Kerala's humid tropical climate, characterized by heavy and prolonged rainfall, plays a major role in determining soil properties.

excess, it negatively affects plant growth and development. The replacement of exchangeable base cations such as calcium (Ca^{2+}), magnesium (Mg^{2+}) and potassium (K^{+}) by H^{+} and Al^{3+}, and the dissolution of Fe and Al-bearing minerals are the most significant consequences of soil acidifications. Metal toxicity (i.e., Mn, Fe, and Al) and nutrient imbalance (i.e., P) are found to occur in acid soils, wherein Al toxicity is the most significant threat to plant survival in acid soils. Excessive Al inhibits roots cell division elongation, root hair formation, and enhances the development of swollen roots apices. Concurrently, toxic Al inhibits the uptake of water and nutrients by plants .One of the clearest signs of Al toxicity is the inhibition of root growth in plants. , Fe is usually present in insoluble ferric (Fe^{3+}) oxide form, while in anaerobic conditions, the higher content of ferrous ion (Fe^{2+}) is generated by the reduction of ferric oxides. Fe^{2+} is readily absorbed by plants and stored in leaves resulting Fe toxicity. It shifts the cellular redox balance toward a poor-oxidant state. The direct effect of Fe toxicity is leaf chlorosis, necrosis, lower germination rate, reduced root and stem elongation and pigment. It affect mineral uptake, photosynthesis, respiration, enzyme inactivation etc.

Nutrient status in acidic Kerala Soils

Acid soils are stressed environment for plant growth. Soil acidity seriously impairs availability of nutrients and microbial processes responsible for organic matter decomposition and nitrogen fixation. At low pH, essential nutrients such as phosphorus, calcium, magnesium, and molybdenum become unavailable to plants. This leads to nutrient deficiencies

Image of boron deficiency in coconut, source: agritech.tnau.ac.in

even when soils contain adequate nutrient reserves. N deficiency is not at all a problem in acidic soils. Two third of Kerala soil recorded high levels of nitrogen. But high rain fall impairs leaching loss.The highly weathered and leached laterite soils of Kerala, developed under humid tropics, do not have any significant amount of K bearing minerals. Cation exchange capacity of the low activity clay minerals in the soils (mainly kaolinite) does not permit retention of significant amounts of K in exchangeable form. Again, K is sparingly fixed by laterite soils unlike in the case of P. Thus, the nature of the soil and prevailing humid climate necessitates regular application of K fertilisers to crop plants in as many splits as feasible. But available S is sufficient in soils of Kerala due to its organic matter rich nature. There is a wide spread deficiency of Ca and Mg due to heavy leaching. There was no deficiency of Fe and Mn, Zn and Cu deficiency. But there is widespread deficiency of available boron in soils of Kerala.Boron is a micronutrient necessary for cell division and differentiation. It is also important for early growth and aids in pollen tube formation, making it essential for reproduction. Boron helps to maintain a balance between sugar and starch in the fruit, and it aids in the translocation of calcium.A plant showing stunted and deformed growth are one of the most common representations of boron deficiency. Boron is needed continuously in the growing points of all plants. Because it aids in the movement of calcium to these points, affecting the strength of the cell walls, it is important for high-quality fruit production. Molybdenum Deficiency is also noticed in plants. It acts as a catalyst in nitrate reduction and in nitrogen transport and utilization within the plant. Molybdenum may also be associated with disease resistance in plants.Deficiency is often observed as nitrogen starvation. Mo availability decreases with increased soil acidity and increases with soil basicity. Deficiency is most

likely on sandy or peat soil with a low pH.The acid leaching environment of Kerala soils is not conducive for retention of these nutrients.

Reviving soil for enhancing crop production

The soils of Kerala exhibit severe and widespread acidification, a condition that has emerged as a major constraint to crop productivity across the state. Nearly the entire cultivated landscape is affected by low pH, with a substantial proportion falling into the strongly or extremely acidic categories. Such acidity intensifies the solubility and toxicity of aluminum, restricts biological activity, and suppresses efficient nutrient cycling. Under conditions where soil analyses are unavailable, the periodic application of liming materials at approximately 600 kg ha^{-1} is essential to neutralize active acidity and reduce aluminum-induced stress on plant roots.

Among calcium amendments, materials such as oxides, hydroxides, carbonates, dolomites, and gypsum play a crucial role in mitigating soil acidity. Gypsum, in particular, is valuable in acid subsoils due to its ability to supply both Ca and S and to promote the formation of less harmful aluminum–sulfate complexes. This transformation reduces the activity of toxic Al species and contributes to improved root growth and nutrient uptake. Organic matter dynamics are also strongly influenced by soil acidity. High organic matter content can enhance soil fertility by improving nutrient retention and supplying part of the nitrogen requirement; however, mineralization proceeds slowly under acidic and reduced soil environments. Similarly, microbial inoculants especially bacteria-based biofertilizers perform poorly in strongly acidic conditions, reducing their effectiveness unless soil pH is corrected.

Deficiencies of secondary nutrients such as calcium and magnesium can be managed through liming, regular application of magnesium sulfate, or the use of dolomitic limestone, which simultaneously supplies Ca and Mg while correcting acidity. In addition, boron deficiency is prevalent and often severe. Application of boron sources such as borax at 10 kg ha^{-1} is necessary to restore the micronutrient balance and support reproductive development in crops. Long-term imbalanced fertilization, especially the indiscriminate use of phosphatic fertilizers, has resulted in excessive phosphorus accumulation in many soils. Elevated soil P levels can antagonize the uptake of crucial micronutrients, making it advisable to reduce application rates to nearly half of the conventional recommendations in high-P soils.

Overall, soil acidity and related nutrient imbalances have significantly limited the positive impacts of modern agricultural technologies in Kerala. Addressing these constraints requires a strengthened soil testing infrastructure that includes secondary and micronutrient diagnostics, targeted extension activities to enhance farmer awareness, and greater availability of soil- and crop-specific amendments and customized fertilizers. Such interventions are crucial to reversing productivity stagnation, restoring soil health, and ensuring long-term environmental sustainability in Kerala's cropping systems.

Acid soils are stressed environment for plant growth. Soil acidity seriously impairs availability of nutrients and microbial processes responsible for organic matter decomposition and nitrogen fixation.

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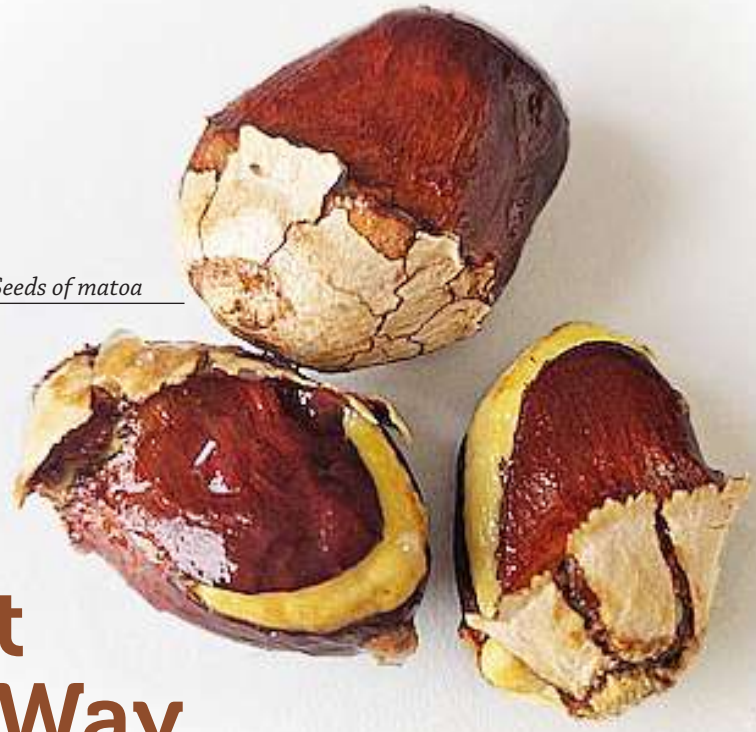


Seeds of matoa

Matoa
A New Fruit making its Way into Indian Orchards

VIVEKA V. F., DR. SIMI S. AND DR. MANJU P. R.
Department of Fruit Science ,College of Agriculture, Vellayani

Matoa (Pometia pinnata), a tropical hardwood fruit tree native to Papua, Indonesia, is a member of the Sapindaceae family, which also includes well-known fruits like rambutan, lychee, pulasan and longan. It is cultivated across the Pacific and Southeast Asia. Matoa is known by various names such as taun tree and island lychee. In this era of increasing importance of exotic fruit crops, matoa has also begun to gain attention as a potential new crop.

Matoa is a medium-sized tree that can grow up to 40 meters height, with a broad, spreading canopy and pinnate leaves. The tree produces small, greenish-yellow flowers in panicles, which develop into edible fruits with a single seed surrounded by a sweet and slightly sour pulp.

Matoa fruits are typically round or oval in shape, with green, yellow, purple colours depending on the cultivar. The tree is known for its adaptability to various soil types and climates, making it a valuable crop for tropical regions.

Since the seeds are recalcitrant, it should be planted immediately after being separated from the fruit.The seedlings must be planted in places where they get sufficient sunlight. Otherwise, the plant will grow tall and harvesting will become difficult. The seedlings start bearing within 2.5 to 3 years after planting. Clonal propagation methods like cutting, layering, budding and grafting are helpful for multiplication and conservation of genotypes with desirable traits.

Seedling of matoa

The species is monoecious, with male and female flowers on the same tree and on the same panicle. Male flowers usually mature first and outnumber female flowers.

Matoa plants usually flower only once a year, between July and October with a fruit ripening period of about four months. In Kerala, they flower twice a year (January–February and August–September). The developing

Matoa tree

Infloresence of matoa

Green matoa

Purple matoa

fruits are green-yellow in colour and are tough and fleshy. When it is ripe and edible, the fruit turns to the characteristic colour of the cultivar and becomes softer in texture.

The fruits are globose to ellipsoid in shape. The fruit offers a unique, refreshing taste, a blend of rambutan, longan, and durian flavours, and is rich in vitamins C and E. They contain active compounds and secondary metabolites, namely, flavonoids, phenols, tannins, and alkaloids. Various parts of the tree possess antiobesity, antidiabetic, antimicrobial, antihypertensive and many other therapeutic properties.

Despite its great potential, the cultivation of matoa is still limited. This may be due to the limited information related to flowering season, geographical distribution of fruit and cultivar characteristics. Research needs to be focused on standardisation of agrotechniques, processing and potential value addition of matoa. Research on the characterisation of matoa trees grown in various regions of Kerala as well as on different vegetative propagation techniques is being conducted in the Department of Fruit science at the College of Agriculture, Vellayani under Kerala Agricultural University.

Developing value chains for matoa products can create economic opportunities for local communities, and promoting these products can expand market opportunities. Overall, matoa has the potential to become a valuable crop for sustainable development, supporting the well-being of local communities and promoting ecosystem services.

With its remarkable market potential, this fruit is poised to witness a surge in cultivation in the near future.■

From Weeds to Wonders

Unlocking the Secrets of Wild Solanum

Dr. M SANGEETA KUTTY, ANAGHA PTK AND BHAGYA PRAKASH

Brinjal, often called the "king of vegetables," is a familiar sight in our kitchen and holds an important place in our daily diet. What many may not realize is that behind this humble crop lies a hidden world of diversity within the great plant family Solanum, one of the largest groups in the plant kingdom. Alongside brinjal, this family includes well-known crops like potato and tomato, as well as an extraordinary range of wild relatives that thrive across the world. These wild species often grow unnoticed along field edges, forests, and backyards, while some are thorny or bear small, bitter fruits, they hold remarkable traits that link farming, food, and medicine. They can withstand drought, poor soils, and constant pest and disease pressures, while also providing valuable nutrients, healing compounds, and genetic resources for future crop improvement. Communities across regions have long recognized their value, using them in traditional medicine, food, and farming systems.

Today, these wild relatives are seen as a living library of resilience, carrying traits crucial for modern agriculture such as early flowering, high seed production, improved fruit quality, and natural resistance to pests and diseases. At a time when farming faces challenges from climate change, declining soil fertility, and the demand for more nutritious food, they are no longer background plants but guardians of food security and human health. Conserving and studying them is essential, as it not only preserves biodiversity but also secures the future of sustainable agriculture, nutrition, and medicine for generations to come.

We can now get familiar with some of these wild relatives:

Solanum insanum

Among the many wild cousins of brinjal, Solanum insanum holds a very special place. It is believed to be the direct ancestor of our cultivated brinjal, carrying within it the genetic roots of a crop we know so well today. At first glance, the plant looks simple upright in

Today, these wild relatives are seen as a living library of resilience, carrying traits crucial for modern agriculture such as early flowering, high seed production, improved fruit quality, and natural resistance to pests and diseases.

Solanum insanum

and medicine. It is naturally tolerant to pests, diseases, and drought, traits that are highly valued in today's agriculture. Traditional communities have long used parts of the plant to treat stomach disorders, fevers, and skin problems, showing its place not just in the field but also in folk healing. For scientists, its greatest treasure is its closeness to cultivated brinjal. Because it is the wild ancestor, it can easily share its resilience, adaptability, and genetic strength with modern varieties, making it a crucial resource for crop improvement.

Solanum torvum

Solanum torvum, often known as the turkey berry, is one of the most remarkable wild relatives of brinjal. The plant itself is sturdy and upright, with deeply lobed leaves and clusters of white, star-like flowers. Its stems and leaves may bear a few spines, but this toughness is part of what makes the species so valuable. Soon after flowering, the plant produces bunches of small round

growth with green ovate leaves that have gentle lobing, spines scattered across the leaf and calyx, and delicate flowers that open in shades of white or light violet. The fruits are small and round, sometimes prickled at the base, holding seeds that are brown and numerous. It grows to about half a meter in height, branching out into four or five stems, and starts flowering early, around 42 days from planting. Within two months, its first fruits appear about 35 per plant each weighing close to 20 grams. Beyond its physical traits, Solanum insanum carries gifts that reach far into farming

Solanum torvum

berries that ripen from green to yellowish, each berry filled with numerous seeds. In terms of growth, S. torvum is a true giant among its relatives. Plants can reach an impressive two meters in height, spreading wide with strong branches. They take about 95 days to flower, but once fruiting begins, the plant becomes highly productive. Its ability to produce so many fruits, even under less-than-ideal conditions, shows just how vigorous and resilient this species is. Yet the importance of S. torvum goes far beyond its berries. For farmers, it is most famous as a rootstock for brinjal grafting. When brinjal plants are grafted onto the strong roots of S. torvum, they gain protection against some of the most devastating soil-borne diseases, including bacterial wilt and nematodes. The plant is also celebrated in traditional medicine and diets. In many cultures, the berries are used to manage high blood pressure, anemia, and digestive issues, and is rich in iron, antioxidants, and beneficial compounds.

Solanum aethiopicum

Solanum aethiopicum

Solanum aethiopicum, commonly known as the African eggplant or garden egg, is both a cultivated food crop and a medicinally significant species, especially in Africa where it is widely grown in countries like Nigeria. The plant grows upright to an average height of about 95 cm, bearing ovate leaves that show strong lobing, intermediate hairiness, and no prickles or spines, making it easier to handle in cultivation. Its white flowers give rise to round fruits with smooth calyces and light-yellow seeds. The crop begins flowering at about 57.5 days and can be harvested by 75 days, producing on average 15 fruits per plant. Although the number of fruits is relatively low, they are large, weighing around 30.8 grams each and measuring about 4.1 cm in length and 4.3 cm in breadth. Beyond its agricultural importance, the species is valued for its therapeutic uses, particularly in managing anaemia, which is linked to its rich phytochemical content. Research has confirmed the presence of alkaloids, flavonoids, saponins, and phenolics that provide antioxidant, antimicrobial, and anti-inflammatory benefits. While the exact compounds responsible for its anti-anaemic activity are still under study, its chemical richness underlines its dual importance as a productive food crop and a potential plant-based medicinal resource.

Solanum violaceum

Solanum violaceum, commonly known as the Indian nightshade, is a wild relative of brinjal native to South and Southeast Asia, especially India, Bangladesh, and Sri Lanka, where it is found in open fields, forest margins, and wastelands. The plant grows as an upright shrub, often reaching more than a meter in height, with

Solanum violaceum

Solanum viarum

ovate leaves, show intermediate lobing, and bear numerous prickles, while the stems are pubescent with relatively fewer spines. Flowering begins around 55–60 days after planting, producing clusters of small white star-shaped flowers. The fruits are small, round berries, generally less than 1 cm in size, with a smooth surface and only a few prickles on the calyx. When immature they are green, turning yellowish to orange as they ripen, and they contain numerous brownish-yellow seeds. Although the fruits are too small to be of major food value, the species is ecologically significant as it adapts well to poor soils and harsh growing conditions, helping stabilize degraded lands. Beyond its ecological role, S. violaceum has long been valued in traditional medicine. Extracts from the roots, leaves, and fruits are used to treat coughs, asthma, fevers, gastrointestinal troubles, and skin ailments. Phytochemical studies have identified alkaloids, flavonoids, saponins, and glycosides with antioxidant, anti-inflammatory, antimicrobial, and hepatoprotective properties. The species is also recognized as a genetic reservoir for brinjal improvement, contributing useful traits such as stress tolerance and pest resistance.

Solanum viarum

Solanum viarum, commonly known as the tropical soda apple or poison apple, is a spiny perennial shrub native to South America, particularly Brazil and Argentina, but now naturalized across Asia, Africa, and parts of North America. The plant grows upright to about 70–80 cm in height with ovate leaves that are densely hairy, deeply lobed, and armed with numerous prickles on both the surface and margins. The stems are pubescent and heavily covered with spines, making the plant highly unpalatable to grazing animals. Flowering begins early, around 40–45 days after planting, producing clusters of small white star-shaped flowers. Fruits are round berries about 2–3 cm in diameter, initially green with distinct white mottling and turning bright yellow upon ripening. Each fruit contains a large number of brown seeds, averaging more than 300 per fruit, and the plant is capable of producing high yields with over 70 fruits per plant. Although considered a serious invasive, S. viarum carries important medicinal and industrial value. Its fruits are a rich source of steroidal alkaloids such as solasodine, which are used in the pharmaceutical industry as raw material for the synthesis of corticosteroids, contraceptives, and anti-inflammatory drugs. In traditional medicine, different parts of the plant have been employed to treat respiratory ailments, fevers, and skin infections, though care must be taken due to its toxic nature. Ecologically, it is a hardy species tolerant to poor soils, pests, and drought, making it a potential genetic reservoir for improving resistance traits in cultivated crops like brinjal.

Conclusion

Wild relatives of cultivated crops represent a vital but often overlooked resource, carrying within them remarkable resilience, genetic diversity, and medicinal value. Adapted to survive under drought, poor soils, pests, and diseases, they not only safeguard ecosystems but also provide traits essential for crop improvement and sustainable agriculture. Rich in bioactive compounds with nutritional and therapeutic benefits, they have supported traditional food and healthcare systems for centuries while offering new opportunities for modern medicine and industry. In the face of climate change, soil degradation, and rising food demands, conserving and utilizing these species is crucial for ensuring food security, ecological stability, and human well-being, making them true guardians of our agricultural and cultural future. ■

Chekurmanis
The 'Multivitamin Green' with Potential for Nutritional Security

MIDHUN M. 2nd Year B.Sc. (Hons) Ag student,
College of Agriculture, Vellayani, Thiruvananthapuram, Mobile No. 8606701691

Chekurmanis, scientifically Sauropus androgynus, is an underutilized perennial shrub of phyllanthaceae family. It is native to the Indo-Burma region and grows naturally in hot and humid climates, spreading over China, India, Sri Lanka, Vietnam, Indonesia, Malaysia, Papua New Guinea, Indonesia, Philippines and Cambodia. In India, it is particularly prevalent in the Western Ghats of Kerala and the northeastern states. Known by various names such as 'Multivitamin Greens,' 'Vegetable of 21st century,' 'Tropical asparagus' and 'Powerhouse of Multivitamins,' chekurmanis holds significant nutritional value, but is considered as an underutilized crop due to lack of large scale commercial cultivation and public awareness of its benefits. In India, the plant has various ethnic names like sengtungrung (Sikkim), malay cheera and veli cheera (Kerala), chakrmani (Andaman and Nicobar islands), chakurmani (West Bengal), chinese soppu (Karnataka) and dieng soh pit (Meghalaya). The plant was reportedly introduced to Kerala from Malaysia in 1953.

Constituent	Composition
Moisture	73.6%
Carbohydrates	11.6 g
Protein	6.8 g
Fat	3.2 g
Energy	103 kcal
Fiber	1.4 g
Calcium	570 mg
Iron	28 mg
Phosphorus	200 mg
Vitamin A	9670 IU
Vitamin B1	0.48 mg
Vitamin B2	0.32 mg
Vitamin B3	2.60 mg
Vitamin C	247 mg

Despite its benefits, chekurmanis contains anti-nutritional factors, including papaverine, an alkaloid that can cause drowsiness and respiratory issues if consumed raw in large quantities.

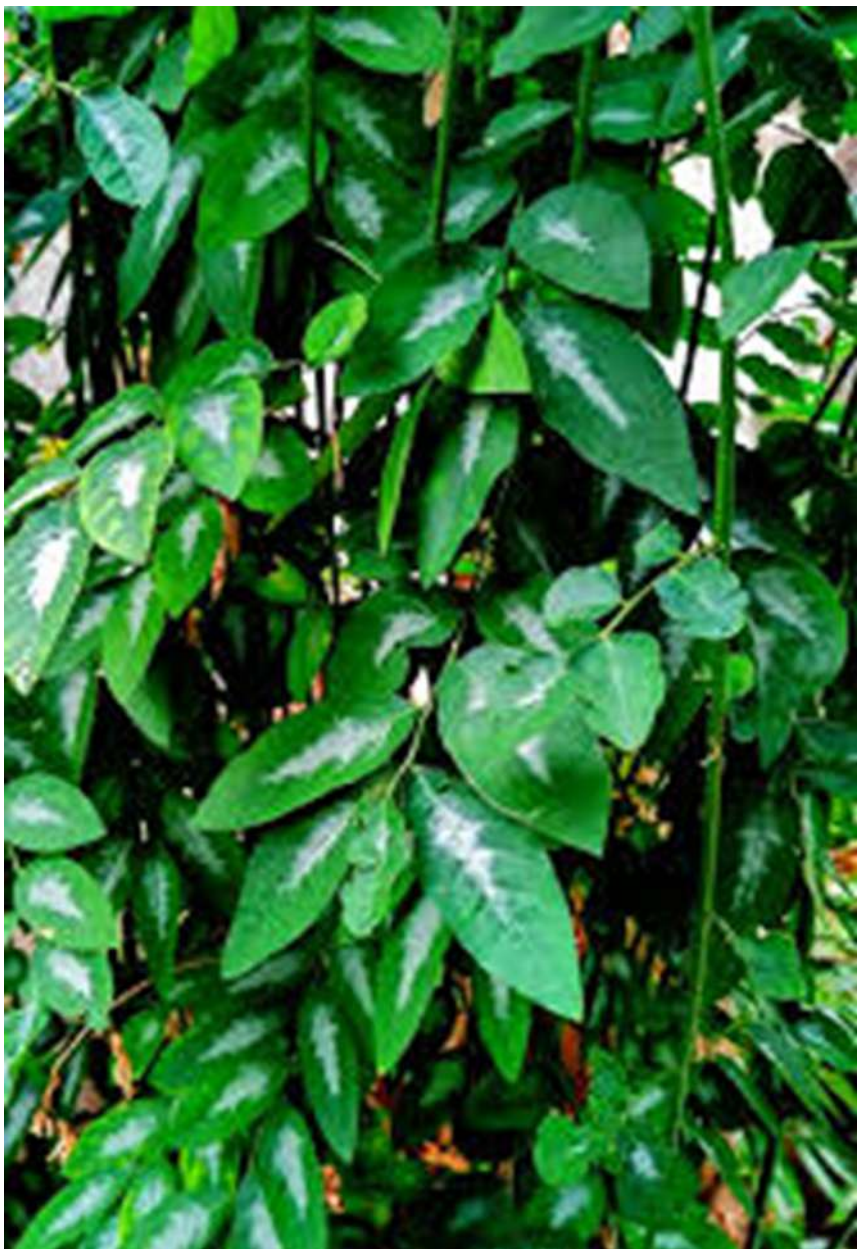
Nutrient and phytochemical constituents

It is a rich source of both micro and macronutrients and packed with several bioactive compounds. They are particularly rich in protein (6.8–7.4%), surpassing that of amaranthus (3.2%). They also contain high amounts of vitamin A and are a good source of vitamins B and C. The leaves have a high bioavailability of iron and zinc. Mature leaf tissues have more vitamin and nutrient content than young leaves. Calcium content of fully matured leaves is also higher than the tender leaves.

The table below summarizes the key nutritional components per 100 g of fresh leaves:

Leaves of chekkurmanis contain different compounds such as sterols, terpenoids, glycosides, resins, tannins, saponins, alkaloids, flavonoids, phenols, catechol, cardiac glycosides and acidic compounds. Some phytoconstituents such as saponins, tannins, triterpenoids, and coumarin are linked with non-steroidal anti-inflammatory drugs, antinociceptive and analgesic. Besides flavonoids and polyphenols, it is rich in Coenzyme Q10 (CoQ10) which acts as a strong antioxidant.

Despite its benefits, chekurmanis contains anti-nutritional factors, including papaverine, an alkaloid that can cause drowsiness and respiratory issues if consumed raw in large quantities. Regular consumption of chekurmanis leads to obstructive ventilatory impairment especially in patients



with respiratory symptoms. Overconsumption of papaverine is known to cause bronchiolitis obliterans. Other anti-nutritional factors include cyanogens and phytic acid. However, traditional processing methods such as drying, pressure cooking and fermentation can significantly reduce these compounds, making the leaves safe for consumption.

Medicinal Uses

Chekurmanis has been traditionally used to treat various ailments. A decoction of roots is used for fevers, while a poultice of pounded roots and leaves is applied to nasal ulcers. Leaves are a galactagogue agent that stimulates lactate glands, enhancing milk secretion. It increases the hormones prolactin and oxytocin to stimulate lactation. The root extract has been used to cure ailments such as dysentery, tuberculosis and scabies The juice of the leaves, combined with pomegranate roots and jasmine leaves, is used in some parts of South India for eye problems. The leaves are also a rich source of chlorophyll, which is beneficial for blood circulation and bowel elimination. The plant's leaves possess antioxidant, anti-inflammatory and antimicrobial properties. The polyphenols in the leaves have protective effects against human carcinogenesis, cardiovascular disorders and renal disorders. In Taiwan and Malaysia it has been used to control hypertension, gall bladder stones, hyperlipidemia, urolithiasis and various gynecological disorders.

Culinary Uses

The leaves and tender tips of chekurmanis are edible and are used in various cuisines across Southeast Asia. In Kerala, Karnataka and Arunachal Pradesh they are typically eaten as cooked vegetable and also as raw in salads or steamed, similar to tropical asparagus. In Indonesia, the leaves are used as a natural green food colourant in pastries and fermented rice. They can be incorporated into sandwiches, salads, curries and stir-fries, and are used in omelettes, pickles and as a garnish. People of Vietnam make soup of the leaves by mixing it with meats such as dried shrimp, crab and minced pork. At the same time, in Malaysia, it is commonly stir-fried with eggs and dried anchovies .

Morphology and Floral Characteristics

Chekurmanis is a slow-growing, glabrous perennial shrub that can reach a height of 2 to 3.5 meters. Its main branches are erect and flaccid, with thin lateral branches. The leaves are oval or oblong, 5–6 cm long, and dark green. They are sessile, alternating, membranous, and have a short stalk.

The flowers are monoecious and are arranged in axillary inflorescences. They are pedicelled and clustered, with a reddish hue, and typically

bloom from April to July. Fruits are sessile, white or pinkish with a fleshy epicarp. Fruit development usually occurs from July to December. The crop is highly cross-pollinated (entomophilous), a feature attributed to the protogynous and monoecious nature of its flowers.

Soil and Climate

Chekurmanis is adaptable to various soil types but thrives best in well-drained sandy loam or semi-laterite soils rich in organic matter. It prefers a neutral pH of around 7 but can tolerate acidic conditions. The plant requires a warm, humid climate and grows well at lower altitudes, though it can be found up to 1,200 meters above mean sea level.

Propagation

Propagation is primarily done using stem cuttings, although viable seeds can also be used. Propagation through cuttings is preferred as it leads to an earlier harvest. Herbaceous semi-hardwood cuttings, 20–30 cm in length with 5–6 nodes, are taken from plants that are 6 to 12 months old. For optimal rooting, cuttings can be dipped in a 50 ppm IAA/IBA solution before being planted in polybags filled with a mixture of soil, sand and manure. Rooting typically takes 20–25 days.

Planting and Aftercare

Cuttings should be transplanted into shallow furrows at least 15 days before the onset of the monsoon in April–May. Once the plants reach a desirable height, they are transplanted into pits measuring 30 cm x 30 cm x 30 cm, spaced 60 cm apart. Each pit should be filled with 5 kg of farmyard manure and 25 g each of urea, single superphosphate and muriate of potash. After each clipping, applying a balanced NPK fertilizer (7:10:5) at 30 g per plant, supplemented with a 1% urea spray, significantly enhances leaf yield.

Although the plant can withstand hot, dry periods, regular watering is crucial for continuous growth and the production of new leaves.

Pruning and Harvesting

Regular pruning of tender shoots and leaves is essential to encourage bushier growth and continuous harvests. Pruning can begin 3–4 months after planting and continue every two weeks. Trimming plants to a height of 1 to 1.5 meters facilitates easy harvesting. The first harvest of succulent leaves can be done 3–4 months after planting, when the plant is 60–90 cm tall. Subsequent harvests can occur every fortnight with proper manuring and irrigation. The annual yield can range from 30 to 50 tonnes per hectare.

Conclusion

Chekurmanis holds significant promise as a climate-resilient crop that can address nutritional deficiencies. By increasing public awareness of its benefits and promoting large-scale cultivation, this underutilized vegetable could become a vital component of global nutritional security. Efforts to expand research and develop effective supply chains are crucial to bringing chekurmanis from household gardens to a more prominent position in the global food system.

Chekurmanis is a slow-growing, glabrous perennial shrub that can reach a height of 2 to 3.5 meters. Its main branches are erect and flaccid, with thin lateral branches.

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Lemon vine
Versatile treasure of garden and home

SINGAMANENI ALEKYA NAIDU1*, KEERTHANA SETHUNATH2
Ph.D. Scholar, Department of Fruit Science, Kerala Agricultural University, College of Agriculture, Vellanikkara, Thrissur-680656
Corresponding Author email Id: alekyanaidu1517@gmail.com

Scientific Name : Pereskia aculeata Family : Cactaceae
Common Name : Lemon vine, Barbadaos gooseberry, Blade apple cactus, Ora- pro-nobis (OPN) (Silva etal., 2023) Origin : Tropical America

Pereskia aculeata, also known as Barbados gooseberry or lemon vine, is a unique flowering plant in the Cactaceae family. Unlike most cacti, it features leafy stems, resembling a shrub or small tree. Native to tropical regions, it has spread globally due to its hardiness and versatility. Thriving in warm climates, lemon vine is popular in garden designs for its vibrant green foliage, striking yellow flowers, and sprawling growth. Beyond its aesthetic appeal, it produces edible fruit and has medicinal properties. Whether used for landscaping, ground cover, or vertical gardening, this plant combines beauty, functionality, and cultural significance.

Cultivation and Importance

Lemon vine is a low maintenance plant grown in warm, humid environments (20°C to 30°C). It prefers well-draining soil and thrives with consistent moisture during growth, though it is drought-tolerant once established. Its climbing ability makes it ideal for ground cover, landscaping, or trellises, adding versatility to garden designs. The plant's value lies in its multifunctional uses. While not widely recognized in commercial horticulture, it is important in local agriculture, particularly in tropical fruit regions. Its drought tolerance and adaptability to various soil types make it a reliable choice for farmers in diverse climates.

- Growth Habit: It grows as a sprawling, shrubby vine or climbing plant. It can reach heights of about 2 to 3 meters (6.6 to 9.8 feet).
- Leaves: The leaves are broad, green, and somewhat leathery, which is a distinctive feature compared to other cacti.
- Flowers: The flowers are typically large, showy, and yellow with a reddish centre. They are often fragrant.
- Fruit: The plant produces small, edible fruits, which are usually greenish or yellowish when ripe and are considered a type of berry. The fruit has a sour taste and is sometimes eaten raw or used in drinks.
- Thorns: Long, slender thorns on its stems, characteristic of many cactus species.

Distribution

- It is native to tropical regions of the Americas, particularly in areas such as the Caribbean,

such as jams or juices.

- **Ornamental:** The plant is also grown for ornamental purposes, particularly in gardens or as a decorative groundcover.

Nutrition Value: Pereskia aculeata, also known as Barbados cherry, is rich in vitamin C, antioxidants, and dietary fiber. It provides essential nutrients such as calcium, iron, and magnesium, supporting immune function and bone health.

Propagation: Propagated through seeds or vegetative cuttings. Seeds should be soaked for 24 hours before planting in well-drained, sandy soil to speed up germination. Alternatively, semi-hardwood cuttings can be taken from healthy plants, treated with rooting hormone, and planted in a suitable medium to develop roots.

Central America, and parts of South America.

- The plant thrives in warm, tropical climates and is often found in open or disturbed areas, such as forest edges and roadsides.

  Uses: Primary uses of Lemon vine is its fruit. The plant produces small, berry-like fruits that are typically green or yellow when ripe. These fruits are sour in taste and are consumed in various ways.

- **Medicinal:** In some regions, the plant is used in traditional medicine for its purported health benefits, including its ability to treat wounds or as a mild laxative.

- **Culinary:** Its fruits are sometimes eaten fresh or used in culinary preparations,

Growing conditions: Thrives in warm, tropical climates with plenty of sunlight and well-drained, sandy soil. It prefers temperatures between 20-30°C (68-86°F), is drought-tolerant once established, and adapts to various soil types as long as they aren't waterlogged.

Aesthetic value: It offers significant aesthetic value in landscaping. Its vibrant yellow flowers with reddish centers add a colorful touch, while it's broad, lush green leaves create a beautiful backdrop. The sprawling vines can be trained on trellises or fences, providing a natural privacy screen or decorative feature. This visually striking, low-maintenance plant is ideal for both public and private gardens, enhancing tropical or garden settings.

Lemon vine is a remarkable plant, valued for both its fruit and floral aspects. The fruit, rich in vitamin C and antioxidants, offers nutritional benefits, while the attractive yellow flowers with reddish centers enhance its aesthetic appeal.

Harvesting

Harvesting involves collecting both its fruit and leaves for various uses. The fruit, small and berry-like, is ready for harvest when it softens and changes colour, typically from green to yellow, about 3-4 months after flowering. It can be gently picked by hand or with pruning shears to avoid damaging the plant. The leaves, which can be harvested year-round for medicinal or culinary purposes, are collected by cutting the stems or leaves with clean pruning shears, taking care to leave enough foliage for continued growth. By harvesting in moderation, the plant continues to thrive, providing fruit and leaves for future use.

Conclusion

Lemon vine is a remarkable plant, valued for both its fruit and floral aspects. The fruit, rich in vitamin C and antioxidants, offers nutritional benefits, while the attractive yellow flowers with reddish centers enhance its aesthetic appeal. Its versatile growth, vibrant foliage, and ability to thrive in various landscapes make it an excellent choice for gardeners seeking both a visually striking and practical plant. Whether for its health benefits or ornamental beauty, Pereskia aculeata proves to be a valuable addition to any garden.

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West African Okra
a potential candidate for widening the nutrient basket

SUMA A1*, JOSEPH JOHN K1, LATHA M1, P P THIRUMALAISAMY1,
CHITHRA DEVI PANDEY2, K VENKATESAN1, K PRADHEEP1
1ICAR- National Bureau of Plant Genetic Resources, Regional Station,
Vellanikkara, KAU. P. O, Thrissur, Kerala, India – 680656
2ICAR- National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi, India-110012
*Corresponding author email address: suma.a@icar.org.in; sumaagri@gmail.COM

Incorporating a variety of vegetable crops into the cereal and tuber-based agriculture will be crucial in promoting food and nutritional security which will results in diversifying sources of income for those engaged in the subsistence farming system, common in developing and impoverished nations. West African okra or Guinean okra (Abelmoschus caillei A. Chev Stevels) belonging to the family Malvaceae, is a potential vegetable crop found common in traditional agricultural systems like home gardens/ kitchen gardens. It is indigenous to the humid West and Central Africa (Siemonsma and Hamon, 2004). They are reported to be cultivated in Guinea to Nigeria in West Africa, in Cameroon, Gabon and DR Congo in Central Africa, and in Uganda in East Africa (Siemonsma and Hamon, 2004). Taxonomically, A. caillei is very distinct from A. esculentus with respect to the fruit shape which is lanceolate to lance-ovate in the former whereas lanceolate in latter. However, the epicalyx offers the best discriminating characteristic: ovate deltoid segments 7-9, free, 1.0-3.5 x 0.4-1.5 cm in A. caillei as against 6-10, free, linear 2.1-2.4 x 0.4-06 cm in A. esculentus, besides the significant difference in chromosome number between the species. A. caillei is reported to contain 184 to 200 diploid chromosomes in contrast to 130 to 140 in A. esculentus. It is believed to be an amphipolyploid between A. esculentus and A. manihot (2n = 60 to 68) (Siemonsma, 1982). Occasionally seen cultivated as a homestead vegetable in Kerala, Tamil Nadu, Coastal Karnataka, Goa, Andaman & Nicobar Islands and North eastern states, A. caillei possess great potential in widening the vegetable basket diversity of our country. The acceptability for consumption is also reported to be comparable to that of common okra.

Phenology

The life cycle of West African okra is longer than the common okra. It extends up to 9-10 months and may even grow for one more year (as a biennial crop). Thus, it is a suitable candidate for promoting as a homestead/ kitchen garden vegetable. However, A.caillei is reported to be photoperiod sensitive (Ariyo, 1993; Adeniji et al. 2007) in contrast to A. esculentus (Kehinde 1999). Flowering starts by 40-45 days after sowing and may continue throughout the year depending on the genotype. Tender fruits at the age of 4-6 days after anthesis should be harvested for vegetable purpose as the development of fiber formation in the fruit is faster than A. esculentus. The productive period is extended when early fruits are routinely removed to allow for sustained vegetative development and flowering. Further, the mucilage content is also observed to be higher in magnitude compared to A. esculentus.

Nutritional composition

As per Thampi and Indira (2000), it is reported to contain protein (14.19 – 17.65 %), fat (12.52 – 14.83 g/ 100 g, carbohydrate (12.23 – 17.81 %), starch (3.87 – 7.30 %), fibre (9.28 – 15.17 %) (all parameters on dry weight basis) and moisture (90.16 – 92.04 %). The major minerals and vitamins comprised of Calcium (92.6

Variability in fruit characters in A. caillei

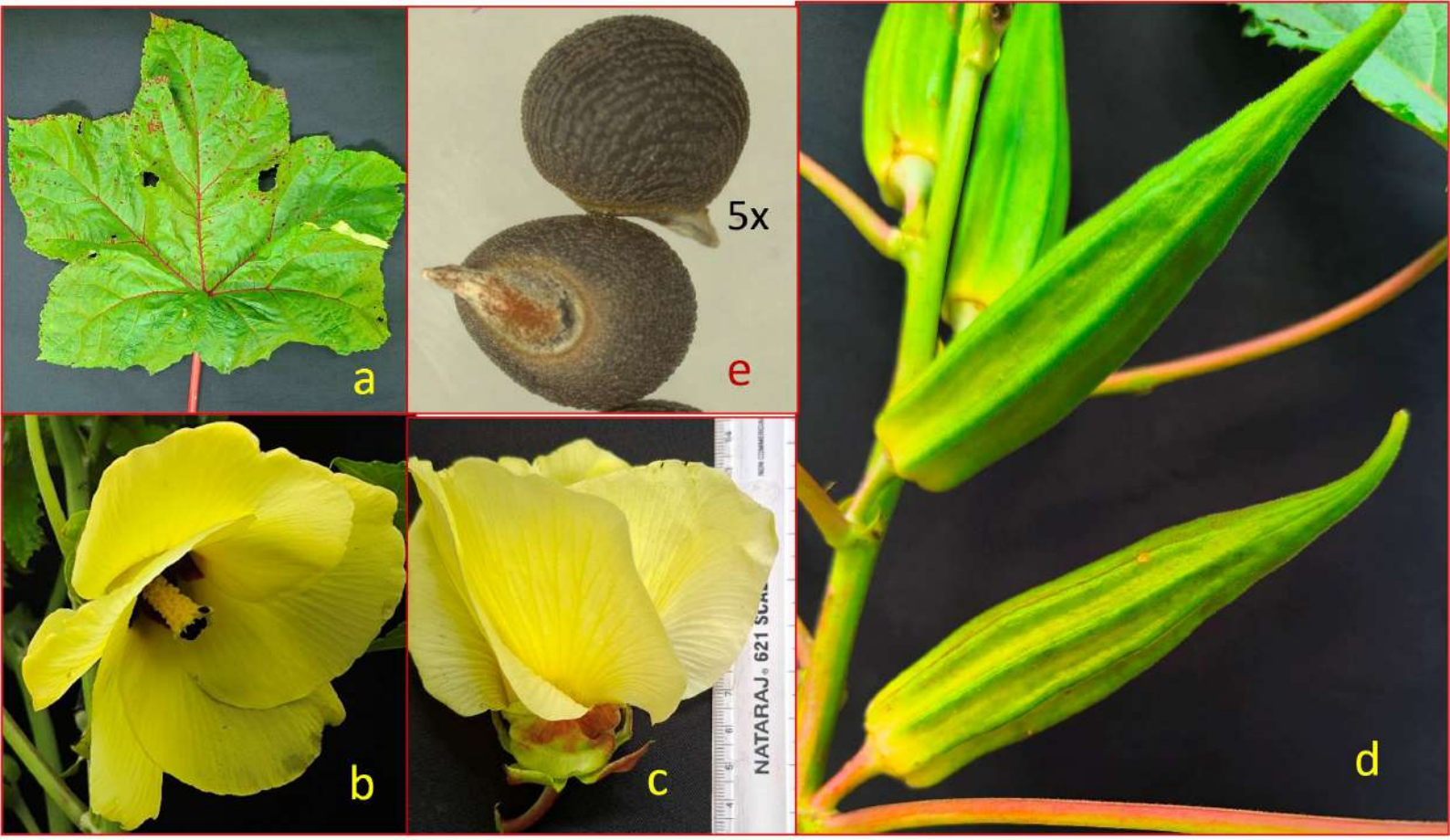
– 140.6 mg/ 100 g), Phosphorus (91.61 – 111.0 mg/ 100g), Iron (1.0 – 1.58 mg/ 100g), vitamin C (78.67 – 92.29 mg/ 100g), and mucilage content of 0.27 – 0.49 g/ 100 g.

Genetic resources

A. caillei is known in different primitive names viz. Maravenda, Thamaravenda, African venda etc, the names being correlated with the specific attribute it holds. The seeds of both the cultivated okra species (A. esculentus and A. caillei) are found in many national genebanks, although curators frequently not aware of their taxonomic distinction and separate species status. Through germplasm exchange, West African okra has already been shared with a number of Asian and American nations for research purposes. ICAR-NBPGR, Regional Station, Thrissur, Kerala holds 74 accessions of A. caillei germplasm including both naturalized and exotic collections. There exists wide variability among the collections of A. caillei, which was depicted in terms of fruit colour varying from light green to green to green with reddish tinge, dark green, and ridges sometimes starting from half the length of the fruit. The shape also varied from elongate to lanceolate to lance-ovate, acuminate but in few flat apical ends are observed.

Uses

A. caillei is grown as vegetable for its young leaves, fruits and floral parts. The young immature fruits are consumed cooked or fried. The fruits are usually boiled in water to make slimy soups and sauces. In Nigeria, both floral and fruit parts are processed for edible uses. The fresh unripe and tender fruits are made in to a glutinous soup after they are sliced, grated, boiled, steamed or fried and beaten. Okra mucilage is reported to have medicinal and industrial applications (Siemonsma and Hamon, 2004) and an excellent thickener for stews and soups (Osawaru and Ogwu, 2013). As per their report, the sun dried whole or sliced



Morphology of A. caillei: (a) Leaf; (b & c) Flower; (d) Fruit; (e) Seed

fruits are conserved for year-round consumption. The powder made out of the dried fruits and seeds are used for flavouring and as thickener for soup (Osawaru and Dania-Ogbe, 2010). They have numerous industrial uses. The reasonably thick stem with bark and fibers can be spun into rope and used to make paper and cardboard. (Charrier 1984). In Africa, the fibres are also used to make fishing lines, game traps and sponges (Osawaru and Dania-Ogbe, 2010).

Cultivation practices

It can be cultivated in the three main seasons viz. February-March, June-July and Oct-November. Presently, "Susthira" developed by Kerala Agricultural University, Thrissur, Kerala, India is the only released variety in this crop and is acclaimed as yellow vein mosaic virus (YVMV) disease resistant. Seeds are sown at a spacing of 60 cm x 45 cm. After the field preparation, apply lime @ 0.50 – 1.0 ton/ ha depending upon the acidity of the soil and allowed to wash down through soil (give an irrigation after liming or leave aside for10 days/expose to rain for leaching out). Soaking the seeds in water for 24 hours prior to sowing will improve germination. Cultivation practices similar to okra (A. esculentus) can be followed for West African okra also. Farm yard manure may be applied as basal dose at the rate 20 t/ha along with 55, 35 and 70 kg/ha of N, P2O5 and K2O respectively. Remaining doze of 55 kg N/ha may be applied one month after sowing. Thinning (at the rate of one plant per pit) and earthing up may be coincided with the first weeding and fertilizer application. Addition of compost in the soil invigorates the plant growth. Flowering can be improved by applying fish amino acid or diluted groundnut cake extract supernatant (Groundnut cake soaked for 3 days and the supernatant solution serve as the spray fluid). Intercultural operations like timely weeding, earthing up, and irrigation (during Oct-Nov and Feb- March crop) should be done as per requirement.

The crop is attacked by very few pests and diseases. Many of the genotypes are found to be tolerant to major diseases such as YVMV and Enation Leaf Curl Virus (ELCV) diseases. Other important pests are jassids, shoot and fruit borer and root knot nematode. The plant protection measures followed for okra may be followed for this crop also. For controlling fruit and shoot borers, remove all drooping shoots and damaged fruits. As stated in the package of practices recommendations of Kerala Agricultural University for okra (available at https://kau.in/sites/default/files/documents/pop2016.pdf), severe infestation of jassids and fruit and shoot borers can be controlled by use of quinalphos 0.05 per cent or Imidacloprid 17.8% SL20g ai/ha or Thiamethoxam 25% WG 25g ai/ha as foliar sprays, and Emamectin benzoate 5% SG @ 10 g ai/ha or Chlorantraniliprole 18.5 SC @ 30 g ai/ha at an interval

of 15 days respectively.

Conclusion

West African okra is a suitable substitute for common okra, with prolonged growth and extended harvest period. The mucilaginous fruits are also famed for controlling blood sugar, promoting heart health, and potentially aiding in digestion. Eventhough the crop does not demand frequent irrigation for its growth, it assures consistent fruit production in the home garden. Further the problem of pests and diseases are also reported very less in this crop.

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A. caillei - habit

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