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English journal

The First English farm journal from the house of Kerala Karshakan

Jack fruit

"A journey of becoming
Kerala's official fruit"

INSIDE KERALA KARSHAKAN

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Jack fruit

"A journey of becoming Kerala's official fruit"

Jack fruit *(Artocarpus heterophyllus)* is the most versatile of all tropical fruits which belongs to the latex exuding family Moraceae. It is an evergreen tree native to tropical Asia and widely grown throughout the wetland tropics for its large fruits and durable wood. It is a common fruit in Kerala and South India.One unique aspect of jackfruit is its unusual large size. It is the largest tree fruit in the world and can reach up to 80 pounds (35 kg) in weight. It has a spiky outer skin and is green or yellow in colour. The greenish unripe fruit is cooked as a vegetable, and the brown ripened fruit is eaten fresh for the sweetly acid but insipid pulp surrounding the seeds. The seeds are cooked and eaten locally. Canned or processed jackfruit has gained popularity as a meat substitute in some places.

The Kerala government on March 21, 2018,declared

jackfruit as its official fruit with an aim to promote the 'Kerala jackfruit' as a brand in markets across the country and abroad, showcasing its organic and nutritious qualities.The official announcement in this regard was made by the then Agriculture Minister, VS Sunil Kumar.In Kerala, it is grown organically with good taste as it is produced in a very natural way without using any chemical fertilisers or pesticides.The status of jackfruit as state fruit might help in boosting the fruit's production and sale, besides increasing its value-added products.

Health benefits of Jackfruit

Jackfruit is just like a magical exotic fruit which fills our body with all sorts of awesome healthy nutrients.

Enhances Immunity

Jackfruit contains a high amount of vitamin C and antioxidants which is known to boost immune health and improves the ability to defend against the pathogens. This vitamin will stimulate the production of white blood cells which in turn protect the body from foreign invaders such as virus and bacteria.

Replenishes Energy

The jackfruit contains 94 calories per 100g and is high in carbs. When consumed, it provides an immediate energy boost. It contains simple, natural carbohydrates like fructose and sucrose, which the body can easily absorb. These carbohydrates are referred to as slowly accessible glucose, implying that the jackfruit releases glucose slowly in the body. The low glycaemic index of the fruit is due to this. As a result, in addition to providing

Nutritional value of Jackfruit per 100 g of edible portion

Principle	Nutrient Value	Vitamins	Nutrient Value (mg)	Minerals	Nutrient Value (mg)
Energy	95 Kcal	Folates	0.024	Calcium	24
Carbohydrates	23.5 g	Niacin	0.92	Iron	0.23
Protein	1.72 g	Pyridoxine	0.327	Magnesium	29
Saturated Fat	0.195 g	Riboflavin	0.055	Manganese	0.19
Unsaturated fat	0.155 g	Thiamine	0.105	Potassium	448
Cholesterol	0 mg	Vitamin A	110 IU	Phosphorus	21
Dietary Fiber	1.5 g	Vitamin C	13.7	Selenium	0.6
Sugar	19.08 g	Vitamin E	0.34	Zinc	0.42

(Source: USDA National Nutrient data base)

rapid energy, it is also a good supply of natural sugar for diabetics.

Improves cardiovascular health and regulates blood pressure

Potassium in the appropriate amount ensures a balanced regulation of salt in the body, which if left uncontrolled can damage the arteries and heart.

Potassium also coordinates and maintains muscular function, including that of the cardiac muscles, making it necessary for a fully functional system. Jackfruit is high in potassium, which helps to keep the heart and circulatory system in good condition.

Improves Digestion

Jackfruit is high in both soluble and insoluble fibres. It is critical to include a healthy quantity of fibre in each meal. The body quickly breaks down the soluble fibre to produce energy, while the insoluble fibre adds volume to the stool, making

bowel movements easier.

Prevents Cancer

Jackfruit is rich in antioxidants, phytonutrients and flavonoids. The presence of these antioxidants eliminates the toxins produced by the body as well as the free radicals which are harmful. Both toxins and free radicals have been known to cause cancer in the body.

Enhances Vision

Being rich in vitamin A (β-Carotene), jackfruit provides a healthy nutrition for eyes. It protects the eyes from bacterial and viral infection and rids them of free radicals which might be harmful. It also saves the eyes from intense and harmful light waves like ultraviolet rays and helps in improving the eyesight. It is especially effective in preventing degeneration of the retina and reduces the risk of cataract.

Prevents Ageing

The reason behind ageing is free radicals. These are produced in the body during high oxidative stress caused by pollution. Antioxidant rich jackfruit destroys these free radicals which slows down the ageing process.

Strengthens Bones

Jackfruit is loaded with high amounts of calcium which strengthens the bones and potassium which reduces loss of calcium through kidneys. Symptoms of bone related disorders like arthritis; osteoporosis can be managed by consumption of jackfruit.

Improves Blood Quality

Jackfruit also contains a good amount of iron in it. A proper concentration of iron in the body helps prevent disorders like anaemia. Iron also helps in aiding metabolism. Vitamin C, magnesium and copper also help in improving the quality of the blood.

Prevents Asthma

Jackfruit helps control the imbalances in the body which result in controlling of the asthmatic attacks. Especially when the symptoms are triggered by pollution, jackfruit helps control the symptoms by eliminating the free radicals being produced in the body due to the pollution which otherwise lead to asthmatic attacks.

Ensures a High Functioning Thyroid

Jackfruit being rich in copper which helps in thyroid metabolism, especially in hormone production and absorption, ensures a healthy and fit thyroid. It also helps people suffering from thyroid disorders.

Delicious Jack/ Chakka Recipes of Kerala

The sheer variety of recipes with jackfruit is quite astounding. The following are the recipes of jackfruit in Kerala which adds to its importance and uses in the land of God's: Kerala.

Chakka Puttu: Steamed Jackfruit Puttu

Idichakka Thoran: Tender Jackfruit Stir fry with Coconut

Chakkakuru Mezhukkupuratti: Yard Beans and Jackfruit Seeds Stir Fry

Chakka Puzhukku/Chakka Kuzhachathu: Mashed Jackfruit and Fish Curry

Chakka Ada: Steamed Jack fruit Rice Cakes

Conclusion:

Apart from the health and nutrition values it also finds its importance in economic aspects.

Every year, around 32 crore jackfruits are produced in the State, of which 30 per cent gets wasted.A total revenue of ₹15,000 crore is expected through the sale of jackfruit and its allied products through branding of the fruit.Kerala is considered as the god's gift state for growing jackfruit. Hence, it is no wonder, Jackfruit to be considered as State fruit of Kerala.

Green leafy VEGETABLES

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A step towards Nutritional security

Malnutrition is defined as "a state where adequate nutrients are not delivered to the cells for its optimal functioning."About 46.6 million children in India are suffering from stunting and 51 per cent women of reproductive age are suffering from anaemia in India.

Leafy vegetables also called pot herbs, greens,vegetable greens, leafy greens or salad greens are the plant leaves eaten as a vegetable. Leafy vegetables are rich sources of vitamins, minerals and fibres.They have multipurpose uses like some are used as spices, condiment and also for medicinal purpose.The Indian Council of Medical Research (ICMR) recommended a daily intake of 125g of leafy vegetables in the human diet.

Spinach

Drumstick

Special features of leafy vegetables

1. Quick growing
2. Best suited in kitchen garden
3. Best suited as inter crop
4. Growth throughout the year
5. Short duration
6. Cheapest source of minerals and vitamins
7. Having medicinal properties
8. Can be grown even in partial shady places
9. Per unit area yield is high
10. Usually harvested in multiple cuttings

Important leafy vegetables

Amaranthus

The word Amaranths is basically derived from the Greek word "Anthos" which means everlasting or unwilting. A high genetic diversity of about 400 spp. are distributed throughout the world, among which 20 species are found cultivated/ wild in India. It acts as Blood purification, Excellent source for reducing vitamin deficiency and it is popularly used as multi mineral provider.

Drumstick

It is known as Miracle tree as it is small and with fast growth habit, providing high nutrients along with many health benefits. Its known to increase milk production and also helps in treating anaemia which are common in lactating women. Leaves can be used in the diet of the obese. It contains Anti-cancerous agents like glucosinolates which helps in preventing cancer. Moringa powder can be used as a substitute for protein and iron tablets.

Curry leaf

Its green leaves, dried leaf powder, and essential leaf oil are used for flavoring soups, curries and also in food preparations, such as dal, sambar, and chutney. The leaves provides major nutrients like N, P, K and S along with protein. Leaves also provide an excellent source of micro nutrients like calcium, iron, and phosphorus. Health benefits of curry leaves are its Nephroprotective, Hypoglycemic effects, Antimicrobial activity, Anti-obese activity, Antipyretic activity and Anti-inflammatory activity.

Spinach

Spinach has a high nutritional value and is extremely rich in antioxidants, especially when fresh and even after steamed or quickly boiled. It is rich in many minerals

Amaranthus

like magnesium, calcium, phosphorus, iron and zinc. It contains different carotenoids like lutein and ß-carotene, and also contains high amount of vitamins like A, C and K. It has various biological activities like virus inhibitor and reducing risk of breast cancer. Its use prevents some diseases like osteoporosis, and anaemia. Its consumption is reported in reducing Antidiabetic effects and Anti-inflammatory activity.

Anti-nutritional Factors in Green Leafy Vegetables

These are the undesirable chemical substances present in both cultivated and wild plant species. These antinutrients are also referred to as "Allelochemicals". Commonly found anti-nutrients in leafy vegetables are, Nitrate, Oxalates, Phytates, Cyanogenic glycosides.

Effect of anti-nutritional factors on human health

1. Nitrate concentration in leafy vegetables is found higher than other groups of vegetables such as root and fruits vegetables
2. The presence of nitrates causes very serious disease called methemoglobinemia or blue baby syndrome in infants leading to suffocation and death
3. Oxalic acid in combination with its salts or minerals form oxalates.
4. The insoluble calcium oxalate in the crystal form is stored in the kidney causing serious health-related problem called kidney stone
5. Phytic acid is a natural substance that acts as a major storage of phosphorus in all leafy vegetables
6. It has negative impact on the activity of digestive enzymes and act through chelation of mineral cofactors or interaction with protein
7. Cyanogenic glycosides are derivatives of amino acids, and a group of secondary metabolites present in plant species

Methods to reduce anti-nutrients

1. Heat treatment is the most effective method to reduce the anti-nutrition factors present in green leafy vegetables
2. Cooking and blanching helps in the removal of anti-nutrients through rupturing the plant cell wall followed by leaching out of soluble compounds into the blanching medium.
3. Phytic acid and oxalic acid can be effectively reduced by cooking and blanching methods whereas oxalic acid content was reduced by both blanching and cooking

Conclusion

Growing human population make us depend on major crops like cereals and pulses which lead to increase in malnutrition and various health problems among the people. Diversification of food and utilization of Leafy vegetables in daily diet is the best way to achieve nutritional security.

Curry leaf

SUPER FOOD CROP CHIA

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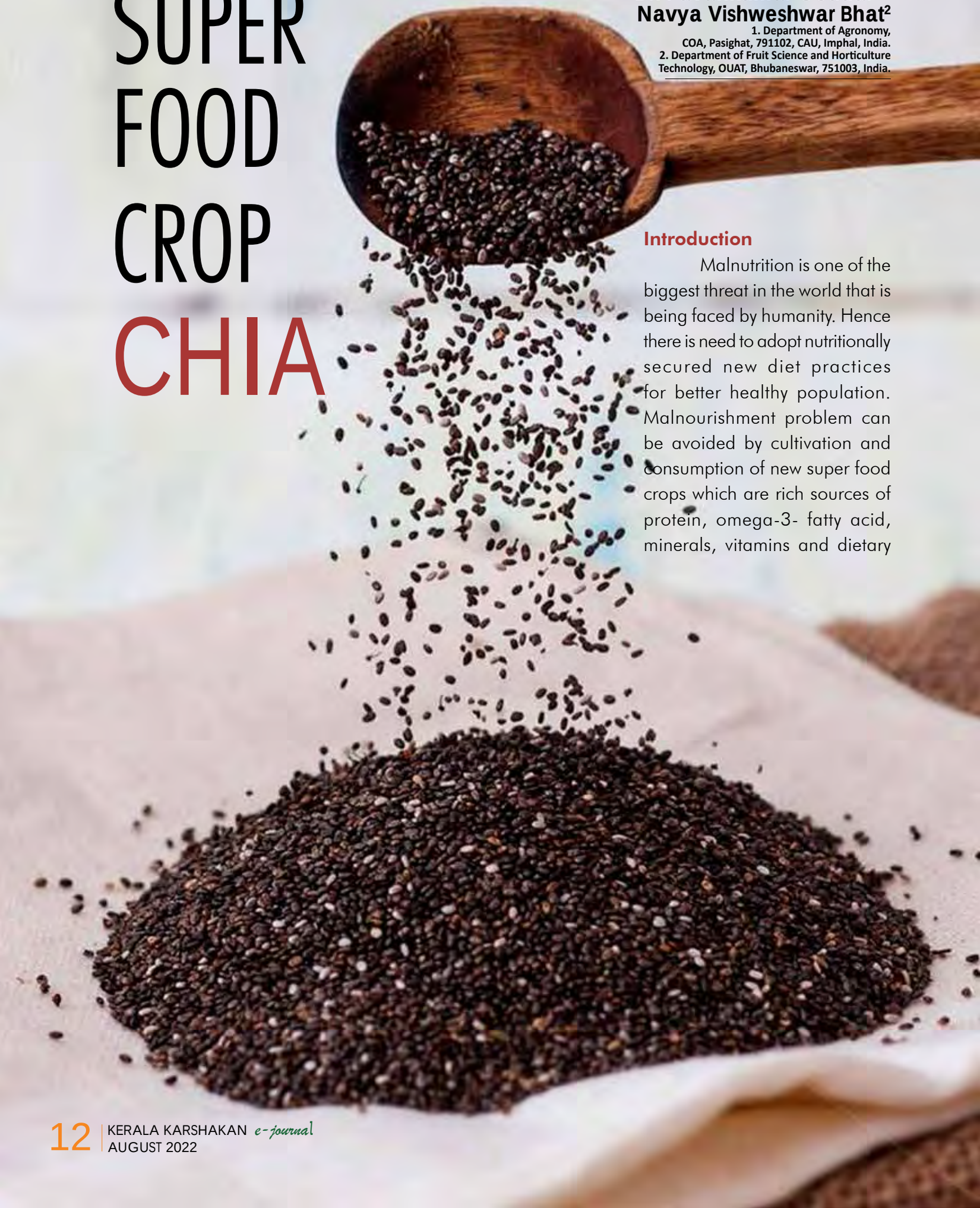

Introduction

Malnutrition is one of the biggest threat in the world that is being faced by humanity. Hence there is need to adopt nutritionally secured new diet practices for better healthy population. Malnourishment problem can be avoided by cultivation and consumption of new super food crops which are rich sources of protein, omega-3- fatty acid, minerals, vitamins and dietary

fibres. Monotonous cultivation of traditional food crops can be replaced by nutritionally rich new super food crops. Among these the most important one is Salvia hispanica L., commonly referred to as chia and also known as "lime-leaf sage". This crop is not only recognized for its health benefits but also for its drought resistant behaviour. It has been suggested as a choice from cropping system in semi-arid environments.

Chia *(Saliva hispanica L.)* is an annual oilseed crop belonging to the family lamiaceae originated in Mexico and Guatemala (Ixtaniaet al., 2008). Chia is dicotyledonous, approximately1 to 2 metre tall, with opposite, pestiolate and serrated leaves that are 4 to 8 cm long and 3 to 5 cm wide. The plant has quadrangular stems that are ribbed and hairy. The flowers are hermaphrodite and grow in numerous clusters in a spike protected by small bracts with long pointed tips. Currently, Chia seed offers a huge potential in the industries of health, food, animal feed and pharmaceutical and nutraceuticals, due to its functional components.

Nutritional Value

As public health awareness is increasing day by day throughout the world, demand for functional food with multiple health benefits is also increasing. The use of medicinal food from folk

medicine to prevent diseases such as diabetes, obesity, and cardiovascular problems is now gaining momentum in the globe. Since chia crop is gaining popularity in the world due to its health benefits; this is recognised as super food crop for its superior nutritional value. It is consumed as seeds and can be used as food supplements.

Chia seed is composed of protein (15% –25%), fats (30%–33%), carbohydrates (26%–41%), high dietary fibre (18%–30%), ash (4%–5%), minerals, vitamins, dry matter (90% – 93%) and also contains a high amount of antioxidants (Ixtainaet al., 2008). Recently, chia seed has become important for human health and nutrition because of its high content of omega-3- fatty acid that promotes beneficial health effects (Vuksanet al., 2010). The ALA (alpha linolenic fatty acid) in Chia seed is the only known essential omega-3 fatty acid that the body can't produce on its own. If you are looking to boost your nutritional intake, look no further than the humble chia seed. Per gram chia seeds contain 8 time more omega-3 than salmon, 6 time more calcium than milk, 3 time more iron than spinach, 15 time more magnesium than broccoli, 2 time more fiber than bran flakes, 6 time more protein than kidney beans, 4 time more phosphorous than whole milk. Hence now a day chia is treated as a newly discovered superfood.

Climate and Soil

Chia is a low-maintenance crop that prefers moderately fertile, well-drained soils. Chia is planted in May or June and harvested in October. While moisture is necessary for seedling establishment, this crop is highly intolerant of wet soils. Water logging near to the root zone be will able to kill the whole plot within two days.

Land Preparation and Sowing

The land is ploughed and further cross-ploughed several times followed by laddering until a good tilth is achieved. Seeds are planted into a fully tilled seed bed using a standard grain drill or planter with small seed metering capability; some adjustments to this equipment may be necessary. Because of the small seed size, precision planting is important to ensure good seed-to-soil contact. The modern commercial chia cultivation includes a typical seed rate of 3 to 5 kg per ha-1 and suitable spacing is maintained as 60 cm X 30 cm between the two crop rows and between the plants respectively.Chia seeds are currently imported from Australia, Bolivia and the US, which are sold at the rate of Rs. 2000 kg-1 in India. There are no popular varieties released in the field of chia. But fortunately GKVK Chia-1 is under field trails today and giving handful of income to the farmers.

Fertilization

At the time of sowing FYM may be applied at the rate of 5 tonnes ha-1. Urea (80 Kg ha-1), Super phosphate (60 Kg ha-1), Muriate of potash (60 Kg ha-1), Gypsum (30 Kg ha-1). Full dose of phosphorus and potassium is applied as basal during sowing while, fifty percent of nitrogen is applied as basal and remaining half is top dressed at 40 DAS when the plants reach juvenile stage.

Irrigation

Chia crop should be irrigated frequently for better crop growth and to achieve maximum yield potential. The first irrigation is given immediately after sowing, mainly at an interval of 3-4 days during establishment period and later supplemental irrigation is given at an interval of 7-10 days. In chia field it may require 8 to 12 irrigations per growing season, depending on the climatic condition and the rainfall

Characteristics of Seed

The fruit of chia, as in other plants of the lamiaceae family, is a schizocarp consisting of indehiscent locules that separate to form four fruitlets, referred to as mericarps or nut lets. Commercially, each of these fruitlets is called seed, but actually, the (true) seed is contained within each fruitlet. Each of these nutlets has a stratified pericarp, cuticle,

epicarp, mesocarp, a layer of bone cells, and endocarp, the latter is in contact with true seed. The seeds are oval, smooth and shiny, and are mottle-coloured with brown, gray, dark red and white, generally found in groups of four and the shape is oval with size ranging from 1 to 2 mm (bressonetal., 2009). Chia crop is very sensitive to low temperature and day length. So the growing cycle strictly depends on the latitude where it is planted (Coates, 2011).

Harvesting and threshing

The crop is harvested at 130 to 150 days after sowing. The dried spikes are cut from the plants by using a sickle. The seeds are cleaned by removing stubbles and stones and weight recorded.

Diseases and Pest Management

Essential oil in chia leaves make the plant more resistant to diseases and pests hence there will be no much disease and pests for the chia plant. Very few viruses will affect the chia seeds like cucumber mosaic virus, Broad bean wilt virus, Mung bean yellow mosaic virus, Tomato yellow leaf curl virus etc. There will be no specific insecticide or pesticides for effective control, we need to use cultural methods only to avoid the vectors spread in the field and any systemic insecticide can be used if the scenario is more than the economic thresh hold level.

Economics of Chia Seeds

In an acre we can harvest nearly four quintals and receive between Rs 150 and Rs 200 per kg. In off-season it is nearly Rs 300 per kg. The cultivation costs of chia is a couple of hundred whereas the yields is 3 quintals an acre for the white variety and about 5 quintals and more in well managed plots for the black variety. White chia brings Rs 60.000 - 70000/

Reasons behind Popularity:

Reasons behind cultivation of this new crop in the above area could be easiness of its cultivation under scarce availability of water and labour, besides, better nutritional status of seeds that would Shield nutritional security. Impact of Climate Change also favour cultivation of such new crops which rely on less water and come up very well under adverse climate conditions. Remunerative price for the produce and good buy back arrangement could also be one of the reasons for cultivation of this crop in that area.

Future line of work:

Chia being a new crop, different aspects of plant population and spatial arrangement, besides nutrient requirement for this crop are to be studied to harness potential yield of this crop.

New varieties in chia crop yet to be released, for the potential yield in various regions and different states. The expansion of chia to tropical and subtropical regions is majorly hindered by photoperiodic sensitivity and lack of photo periodic viability in traditional cultivars that need to be resolved and photo insensitive varieties are to be emerged. Resistant lines to various diseases and pests need to be developed. An imperative necessity and other critical questions is about the flowering and day length.

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CARBON NEUTRAL FARMING

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Introduction

Agricultural production depends directly on the climatic conditions of the region. Food security in the face of changing climate circumstances is a major emphasis of the twenty-first century. Greenhouse gas (GHG) emissions are well-known contributors to climate change. After China and the United States, India is the third greatest emitter of greenhouse gases. The majority of GHGs emissions are generated through the production and use of agricultural inputs such as water, fertilizers and pesticides, farm machinery, soil disturbance, residue management and irrigation. To meet the demand for around 9 million people by 2050, all the countries in the world have to increase food production by cutting down the GHGs from agriculture. Crop production and animal production are the major contributions to India's annual GHG

emissions from agriculture, with livestock production accounting for the majority of emissions. In India, most of the intensive production systems are showing yield plateau and crop response to inputs is declining. Also, more and more inputs are required for a unit production of food which enhances emission of GHGs. Most of the soil types in India have multiple production constraints, however, depletion of soil organic carbon (SOC) and subsequent soil health degradation is the major concern. Therefore, sustainable management of natural resources is required such as adoption of carbon neutral technologies.

Carbon neutrality

Carbon neutrality is a state of net-zero carbon dioxide emissions. This can be achieved by balancing emissions of carbon dioxide with its removal (often through carbon offsetting) or by eliminating emissions from society. The term is used in the context of carbon dioxide-releasing processes associated with transportation, energy production, agriculture, and industry. In 2016, the Oxford Dictionaries declared the term carbon-neutral as the word of the year in the United States. In December 2020, five years after the Paris Agreement, the Secretary-General of the United Nations, Antonio Guterres, warned that the commitments made by countries in Paris were not sufficient and were not respected. He has urged all other countries to declare climate emergencies until carbon neutrality is reached.

Carbon-neutral status can be achieved in two ways, although a combination of the two is most likely required:

Carbon offsetting: Balancing carbon dioxide emissions with carbon offsets — the process of reducing or avoiding greenhouse gas emissions or removing carbon dioxide from the atmosphere to make up

for emissions elsewhere. If the total greenhouse gases emitted is equal to the total amount avoided or removed, then the two effects cancel each other out and the net emissions are 'neutral'. Offsets are measured in tonnes of carbon dioxide-equivalent (CO_2e). One tonne of carbon offset represents the reduction of one tonne of carbon dioxide or its equivalent in other greenhouse gases.

Reducing emissions: Reducing carbon emissions can be done by moving towards energy sources and industry processes that produce less greenhouse gases, thereby transitioning to a low-carbon economy. Shifting towards the use of renewable energy such as wind, geothermal and solar power, as well as nuclear power reduces greenhouse gas emissions. Although both renewable and non-renewable energy production produce carbon emissions in some form, renewable sources produce negligible to almost zero carbon emissions.

4 per 1000 or
4 per mille initiative

The "4 per 1000 or 4 per mille" initiative was launched at the 21st conference (COP21) of the United Nations Framework Convention on Climate Change in Paris on November 11, 2015. This is popularly known as "Paris Agreement on Climate Change". The International "4 per 1000" Initiative aims to show that agriculture can provide concrete solutions to the challenge posed by climate change while meeting the challenge of food security through the implementation of agricultural practices adapted to local conditions: agroecology, agroforestry, conservation agriculture, landscape management, etc. An ambition to launch '4 per 1000' initiative was to provide compensatory option for the global emission of GHGs through various anthropogenic sources by enhancing SOC stocks at 0.4 per cent per year. Since carbon storage potential varies with climate, vegetation, soil type, scarcity of scientific data, finite capacity of SOC sink, resource poor small and marginal farmers, financial commitments and implementation, and high spatial variability of SOC, the 4 per mille target is difficult to achieve.

Carbon neutrality in Indian soils

Agricultural soils have the ability to sequester carbon if better management practises are implemented. Restoring these soils with optimum management practises boosts SOC and offsets GHG emissions while also improving soil health and production, resulting in carbon neutrality and global food security. To achieve carbon neutrality in Indian soils, the required C sequestration rate would be around 2.3-2.8 per cent which is much higher than the global requirement of 0.4per cent (Badole et al., 2021).

In Indian soils, achieving carbon neutrality is a huge difficulty. Because, as a result of urbanisation, industrialization, and numerous development activities, productive land is lost. More inputs are required for a unit of food production, which increases CO_2 and N_2O emissions. In India, SOC depletion and associated soil health degradation are serious concerns. To maintain or improve SOC stocks, sustainable natural resource management is essential.

Carbon neutral farming

Carbon neutral farming incorporates agricultural strategies, practices, and technologies available to increase soil carbon sequestration and to reduce greenhouse gas emissions. Practices for making agriculture carbon neutral are as follows;

Nutrient management

In agro-ecosystems, fertilizer-based CO_2 emissions contribute considerably to global GHG emissions and carbon footprints. Using the integrated nutrient management (INM) module, crop yields increased and carbon footprints were reduced. Application of plant nutrients in optimum ratio and adequate amounts is called "Balanced Fertilization". Balanced fertilization has reported higher net return and reduced carbon footprints. INM module in maize-chickpea cropping system reduced the carbon footprints by 17% and 14% in fertilizers and N_2O emissions and leading to 11% total reduction (Meena et al., 2021).

The application of organic amendments like Farm yard manure (FYM), paddy straw and green manure along with inorganic fertilizer can improve or maintain soil quality and productivity whilst building SOC in these environments.

Crop residue management

Burning crop residue in agricultural fields emits a variety

of air pollutants, including GHGs, which can have a significant impact on local, regional, and global atmospheric chemistry. For the proper use of wastes, proper mechanisms must be followed, notably in the process of separating organic elements from masses and subsequent composting of the same. It will have numerous advantages, including being a rich and inexpensive supply of C and nutrients, as well as a pollution-reduction tool. Crop residues can be used for composting, electricity production, biofuel production, as livestock feed, as substrate for mushroom growing, as well as for mulching, thatching and mat-making.

Biochar for attaining carbon neutrality

Using the pyrolysis process to convert organic waste to biochar is one possible alternative for increasing natural rates of carbon sequestration in the soil, reducing farm waste, and improving soil quality. Biochar has the potential to increase conventional agricultural productivity and enhance the ability of farmers to participate in carbon markets beyond the traditional approach by directly applying carbon into the soil. Converting waste biomass into biochar would transfer a large amount of carbon from the active to the inactive carbon pools, providing a compelling chance to interfere in the carbon cycle. A material must have a long residence time and be resistant to chemical processes such as oxidation to CO_2 or reduction to methane in order to sequester carbon, and the use of biochar as a soil amendment meets these requirements because the biomass is protected from further oxidation from the material that would otherwise degrade and release CO_2 into the atmosphere. If only 1 per cent of this biomass is converted to biochar, about 74 thousand tons of carbon can be sequestered annually (Srinivasarao et al., 2013).

Biochar allows carbon to migrate easily from the active to the passive pools. In comparison to the low amounts retained after burning (3%) and biological degradation, the conversion of biomass carbon to biochar results in sequestration of around 50% of the initial carbon (less than 10-20 per cent after 5-10 years). When added to the soil, biochar can significantly reduce the release of N_2O, lowering GHG emissions in farmland soils (Lehmann et al., 2006). Reduction of N_2O and CH_4 emission as a result of biochar application is seen to attract considerable attention due to the much higher global warming potentials of these

gases compared to CO_2. Study conducted by Dainy (2015) reported that when soil was incubated with tender coconut husk biochar @ 2 per cent resulted in 91.40 per cent reduction in CO_2 emission compared to application with 2 per cent FYM.

Conservation agriculture

Conservation agriculture has been recognised as a modern crop production approach that improves soil physical health, nutrient recycling, microbial activity, and biological variety, as well as increasing soil carbon sequestration and cutting GHG emissions. Conservation agriculture (CA) is the incorporation of minimum soil disturbance mainly zero tillage (ZT) or reduced tillage (RT) with retention of crop residues and diversified cropping systems (Badole et al., 2021). A study conducted by Toufeeq et al (2020) reported that the conventional tillage resulted in the maximum CO_2 emission followed by the tillage with cultivator and the least value was observed when tilled with rotovator. The reduction in CO_2 emissions from soil when tilled with a rotovator was 4% and 6%, respectively, when compared to cultivator and conventional tillage.

Livestock and manure management

Livestock farming contributes to GHG emission by ruminant fermentation and management of farm waste in an unscientific manner. Ruminant fermentation leads to production and emission of methane formed by microbial digestion of crude fibre by ruminants. Production of methane by ruminants can be reduced by management of feed, gut microorganisms and animal or farm waste. Production of methane depends both on type of feed provided to animal as well as type of microbial flora established in the gut. Managing the feed by providing the animal with some herbal supplement will help in reducing the substrate for methanogenic microorganisms in the ruminant. Animal and farm waste materials can be properly utilized for the generation of biogas and fertilizers, which would otherwise generate GHG in anaerobic conditions. Plant natural products or secondary metabolites such as tannins, saponins and essential oils have the potential to improve rumen fermentation, reduce loss of feed energy, improve animal health and productivity, increase animal lifetime performance, and reduce greenhouse gases production during animal production (Ugbogu et al., 2019).

Agroforestry

Carbon sequestration as plant and soil C in agroforestry has a large potential for lowering atmospheric CO2. Agroforestry can also help to reduce greenhouse gas emissions from the agricultural sector. C sequestration in agroforestry systems is a dynamic process. At establishment, many systems are likely to be source of GHGs. Then comes a rapid accumulation phase and a maturation stage, during which tonnes of carbon are stored in boles, stems, tree roots, and soil. When the trees are harvested and the land is restored to cropping at the end of the rotation period, some of the C is released back into the atmosphere.

As a result, effective sequestration may only be contemplated if the initial stock has a positive net C balance after a few decades.

Changing to fossil fuel free farming

Most of the agricultural machinery runs on fossil fuels. Using biofuels and electricity from renewable sources could cut GHGs emissions from agriculture by 10 per cent. Also, currently agriculture relies mainly on inorganic fertilizers due to faster result and easy to apply in the fields. However, inorganic fertilizers are an important climatic culprit and it is highly dependent on the natural gas. Therefore, the application of more organic fertilizers, such as animal manure, vermi-compost, green manure or inorganic fertilizers produced from green energy sources could dramatically reduce emissions from agriculture. The biogas combined heat and power (CHP) system would be more beneficial than the conventional energy system in terms of the cost saving ratio and also carbon dioxide equivalent reduction ratio, replacing the conventional technology by biogas.

Carbon neutrality in rice fields

Paddy rice fields are a significant source of GHG emissions. Alternate wetting and drying is the new method which reduces the amount of methane created by stubble and other organic matter decomposing underwater in the paddy. Methane is a significant contributor to global warming,

with rice cultivation the second biggest agricultural source after livestock. Under system of rice intensification (SRI) condition, alternate wetting and drying facilitates higher microbial activity compared to conventional submerged rice thus making the system efficient in sequestering atmospheric C into microbial biomass. Alternate wetting and drying and cono weeding favours the humification process or improved degradation of non-humic substances in aerobic condition creates more humic and fulvic acid compounds under SRI. Thus ensure higher soil C sequestration under SRI over conventionally grown rice (Rajkishore et al., 2013). Alternate wetting and drying check methane (CH4) production and emission by keeping redox potential of soil in mostly positive values.

Carbon trading

Carbon trading is an approach to control CO_2 emission, wherein an economic incentive is provided to achieve the emission reduction. It is administrated by a central authority such as government or international organization, which sets a limit on the amount of CO_2 that can be emitted. If the emission is above this limit, it could be traded with other countries having low emission. In economics, carbon trading is a form of emission trading that allows a country to meet its CO_2 emission reduction commitments, often to meet Kyoto Treaty requirements.

Carbon Neutral Goals by Countries

According to the Energy and Climate Intelligence Unit, 137 countries have committed to carbon neutrality, as evidenced by pledges to the Carbon Neutrality Coalition and recent government policy declarations. Bhutan and Suriname are the only two countries in the world that have achieved carbon neutrality and are actually carbon negative (removing more carbon than they emit).

Over 90% of the 137 countries, or 124 of them, have established a goal of carbon neutrality by 2050. This is largely due to membership in the Carbon Neutrality Coalition, which invites member nations to set a goal of carbon neutrality by 2050 but does not require them to commit to it. Only five countries have committed to net zero emissions by 2050, including Australia and Singapore, which have yet to set a specific target. In addition to Ukraine and Kazakhstan, China, the world's greatest emitter, is aiming for 2060. China's recent vow is noteworthy, as the country is responsible for around 25% of global emissions. According to the Climate Action Tracker, net zero targets are currently covering 73% of global emissions. (NPUC, 2021).

National Mission for Green India (GIM)

The Green India Mission (GIM), also known as the National Mission for a Green India, established in February 2014 is one of the eight missions that make up the National Action Plan on Climate Change (NAPCC). It aims to maintain, restore, and enhance India's dwindling forest cover, as well as respond to climate change through adaptation and mitigation strategies. The Mission would work to improve carbon sinks in sustainably managed forests and other ecosystems, as well as fragile species and ecosystems' resilience to changing climates and forest-dependent communities' adaption.

Conclusion

Carbon neutrality in agriculture is achievable and should be a priority for India. The climate-friendly agricultural practices can significantly reduce greenhouse gas emissions from farming and livestock production. In addition, agriculture is unique among major sectors of the economy in possessing the potential not only to reduce emissions, but also to remove carbon from the atmosphere and sequester it in the soil. By both reducing emissions and increasing soil carbon sequestration agriculture can become carbon-neutral.

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Post harvest Physiological Deterioration in Cassava

An overview

Cassava *(Manihot esculenta Crantz)* is one of the major staple root crops feeding about 500 billion people across the globe. In Kerala, cassava is identified as a staple introduced at times of famine by the rulers for feeding the affected mass of the state. As an important raw material, cassava is extensively employed in starch and alcohol industries for producing starch, sago, glucose, dextrin, bio ethanol and other bio-based products (eg. feed, medicine, cosmetics and biopolymers). However, the tubers of the crop has a very short shelf life and, if unprocessed, the roots will get spoiled within 48 hours after harvest. The short shelf-life of cassava roots is primarily attributed to postharvest physiological deterioration (PPD), which is triggered as a wound response shortly after harvest, developing bluish-black discoloration of the parenchyma within 24-72 h after harvest. Postharvest physiological deterioration (PPD) is an endogenous and unique physiological disorder of cassava where bluish black discoloration (Fig.1) accompanied with foul odour and taste occurs in the tubers within 2 days of harvest, thereby making it highly unfit for consumption, processing and marketing causing severe economic loss up to 40% (Wheatley, 1982, Naziri et al., 2014).

Stages of deterioration

The discolouration of cassava roots occurs either due to primary or physiological deterioration or the secondary or microbial deterioration. The primary vascular streaking is a physiological phenomenon characterised by the development of bluish black discolouration whereas, secondary post-harvest deterioration also referred to as microbial deterioration (Fig.2) occurs due to wide range of pathogenic microorganisms (Sanchez et al., 2006; Garcia et al., 2013). The primary deterioration occurs within 2-3 days post harvest whereas microbial deterioration starts at 10 days after harvest when the tubers have already become unpalatable and unacceptable due to primary deterioration.

Why PPD matters?

The development of bluish-black discoloration necessitates that the tuber be consumed or processed within a short interval of time which in practical terms is difficult for marginal farmers and traders. PPD symptom development on cassava tubers drastically affects the continuous supply of raw materials to the industries for processing. In India, PPD has the prospects of turning into a serious threat because 60% of the cassava production in India is being

Fig.1 PPD symptom development in field grown

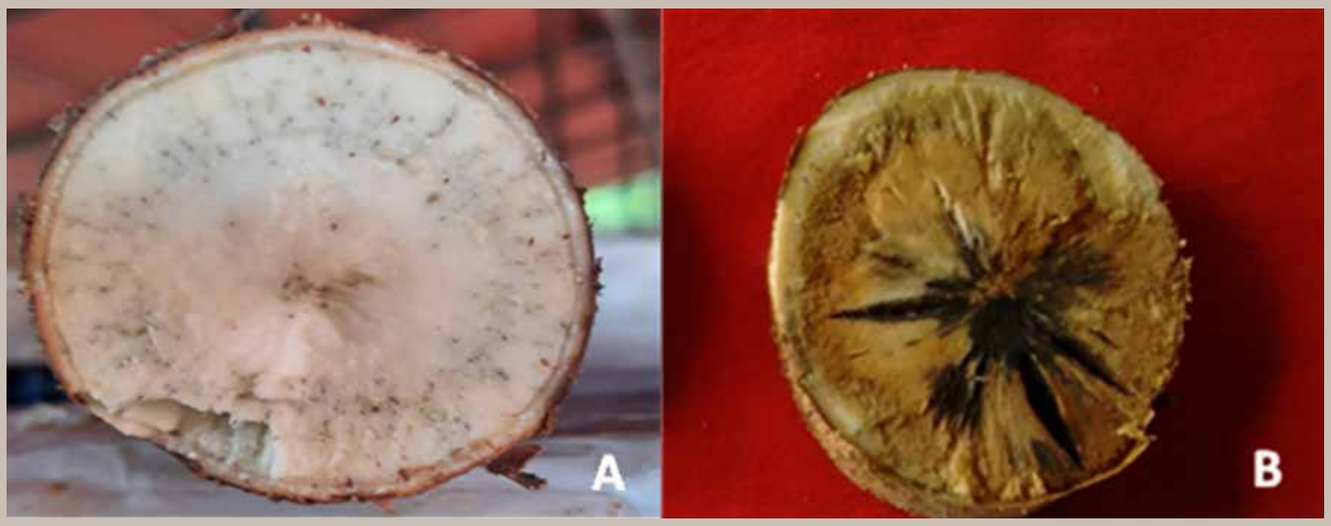

Fig.2 A. Primary or Physiological deterioration B. Secondary or Microbial deterioration

used for industrial purposes and remainder for consumption. There are around 400 sago-producing industrial units in Tamil Nadu alone, which depend solely on cassava tubers for the production of starch, sago and other products.

Factors influencing PPD

The factors influencing PPD initiation and development are mechanical damage during harvesting, genotype, environment, root shape, root length, presence of peduncles, peel adherence and texture, and soil compaction. PPD has positive correlation with root dry matter content and negative correlation with total carotenoid content.

Strategies to overcome PPD

The strategies proposed to overcome the loss due to PPD fall into two main categories namely pre- harvest and post-harvest strategies. Pre-harvest strategies include extended ground storage and pre harvest pruning. Post-harvest strategies include storage of harvested cassava roots, enzyme inactivation, chemical application, and avoidance strategies which can reduce losses due to wounding of the storage roots during harvest. Breeding and biotechnological interventions are also undertaken to overcome the loss due to PPD. Cassava varieties such as Sree Reksha and Kalpaka have high tolerance to PPD symptoms and is found to be free of symptoms until ten days after harvest.

Conclusion

Technically efficient and cost effective storage techniques to delay PPD symptom development must be developed. Breeding efforts to develop varieties tolerating PPD symptoms has the potential to manage the loss caused to cassava farmers and processors. Focussed research on the above aspects can increase the effective utilisation of the staple crop of the tropics - the Cassava.

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Abiu fruit

and its cultivation prospects in Kerala

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Abiu fruit scientifically called as Pouteriacaimito has recently taken the internet by storm, the fruit has been trending among the netizens and instagrammers and has created a huge curiosity among the public because of its unique appearance, enticing color, taste and smell. Commonly called as Luma in Spain and Abierio in Portugeese this fruit has an international market and is in demand as a flavoring ingredient of ice creams and sorbets. Normally the fruit is consumed fresh as it is rich in vitamin A, ascorbic acid, phosphorous and calcium but it can also be preserved, canned and made into syrups and spreads due to its delicate flesh and pleasing aroma. Abiu is a small to medium sized tree which can grow to over 30 feet in height but usually kept low to facilitate easy harvesting.The pyramidal or oval canopy, the willow like secondary branches which emerge from the main trunk along with the alternate oblong elliptical leaves and bright yellow colored fruits makes it valuable as an ornamental

fruiting tree while planning gardens and landscapes.

Origin

The fruit is said to have originated along the deltas of the great Amazon River and naturally found in the wild in Peru, Colombia, Ecuador and Brazil. The fruit is still considered to be an essential component of Native American home gardens and fruit orchards. Small, commercial orchards of Abiu are found in Peru, Ecuador, Venezuela and Australia.

Abiu belongs to the sapotaceae family and closely resembles sapota in flesh texture and seeds but has a very distinct taste compared to sapota fruit.

Though the tree crop is native to amazon regions of South America, the tropical conditions of Kerala, the acid to slightly alkaline soil conditions and rich organic matter available has been found to be highly suitable for large scale plantation and cultivation of the crop.Abiutrees have been found to be sensitive to frost and cold injury and should only be planted in warm, wind protected areas. Trees may grow very well in warm, humid conditions and can even grow in sub-tropical conditions if protected from winds. The Absence of natural pests and disease causing pathogens of the crop is another additional advantage while cultivating the crop under Kerala conditions. Considering the fact that there are no specific pollination requirements and pollinators any flying insect can act as a pollinator of the fruit. The tree is also highly recommended as an intercrop as it requires very little care as well as intercultural operations and is also a very attractive shade tree near lawns. The creamy white flesh is very delicate and lightly sweet and reminds one of the taste of caramel and vanilla. The very pleasant aroma when the fruit is ripe is also one of the reasons for its huge popularity among the curious consumers.

Cultivation

Abiu is commonly propagated by seed, seedling trees usually begin fruit production in 3-4 years after planting and once seeds are extracted from the fruit it remains viable only for a couple of days and should therefor be planted as soon as possible. Proper planting is one of the most important steps in successfully establishing and

growing strong, productive trees; trees are planted at a spacing of at least 7.6 m (25 feet) from nearby tree. Seedling trees come into production in 2-5 years. Abiu may also be grafted or budded onto seedling rootstocks and an early fruiting can be achieved within 1-2 years.

Newly planted Abiu trees should be watered at planting and every other day for the first month or so then 1-2 times a week for the next couple of months.

The period from full bloom to fruit development has been identified as the critical period of water requirement for enhanced yield. Young Abiu trees are trained to form 3-5 main limbs during the first 2-3 years and mature trees are maintained at 8-12 feet by annual selective removal of unwanted poor yielding branches. Mulching is another important operation performed to retain soil moisture, reduce weeds and to improve the soil near the surface.

Harvest

As the fruit matures the color changes from green to light green and then into bright or pale yellow, then it is ready to be picked but fruits with dark golden color are considered over ripe. Fruits picked before full maturity contains a large amount of sticky, white latex, making consumption unpleasant. As the fruit matures the latex disappears from the pulp and remains only in the peel and the translucent flesh becomes jelly like with a pleasant caramel flavored pulp.

Some mature seedlings may produce little fruit; others can yield up to 182 kg of annually.Abiu fruits should be protected from bruising at harvest by placing them directly into padded boxes.

Fruits which are of a cricket ball size are sold to wholesalers at 200-250 rupees for half kg of fruit weight.

Being a highly profitable, highly adaptable and low labor intensive crop, Abiu is highly suited for cultivation in Keral. The lack of popularity of the fruit in local markets and among consumers is attributed predominantly because, it is only recently introduced into Indian markets and propagation materials are not easily available for large scale cultivation. Abiu has a lot of potential to become a staple fruit in most Keralian dinner spreads and to be an intrinsic part while laying out home gardens and orchards in the very near future.

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Rutabaga

THE ROOT OF GOLD

Introduction

Rutabaga (*Brassica napus var. napobrassica*) is a biennial crop in the Cruciferae family that evolved from a hybrid between turnip (*Brassica rapa*) and cabbage (*Brassica napus var. napobrassica*) (*Brassica oleracea*). Because of its slow development, it is a cold season crop that needs a lengthy growing season. It is extensively cultivated all over the globe and is particularly popular in European cuisines like France, Germany, Italy and Switzerland, as well as in the America. It is planted for its fleshy roots, which are cooked and eaten as a vegetable, as well as its young leaves and root tips, which are used for animal feed immediately in winter or foraged in the field for the next season. Despite the quantity of

Laurentian

American Purple Top

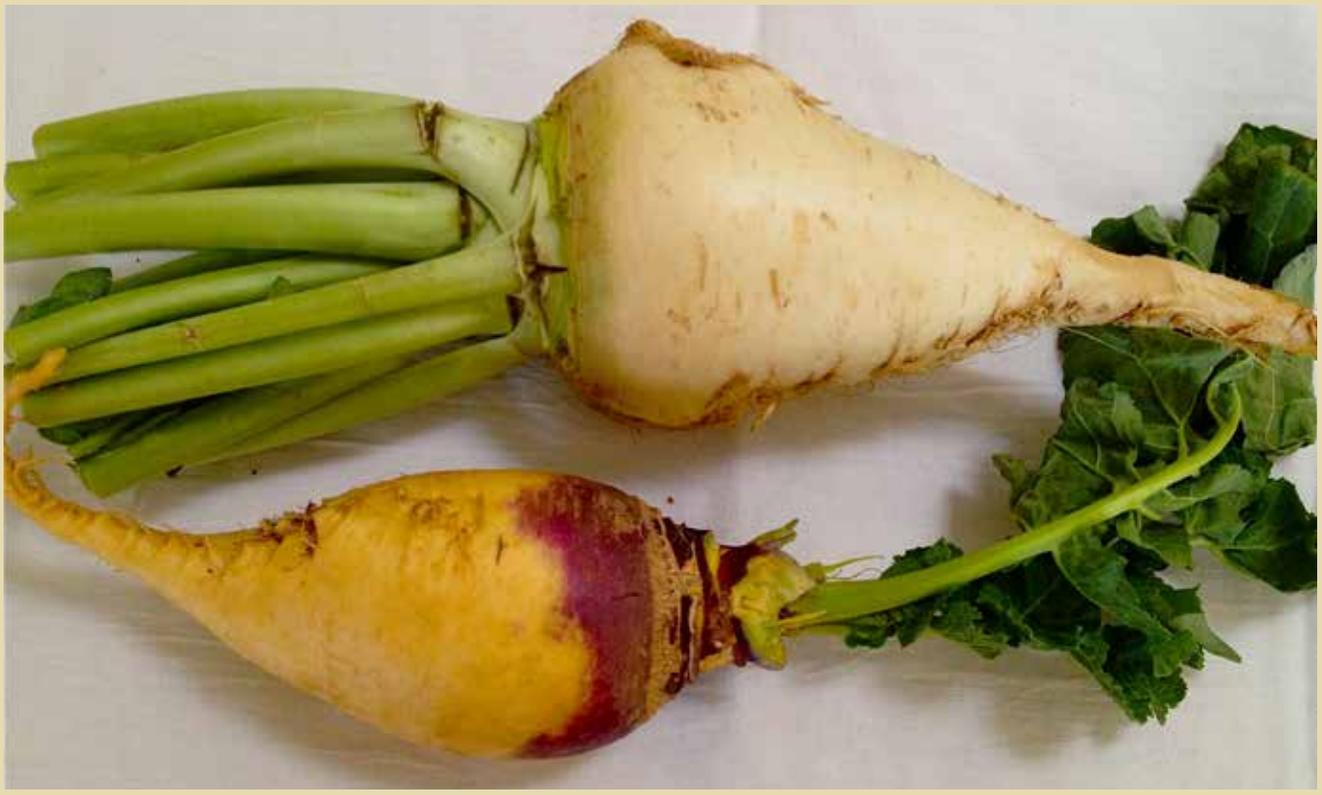
Burpee's Purple Top

Joan

Doon Major

Macomber

vitamins, minerals, phytochemicals, dietary fibres and antioxidants found in this crop, its potential as a vegetable for nutritional security and upliftment remains vastly untapped. Rutabaga is known by a number of regional and colloquial names across the globe, including 'Swedish Turnip' or 'Neep' in Scotland, 'Rweden' in Welsh, 'Yellow Turnip' or 'Wax Turnip' in the United States, and 'Snaggers' and 'Snarkies' in England. However, in 1799, the name "Rutabaga" was taken from the Swedish dialect "Rotabagge," where "Rota" (from wrad= branch/root) & bagge meaning bag, owing to the usual form of the roots/ saggy roots. It is also known as "ram Root" since it is often used as a superb fodder crop for livestock (sheep) as well as providing rich nutrition. However, turnips and rutabagas are not the same; rutabagas have smooth, glaucous, non-hairy, blue leaves and denser roots that are elongated or rounded, while turnips (2n=2X=20) have flattened roots and greenish leaves with pubescence. Rutabagas are cultivated in colder temperatures, but turnips may be produced in a variety of climates. It is a dicot, herbaceous biennial plant for seed production and an annual plant for root production with swollen roots that are yellowish, white, or purple with ridges and leaf scars at the base and may be round, oval, cylindrical, conical, or globular in form. Leaves are greenish to blue, slow spreading, alternating with slightly to deeply serrated edges, occasionally with dents, non-pubescent, glaucous, and waxy, and form a rosette in clusters rising from a crown. The short stem from which the leaves emerge develops into a seed stalk 90-150 cm in length after the second year, indicating the transition from the juvenile to the reproductive phase. Depending on the colour of the roots, the flowers vary from brilliant yellow to white or orange. Sepals and petals are arranged in groups of four in the form of a cross. The inflorescence is a terminal raceme with strongly cross-pollinated flowers that are entomophilous owing to self-incompatibility. Stamens are tetradynamous, meaning that four are long and two are short. The fruit is a siliqua, bicarpellary pod with tiny, globular, blackish seeds. For the emergence of flowering stalks, plants must be exposed to temperatures below 5 degrees Celsius for 10 weeks.



Gil feather

Origin and Distribution

The most widely accepted theory about the origin of this crop is that it is an interspecific hybrid between turnip and cabbage that was created in the 17th century in Switzerland or Bohemia. The precise moment of occurrence of this species is uncertain, however it is thought to have first appeared in Europe around the end of the Middle Ages. It was initially brought to England from Germany and Sweden at the end of the 18th century and was afterwards grown in the royal gardens under the name turnip rooted cabbage. For more than 300 years, the European population had access to both white and yellow fleshed types. The rutabaga was first documented by Swiss botanist Gaspard Bauhin in his book Prodromus (1620), in which he recorded several wild species from Sweden. Due to the prevailing favourable weather conditions, cultivation is mostly limited to Northern Europe, where it is a staple vegetable, although it is produced as a secondary crop in Asia, North and South America. During World War I (1920s) and World War II (1940s), rutabaga played a critical role in assisting the populace and masses of the afflicted countries to battle food shortages. As a result, it was dubbed "Food of Last Resort" in Germany.

Related Species

Rutabaga has a complicated taxonomy. It is closely connected to Cole crops, according to Woo Jang chon (1935), and he showed it in the Brassica u Triangle. Carolus Linneaus published Brassica napobrassica as a variation of Brassica oleracea in his book Species Plantarum in 1753. Since then, it has been recognised as Brassica oleracea var. napobrassica. In 1768, a Scottish botanist changed Linneaus' classification to Brassica napobrassica and included it in the Gardeners Dictionary. This naming scheme is now recognised around the globe.

Economic Importance

Rutabagas may be quite lucrative and productive to farmers if they are properly farmed and sold in the market. If taken before heading, it may be used as high-quality feed. Because the leaves and stem are high in crude protein (20-25%), they are utilised as cattle feed. During Halloween, lights made of roots are sold on the market in England, Wales, and other European countries and command extremely high prices. Leaves may also be utilised as green manure. Every year, a local farmer's market in New York celebrates "Rutabaga Festival." Rutabaga may be found in salads, purees, curries, roasted, boiled, and as a side dish with potatoes and sweet potatoes. During the Christmas season, traditional meals containing rutabaga are cooked in European nations such as Sweden and Norway. Rutabaga roots may be cooked, roasted, mashed, baked, or eaten raw; however, the nutritional

content of this vegetable is unclear.

Nutritional Value & Therapeutic Uses

Rutabagas, like many other vegetables, are high in important nutrients and may be used to treat malnutrition. It contains around 143 Kcal of calories, 4g of protein, 0.6% fat, 35g of carbs, 10% fibre, 170mg of calcium, 1.7 g of iron, 1177 mg of potassium, 46 mg of sodium, 97 mg of vitamin C, 80 µg of vitamin B, 9 IU of vitamin A, and 1.2 µg of vitamin K. According to the facts presented above, rutabagas are new foods rich in bioactive and phytochemical substances. It is rich in vitamins, antioxidants, and phytonutrients. They are high in fibre and roughage, which aids digestion and regulates bowel motions. It also reduces constipation and keeps the GI tract healthy by avoiding colon cancer. They have extremely few calories and nearly no fat or trans fat. As a consequence, they aid in the reduction of dangerous cholesterol (LDLP) and the elevation of good cholesterol (HDLP). It is also regarded as an anti-diabetic meal and a hypoglycemic agent since it regulates the body's insulin levels. Furthermore, they regulate normal liver and bile action by modulating enzyme production. They manage blood pressure, enhance skin and eyes via collagen synthesis, and maintain optimal concentrations of thyroxine hormones secreted from the thyroid gland, minimising the danger of goitre. It is also anti-allergenic and anti-hypertensive.

They are also high in calcium, manganese, magnesium, iron, and selenium, as well as vitamins A, B complex, C, D, E, and K. It protects against anaemia, osteoporosis, arthritis, gout, and other degenerative disorders associated with ageing. The fleshy leaves are high in antioxidants, including alpha lipoic acid, which helps to reduce oxidative stress, free radical generation, and consequent cell damage, as well as ageing, stroke, glaucoma, sclerosis, migraine, and other neurological diseases. It is also advised to pregnant women to avoid the foetal neutral tube effect, to lessen labour discomfort, and, lastly, to have a safe birth. Rutabaga secretes isothiocyanates and indoles, which have been related to a decreased risk of colon cancer due to their high levels of glucosinolate compounds. Choline, a chemical bioactive molecule, aids in the improvement of sleep, mood, and memory. It is also anti-inflammatory and anti-depressant.

Production Technology

The plants are cold-hardy, growing best at temperatures of 15-20 degrees Celsius during the day and 5-7 degrees at night, and becoming edible after 2-3 months of sowing. In European nations, the optimal season to plant is early summer (June-July). Plants can endure cold and dry spells, but over fertiliser and watering induce root breaking.

They are biennial plants, with vegetative development occurring in the first year and blooming occurring in the second year after a cooling treatment or vernalization. Except for extremely heavy soils, they may be grown in practically every kind of soil, from sandy loam to clay, with correct drainage and fertiliser. This crop is typically sold from mid-June to September and picked before the roots grow excessively starchy, pithy, or overmatured.

Cultivated Varieties

American Purple Top, Joan, Gil feather, Laurentian, Burpee's Purple Top, Thompson Laurentian, York, Doon Major, Marian, Mary, and Macomber are some well-known kinds grown over the globe. Heirloom types with yellow, pink, and purple flesh that mature in 70-90 days are in great demand. Unfortunately, for breeding purposes, there is relatively little genetic diversity in rutabaga populations, and no natural variants are known. So yet, no dominant breeding programmes on this crop have been attempted. Minor breeding for the creation of innovative characteristics, huge trends, and illness pest resistance, on the other hand, had been undertaken.

Prospects in India & Future Thrust

Rutabaga is an exotic crop that is little recognised and farmed in India. Production programmes, however, may be launched in temperate zones with its near cousin turnip to improve the nutritional security of the people. Rutabaga is an under appreciated vegetable that is high in nutritional content and has health-promoting characteristics. Its capacity to thrive in harsh climates may also benefit producers, consumers, and conservationists. In this context, there is an urgent need to popularise this crop at the national level by ensuring adequate supply of quality planting materials, raising awareness about production, cultivation practises, and post-harvest management, as well as genetic resource exploration and management to ensure food and nutritional security and job creation in the near future.

Coleus

A high value medicinal crop

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Introduction:

Coleus forskholii Briq. *[Syn. Coeleus barbatus (Andr.) Benth]* belonging to the family Lamiaceae is indigenous to India. It is the only source of forskolin (syn. Coleonol) and one of the most potential medicinal crops of the future, as its pharmacopieal properties have been discovered recently. It is said that all plant parts of Indian herb *C. forskohlii* almost have traces of forskolin,

Taxonomical Hierarchy	
Kingdom	: Plantae
Divison	: Magnolophyta
Class	: Magnoliopsida
Order	: Lamiales
Family	: Lamiaceae
Genus	: Coleus
Species	: Forskohlii

Vernacular names	
Sanskrit	: Makandi, Pashanbhed, Mayani
Kannada	: Makandiberu
English	: Coleus
Hindi	: Patharchur
Bengali	: Paterchur
Gujarati	: Garmalu
Marathi	: Maimnul

the roots are the main source possessing 0.1 to 0.5 per cent and preferred for its extraction.

Forskolin is used for the treatment of eczema, asthma, psoriasis, cardiovascular disorders and hypertension, where decreased intracellular cyclic AMP (cAMP) level is believed to be a major factor in the development of the disease process. The major action of forskolin is to rapidly activate a cellular enzyme called adenylyl cyclase. This enzyme is responsible for the synthesis of cyclic AMP. In addition, it has been shown to have anti-inflammatory property.

Distribution:

The crop has been distributed all over the tropical and subtropical region of India, Pakistan, Sri Lanka, tropical East Africa, Brazil, Egypt, Arabia and Ethiopia. In India, it is found in the subtropical Himalayan regions from Kumaon to Nepal, Bihar and the Deccan plateau of Southern India. It is cultivated in parts of Rajasthan, Maharashtra, Karnataka and Tamil Nadu in an area of about 2500 hectares.

Botanical description:

Coleus barbatus (2n=30) is an aromatic perennial plant 0.5 m tall with thick tubers and with very showy bluish to pale lavender type flowers arranged in whorls on long spike like racemes. The entire plant is aromatic (whether fresh or dried). The leaves and tubers have quite different odours, the latter being raminiscent of but quite different from, ginger.

Leaves: Leaves are 3-5 inches in length and 1.2-2 inches in width, usually pubescent, narrowed into petiole.

Stem: Members of the genus Coleus, have square stems branched, where nodes are often hairy. Nodes are hairy in nature.

Flowers: Inflorescence is of raceme type, 6-11.8 inches in length; flowers of the plant are stout, having size of 2-2.5 cm, generally perfect and the calyx hairy inside. The pale blue corolla is bilabiate, lower lobes of the calyx are elongated and have concave shape to enclose essential organs of the plants, while the upper lobe of the calyx is oval in shape. The ovary of the

Botany of coleus plant

plant has four parts, and the stigma is two lobed. Crosspollination occurs with the help of insects or wind. But, nipping off flowers during the growing period is an important cultural practice in coleus in order to obtain more biomass of roots.

Fruits: Fertile flowers are followed by dry, one-seeded, globose, slightly flattened laterally nutlets that are 1.4 mm long and 1.4 mm wide, included in persistent calyx. They are shiny, dark brown colored.

Roots: Roots are tuberous, fasiculated, upto 20 cm long and 0.5-2.5 cm thick, conical fusiform, straight, orangish and strongly aromatic.. Root morphology differs with populations as they may be fibrous, tuberous, nontuberous, or semituberous in nature. Forskolin contents in roots within a population and between populations vary from 0.07% to 0.58% (Lakshmanan et al., 2013).

Verities:

1. CO-1: This variety was released by Tamil Nadu Agricultural University through clonal selection from Periyakulam local, yields 2.5 t /ha dry tuber with 0.40 per cent forskohlin. This variety moderately tolerant to root rot and wilt diseases and tolerant to nematode and mealy bug infestation under field conditions. Except Nilgiris, this variety is cultivating in all parts of Tamil Nadu




Tuberous roots of coleus

especifically suited to Salem, Erode, Namakkal, Coimbatore, Dindigul, Theni, Thiruvannamalai and Vellore districts.

2. K-8: This variety was released from IIHR, Bangalore through clonal selection from Karnataka local. It give 0.5% of forskolin and a higher tuber yield.

3. Aisiri (Mutant-7): This variety was released from University of Agricultural Science, Bangalore through mutation breeding of K-8.

It is a higher tuber and forskolin yielding variety mature in 180- 200 days and give a dry tuber yield of 7000 – 7500 kg/ha with a forskolin content of 0.76%.

4. Manganiperu: It is cultivated in and around Belgaum districts of Karnataka. The tubers are big, 30 cm length. It is also commercially cultivated in Tamil Nadu.

5. Garmai and Maimul: It is cultivated in Gujarat state. The tubers are in medium size.

Ethnnopharmacology

Traditionally, the roots have been used as condiments in pickles and also root juice is given to children suffering from constipation. Kothas, the native tribes of Trichigadi (Kota) in Nilgiri, South India consider the decoction of tuberous roots as tonic for relief of cough and used to cure eczema, skin infections, tumors and boils were also reported. In Ayurvedic system of medicine, Coleus forskohlii has been used to treat hypertension, congestive heart failure, eczema, colic, respiratory disorders, painful urination, insomnia, and convulsions, asthma, bronchitis, intestinal disorders, burning sensation, constipation, epilepsy and angina. Clinical studies of the plant and the forskolin constituent support these traditional uses.

Health benefits of Coleus Forskohli

Listed below are some of the well-known health benefits of using Coleus forskohlii

1. Circulatory remedy

Forskolin is an important heart and circulatory tonic used to treat congestive heart failure and poor coronary blood flow. It also improves circulation of blood to the brain.

2. Respiratory problems

Its antispasmodic action makes coleus valuable for respiratory complaints, including asthma and bronchitis.

3. Cures Glaucoma

Glaucoma is characterized by elevated intraocular pressure (IOP). It is a condition in which the pressure in the eye is too high, due to an imbalance between the formation of aqueous humor in the eye and its absorption in or drainage out of the eye. Eventually, as the pressure builds up, the blood vessels nourishing the optic nerve are constricted, resulting in irreversible damage to the nerve and impaired vision culminating in blindness, if left untreated. Several animal and human research have demonstrated the ability of forskolin to lower IOP, possibly via cAMP activation and a reduction in aqueous flow.

4. Anti-Hypertensive Benefit

Forskolin has a capability to lower blood pressure (anti-hypertensive property). With dilated blood vessels the heart works less to pump blood throughout the body. Coleus can provide health benefit for patients suffering from cardiomyopathy.

5. Beneficial for Hypo-thyrodism

Forskolin found in coleus has been found to regulate various enzymes and hormones in human body. It may be used to control and cure thyroid gland malfunctioning, particularly when the gland is under functioning (hypothyroidism).

6. Promote weight-loss

Active chemical found in Coleus herb is forskolin which has been found to promote weight loss in patients who are considered obese. Research has shown that forskolin in coleus can boost the production of enzyme called adenylate cyclase and as a result boost another enzyme called cAMP. This dropping reaction of enzymes forces the fat cells to burn and release their stored energy.

7. Asthma and Allergic Reactions

By stabilizing body cells responsible for the release of histamines, which trigger allergies, and relaxing smooth tissues of the muscle, Coleus Forskohlii is important in the treatment of allergic respiratory conditions such as asthma.

8. Boosting Sexual Libido

Coleus Forskohlii is among the various nutritional supplements recommended for boosting the male hormone testosterone, responsible for sexual vigor. Additionally, by strengthening the heartbeat while lowering blood pressure, sexual performance has been shown to improve using extracts from the herb.

9. Treatment of Psoriasis

Psoriasis is a skin condition characterized by dry, rough, dead skin on the scalp, knees, groin or lower back. The exact cause is not exactly known but scientists suspect a weak immune system could be among the causes. Because of its ability to boost the body's immune system, Coleus Forskohlii is among the various remedies prescribed for the skin condition.

10. Relief from Irritable Bowel Syndrome (IBS)

It is a disorder of the intestines with symptoms such as irregular bowel movements, abdominal pains, cramps and bloating. Coleus Forskohlii offer relief against this condition by acting on the inflammation of the intestines which aids in the process of digestion thus providing relief against IBS.

11. Boosting Metabolism

It is closely related to providing relief against IBS, Coleus Forskohlii aids in the digestive process by boosting the production of stomach acids thus aiding in digestion thus improving our metabolism.

Perfumery uses:

Over forty compounds belonging to four different classes of aroma compounds have been isolated from oils obtained from different indigenous genotypes of C. forskohlii. These include monoterpenoids, diterpenoids, sesquiterpenes and sesquiterpenes alcohol. The presence of compounds like 3- decanone, bornyl acetate and g-eudesmol were identified in experimental studies.

Capsule form

Scientific Cultivation of coleus Soil

It thrives better in porous and well-drained soils with a pH ranging from 5.5 to 7. It does not require very fertile soils and can economically be grown on soil with marginal fertility. The red sandy are ideal for the cultivation of this crop.

Climate

Coleus is a crop of the tropics and is found growing well on the barren hills at an altitude of about 2400 m under tropical and sub-tropical conditions. In India, it is grown mainly in Belgaum (Sahaydri mountain range of Karnataka) and in Gujarat. It prefers humid climate with a RH ranging from 60 to 85 per cent and a temperature range between 10-25^{0}C for its successful growth. The annual rainfall in such areas ranges from 100 to 160 cm, mainly during June to September months. It is also found to perform well in less humid and warmer regions of South India like Coimbatore where it is grown as an irrigated crop.

Propagation

Coleus can be propagated by seeds as well as by stem cutting. However propagation through seeds it little difficult and slow and should be used only for the breeding of new varieties. Where, propagation by cutting is very easy and economical to raise this crop on large scale.

Nursery raising

The viability of seeds being very poor (8-10%), sufficient quantity of fresh seeds has to be sown in well prepared nursery beds to obtain good germination. Regular care about watering, weeding and plant protection of the nursery is taken. In about 15 to 20 days the germination is completed. When the seedlings are 45 days old and have attained about 8-10 cm height they are ready for transplanting.

Vegetative propagation

Vegetatively, the crop is propagated through terminal cuttings. Normally, 10-12 cm long cuttings comprising 3-4 pairs of leaves are preferred. These cuttings are planted in well prepared nursery beds and regular care about shading and watering is taken. The cuttings establish well in the nurseries and there is no problem in their rooting. After about

Powder form

a month's time when the cuttings have produced sufficient roots, they are transplanted in the main field.

Micro propagation

In vitro propagation is useful for mass multiplication and germplasm conservation of any plant species. C. forskohlii being succulent in nature responds well to in vitro propagation and various explants viz., nodal segments, shoot tip, leaf etc., are effectively used. Sharma et al. (1991) reported that nodal segments as explants on MS medium supplemented with Kinetin (2.0 mg/l) and IAA (1.0 mg/l) are rooted well and their plantlets were established successfully under field conditions. Shoot tip explants from 30 days old aseptically germinated seedlings are also used for multiplication using 2 mg/l of 6-benzylaminopurine (Sharma et al., 1991). Reddy et al. (2001) developed a plant establishment protocol from leaf derived callus and found that the in vitro raised plants produce comparable quantity of forskolin with that of wild plants. Complete plantlets of C. forskohlii were developed within 35-40 days by culturing shoot tip explants in MS medium containing 0.57 M IAA and 0.46 M kinetin through direct multiplication at the rate of 12.5 shoots per explant (Rajasri and Sabita, 2001).

Planting:

In most of the areas, Coleus forskohlii is planted during June-July, when the south-west monsoon sets in. Soon after the monsoon showers the field is ploughed deep and brought to a fine filth. Farmyard manure (8 t/acre) should be applied evenly in the field. The field is further prepared into ridges and furrows at a spacing of 60 cm. The rooted cuttings are planted 20 cm apart in a row. About 28,000 rooted cuttings are required for planting in acre.

Manures and fertilizers:

The crop responds well to organic and inorganic fertilizers. Studies conducted at TNAU, Coimbatore to standardize the nutritional requirement of this crop have shown that application of FYM 20-25 t/ha along with the combination of 40 kg N, 60 kg P_2O_5 and 50 kg K_2O/ha was found to be optimum for obtaining maximum fresh (120 t/ha) and dry (3.982 t/ha) tuber yield from this crop. Half of N, whole P and whole K may be applied as basal dose followed by the remaining half N, 30 days after planting, as top dressing.

Irrigation:

The first irrigation is given immediately after transplanting if there are no rains. During the first two weeks after planting, the crop is irrigated once in three days and thereafter weekly irrigation is enough to obtain good growth and yield.

Weeding:

Due to the frequent irrigations during the initial stages, there is lot of competition from the weeds. In order to obtain economic yields frequent weeding during the early growth period is desirable.

Pests and Diseases

Pests:

Leaf eating caterpillars, mealy bug and root-knot nematodes are the important pests of this crop. The insects can be controlled by spraying the plants and drenching their roots with 0.1 per cent methyl parathion. While, nematodes can be controlled by application of carbofuran granules at the rate of 20 kg per hectare, or soak 85 g

Liquid form (Tonic)

of pices of Garlic in 50 ml of Neem oil (lift for overnight), add 450 ml of water and then dilute the same in 20 liters of water and spray.

Diseases

Among the diseases, bacterial wilt is the major. The spread of wilt can be controlled by spraying and drenching the soil adjoining the affected plants with 0.2 per cent captan solution immediately after the appearance of the disease and later at a weeks interval, or Application of 5 per cent Tricoderma viride through compost to the nursery and also in the field to the individual plants around the root zone along with vermicompost / well rotton farm yard manure.

Harvesting and yield

The crop is ready for harvest four and half to five months after planting. The plants are loosened, uprooted, tubers separated, cleaned and sun-dried for the extraction of `forskolin'. On an average, a yield of 800 to 1000 kg/ha of dry tubers may be obtained. However, if proper cultivation practices are applied, a yield up to 2000 to 2200 kg/ha of dry tubers can be easily obtained.

Post-Harvest and Processing:

The fresh root tubers just after harvesting contain 75%-85% moisture level, which goes down to >12% due to drying. Root tubers can be dried by two methods: sun drying and mechanical drying. Sun drying requires more time to dry root tubers than that of the mechanical drying. Mechanical drying requires a temperature of 40 ^{0}C to dry root tubers. After drying, root tubers having a slice thickness of 0.5 cm are packed in bag that is lined with polyethylene. Dried coleus tuber packed in polyethylene lined gunny bag to retain the highest amount of essential oil, starch and forskolin.

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AEROPONICS
PROMISING SOILLESS FARMING

One of the greatest challenges of today is to end hunger and poverty while making agriculture and food systems sustainable. Agriculture is in a phase of major change around the world and dealing with serious problems. The world food production is rising faster than population and per capita consumption increase. In the future, it would be a difficult task to provide fresh

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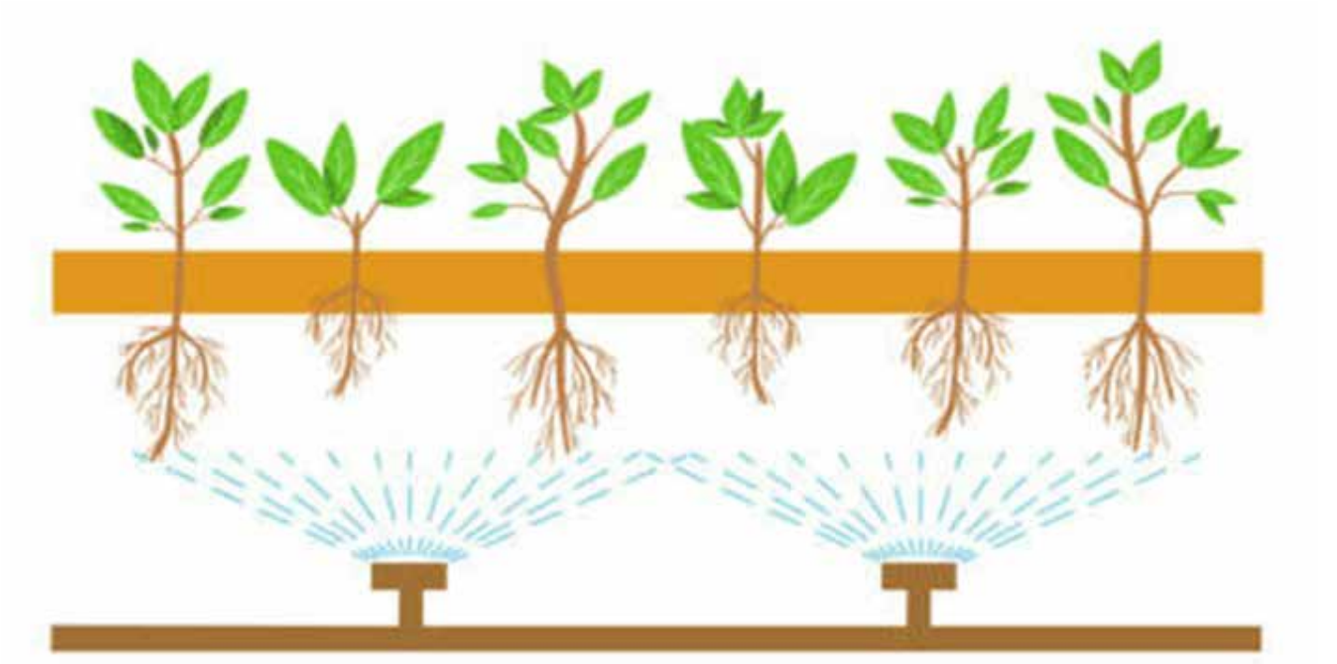


Aeroponic

and clean food supply for the fast-growing population using traditional agriculture. Under such circumstances, soil-less cultivation is the alternative technology to adapt effectively. Aeroponic farming is a form of hydroponic technique and a type of vertical farming. Aeroponics is a promising soilless farming method for solving future food crisis and is relatively a new way of growing plants that is getting increasingly popular with many people because of the speed, cost and novelty. Aeroponics is the process of growing plants in an air or mist environment without the use of soil or an aggregate medium. The word "aeroponic" is derived from the Greek meanings of aer ("air") and ponos ("labour"). Aeroponic culture differs from both conventional hydroponics, aquaponics, and in-vitro (plant tissue culture) growing. Unlike hydroponics, which uses a liquid nutrient solution as a growing medium and essential minerals to sustain plant growth, or aquaponics, which uses water and fish waste, aeroponics is conducted without a growing medium. It is sometimes considered a type of hydroponics, since water is used in aeroponics to transmit nutrients.

Method

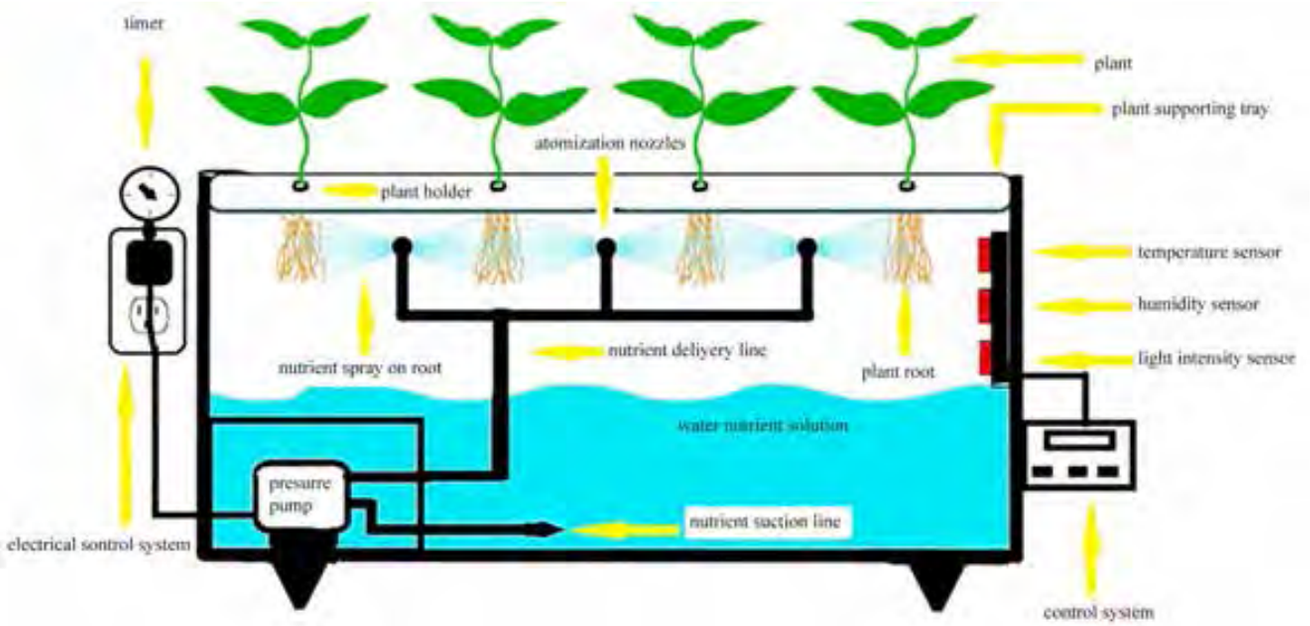
It is a variation of hydroponics were both growing medium and flowing water are absent.The roots of the plants, in this method, are sprayed with water and nutrient solution.This technique enables farmers to control humidity, temperature, pH levels and water conductivity inside a greenhouse.

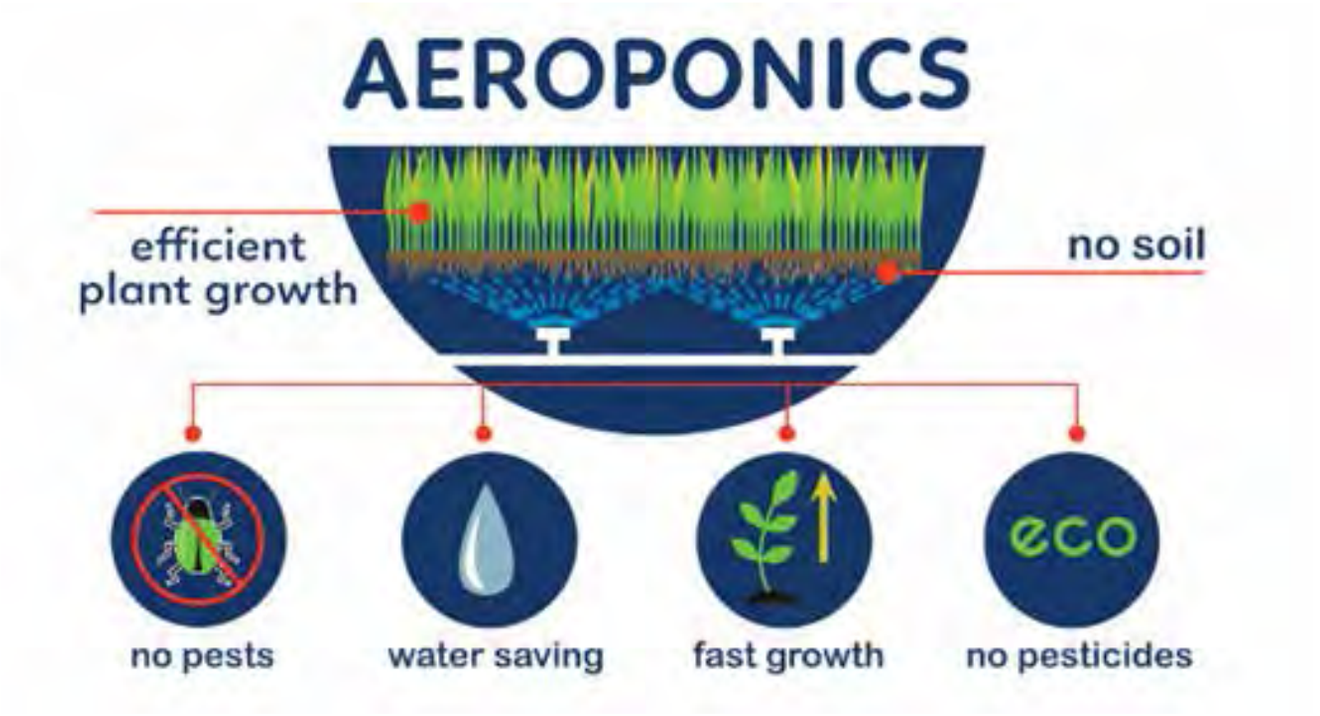
In aeroponic system the young plants can be either raised as seedlings using especially designed lattice pots or cuttings can be placed directly into the aeroponic system for rapid root formation. Lattice pots allow the root system to develop down into the aeroponic chamber or channel where it is regularly misted with nutrient. There is a high success rate with plant cuttings which are rooted in aeroponics - in fact this method has been extensively used as a research tool into root development on many difficult to propagate plant species.

The base of the cutting is supplied with high levels of oxygen and moisture in a humid environment which prevents desiccation and accelerates root formation. Once the young plant has been established into the aeroponics system, the root system rapidly develops in the chamber or channel. Important at this stage is that the optimum

size of the droplets is maintained within the system for maximum efficiency. There is a huge range of aeroponic nozzles so selection of a droplet size range which best suits the plant and system used is fairly easy.

Spray droplets less than 30 microns tend to remain in the air as a 'fog' and are not readily absorbed by the roots. The ideal droplet size range for most plant species is 20 - 100 microns. Within this range the smaller droplets saturate the air, maintaining humidity levels within the growth chamber, the larger droplets 30 - 100 microns make the most contact with the roots, while any droplets over 100 microns tend to fall out of





the air before containing any roots.

The principles of aeroponics are based on the possibility of cultivating crops whose roots are not inserted in a substratum or soil, hanging in a containers filled with flowing plant nutrition. In these containers root can be find the best condition regarding the best oxygenation and moisture. These conditions allow for better plant nutrition assimilation in a more balanced way, with consequential faster development of the cultivated plant. Plant nutrition is supplied into a closed circuit. Consumption is consequently limited to only the quantities absorbed by the plants, allowing water saving.

Strategic benefits

Round the year cultivation

- Fast plant growth and yield
- Easy system maintenance
- Less need for nutrients and water
- Requires little space and high yield
- Great educational value
- Proper root growth
- No transplantation shock
- Easier fruit harvest
- Disease free produce
- Prevention from Climatic Impacts

Drawbacks

- Need to provide nutrients as with hydroponics
- Requires electricity for small pumps and timers
- As with hydroponics, there is need for some form of competency to run system
- Maintenance of an aeroponics farm is very expensive
- In the beginning there is need to monitor water
- Root crops and trees are much more difficult to grow.
- More expensive for long scale production
- Ordinary farmers will struggle to manage all these sophisticated instruments.

Soilless culture is considerd as a new developed technique for agriculture development but it is not simple technique. The growers can adopt the soilless systems according to their needs, the place of the system and according to their potential cash. The system in any case need to take strong care and observation for the parameters needed for good growth of the plants such as nutrient concentrations, light, oxygen around the plants root zone, water quality, pH, disinfection, temperature of the solution and more. Aeroponics helps conserve water, land and nutrients, so aeroponics system is the way of the future, making cultivation of crops easier.

Caulerpa spp

Halimeda spp

SEAWEED EXTRACT

A NATURAL BOON FOR FRUIT CROP PRODUCTION

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Valonia spp

Seaweed extract is a formulated product of plant bio-stimulants which is able to stimulate plant growth and development when applied in minute quantity. They are macroscopic, multicellular and macroalgae which forms an integral part of marine coastal eco-system. Most seaweeds are considered as "plants" or plant-like. It is a good source of auxin, gibberellins, cytokinins, micronutrients, vitamins and amino acids (Lordan et al., 2011). Application of seaweed extracts enhances the crop growth, yield, improves plant tolerance towards abiotic and/or biotic stresses, better interactions between root and beneficial microbes, quality bio-fortification and soil fertility improvement.

Morphological structure of seaweed extract

It is a large, All multicellular and eukaryotic algae, it varies in structure, types of pigments and stored food products, it lacks highly specialized structures and reproductive mechanisms like terrestrial plants which also varies in shapes and sizes.

- **Thallus:** The complete body of seaweed which lack true roots, stems, and leaves
- **Blades:** The leaf-like, flattened portions of the thallus of seaweeds have a large surface area as a main photosynthetic region but not true

Enteromorpha spp

Sea Lettuce

Ulva intestinalis

leaves and veins. The upper and lower surfaces of blades are identical to each other.

- **Pneumatocysts:** Gas-filled bladders that sometimes keep the blades close to the sea surface for maximizing the exposure of blades to the sunlight. The major gas include carbon monoxide
- **Stipe:** The stem-like support structure of seaweeds from which the blade originates which are long and hard
- **Holdfast:** The root-like structure in seaweeds which attaches the thallus to the bottom that are not involved in significant water or nutrient absorption
- The stipe and holdfast usually lack tissues specialized for water and nutrient transport

Types of seaweed extract

There are more than 10,000 species of seaweeds which are broadly classified into three main groups based on their pigmentation viz., Green seaweed extract (chlorophyta), Brown seaweed extract (phaeophyta) and Red seaweed extract (rhodophyta) (Sangha et al., 2014).

1.Green seaweed extract

Most green seaweed live in freshwater and terrestrial environments from the group in which embryophytes (higher plants) emerged. It constitutes about only 10% of the marine ecosystem. Most of them have a simple thallus, chlorophyll pigments and food reserves are same as terrestrial plants. Chlorophyll is not usually masked and thallus is usually a bright green color which may be branched or unbranched.

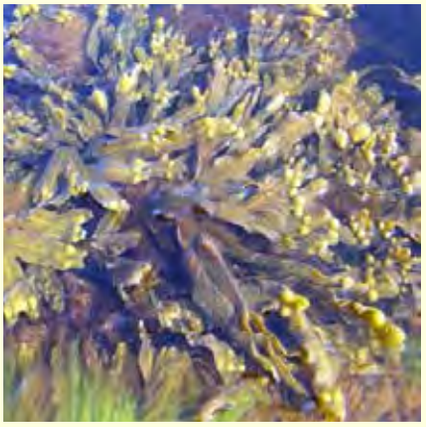
2. Brown seaweed extract

Among all seaweed, brown seaweed extract is abundant upto 80 per cent and commonly used in agriculture. Colour varies from olive green to dark brown, due to yellow-brown pigments over chlorophyll particularly fucoxanthin (Abubakar et al., 2013). Include largest and most complex seaweeds belong to the group Heterokontophyta, a eukaryotic group distinguished by chloroplasts surrounded by four membranes which play an important role in food supplies and environment development.

3. Red seaweed extract

More species of red seaweed extract as red pigments called phycobillins and mask chlorophyll. Very few of the 4,000 species live in freshwater or soil and inhabit most shallow- water marine environments (Lobo et al., 2019). They are harvested for food and for the extraction of various products. Most of

Kelps spp



Fucus spp

Ascophyllum spp

Sargassum spp

Laminaria spp

Ecklonia spp

Coralline spp

Palmaria spp

Chondrus spp

Physiological effects elicited by seaweed extracts and possible mechanisms of bioactivity in fruit crops

Treatment	Effects	Possible mechanisms
Arial application 1. Seed treatment 2. Seedling dip 3. Foliar spray	**Growth responses** 1. Improved shoot & root growth 2. Higher flowering & fruit set	• Modulation of phytoharmones • Increased photosynthetic efficiency & carbon assimilation
	Biotic stress resistance 1. Resistance to fungal, bacterial & viral pathogens 2. Resistance to insect pests	• Up-regulation of disease resistance genes eg: PR-genes
	Abiotic stress resistance 1. Salt & Drought tolerance 2. Freezing & Chilling tolerance	• Reduced transpiration • Enhanced stomatal conductance
	Enhanced nutritional quality "Functional food"	• Altered metabolism • Up-regulation of bio-synthetic enzymes

Treatment	Effects	Possible mechanisms
Soil application 1. Incorporation of marine bio-products 2. Soil drenching 3. Addition of extracts to hydroponics Suppression of soil borne diseases & nematodes	Suppression of soil borne diseases & nematodes	• Anti-microbial • Enhanced growth of friendly microbes
	• Improves nodulation • Promote plant growth promoting rhizobacteria(PGPR)	• Altered metabolism • Modulation of root exudates • Different expression of signal molecules & bio-synthetic enzymes

Common seaweed products used in fruit crops

Product Name	Seaweed name	Company	Application
Acadian	*Ascophyllum nodosum*	Acadian Agritech	Plant growth stimulant
Agri-Gro Ultra	*Ascophyllum nodosum*	Agri Gro Marketing Inc.	Plant growth stimulant
AgroKelp	*Macrocystis pyrifera*	Algas Bioderivados Marinos.	Plant growth stimulant
Alg-A-Mic	*Ascophyllum nodosum*	BioBizz Worldwide	Plant growth stimulant
Bio-GenesisTM	*Ascophyllum nodosum*	Green Air Products, Inc.	Plant growth stimulant
Biovita	*Ascophyllum nodosum*	PI Industries Ltd.	Plant growth stimulant
Espoma	*Ascophyllum nodosum*	The Espoma Company	Plant growth stimulant
Guarantee	*Ascophyllum nodosum*	MaineStream Organics	Plant growth stimulant
Kelp Meal	*Ascophyllum nodosum*	Acadian Seaplants Ltd.	Plant growth stimulant
Kelpak	*Ecklonia maxima*	BASF	Plant growth stimulant
Kelprosoil	*Ascophyllum nodosum*	Techniprocesos Biologicos,	Plant growth stimulant

Reviews on effect of seaweed extract in different fruit crops

Crops Seaweed	extract	Effects/ Role
Apple	*A. nodosum*	Reduced alternate bearing and Increase in yield.
Banana	*Laurencia dendroidea*	Inhibited fruit anthracnose, improved fruit quality and yield.
Clementine	*A. nodosum*	Increased in yield, fruit quality and enhanced antioxidant activity
Grape	*A. nodosum*	Increased in yield, Cu uptake, K+ and Ca2+ influx, improved berry size, berry weight, firmness and uniform ripening.
Olive	*A. nodosum*	Increased in yield, oil content, linolenic, oleic acid and accelerated maturation; reduced palmitoleic, stearic and linoleic acid content.
Orange	*A. nodosum*	Increased in growth under drought stress, improved fruit weight, quality, total soluble solids ,sugar content and early maturity.
Papaya	*Laurencia dendroidea*	Inhibited fruit anthracnose, improved yield, quality and antioxidant activity.
Pear	*A. nodosum*	Increased in yield, fruit diameter, fruit weight and number of cells per area of parenchymatous tissue and total phenolic content.
Strawberry	*A. nodosum*	Increased in fruit yield, size and total fruit anthocyanin content.

them are filamentous, many branches, dense clumps with intricate patterns and increases light- gathering surface for the seaweed.

Available forms of seaweed extract

- Liquid formulations – Foliar application
- Granules formulation – Soil application
- Powder formulations – Soil application

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