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KERALA KARSHAKAN

English journal

The First English farm journal from the house of Kerala Karshakan

Micro greens

Next generation Super food

INSIDE KERALA KARSHAKAN

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JANUARY 2024 Volume - 11 Issue - 07

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

The First English farm journal from the house of Kerala Karshakan

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Design & Layout
Rajesh V

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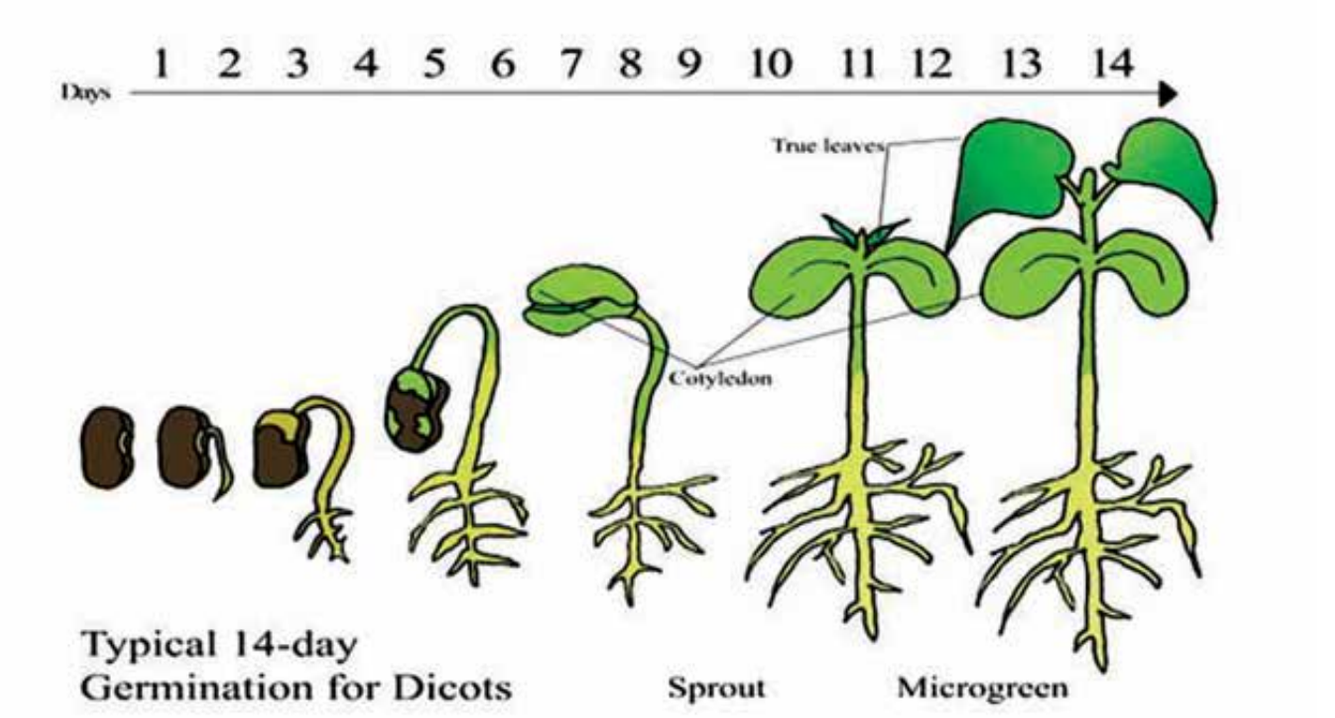
Micro greens

Next generation Super food

Microgreens are young and tiny seedlings of vegetables, harvested when cotyledons (seed leaves) are fully expanded and the first pair of true leaves are emerging or partially expanded. The size of these microgreens ranges from 1-3 inches (2.5–7.6 cm) in height which usually occurs within 7–14 days after germination. Microgreens are considered potential functional foods with nutritional benefits and health improving or ailment prevention characteristics. They have larger concentrations of phenolics, antioxidants, minerals, and vitamins than present in fully developed green or seeds and hence recognized

[1]M.Ananthi,
[2]S.Umesh Kanna
[3]M.Anitha

[1]Teaching Assistant, Directorate of Planning and Monitoring, Tamil Nadu Agricultural University, Coimbatore
[2] Professor, Directorate of Planning and Monitoring, Tamil Nadu Agricultural University, Coimbatore
[3]Assistant Professor, Selvamm Arts and Science College (Autonomous), Namakkal



as functional foods consisting of health improving or ailment prevention characteristicsapart from their nutritional benefits.

MicrogreensVs Sprouts

Microgreens and sprouts are consumed in immature condition however they are distinct with each other. Sprouts are mainly grown-up in dark moist environment, which is favourable for microbial growth. Their use is different from that of micro-greens & baby-greens, Also, micro greens are having wide range of leaf colour, shape and varieties and greater taste increasing properties than sprouts.

Different Types of Microgreens

Microgreens can be obtained from different sorts of seeds. The most popular varieties are produced using seeds from the following plant families:

Cereals such as rice, oats, wheat, corn and barley, as well as legumes like chickpeas, beans and lentils, are also sometimes grown into microgreens.

Microgreens vary in taste, which can range from neutral to spicy, slightly sour or even bitter, depending on the variety. Generally speaking, their flavour is considered strong and concentrated.

Importance of Microgreens:

Easy to Grow:

Microgreens are incredibly easy to grow, as they are harvested at the first true leaf stage and can be grown effortlessly on a sunny windowsill.

Quick to harvest:

Microgreens becomes ready to be eten in just two weeks.

Packed with flavours:

Though microgreens are tiny, the concentration of flavours makes them a favourite of chefs and food lovers around the world.

Loaded with nutrients:

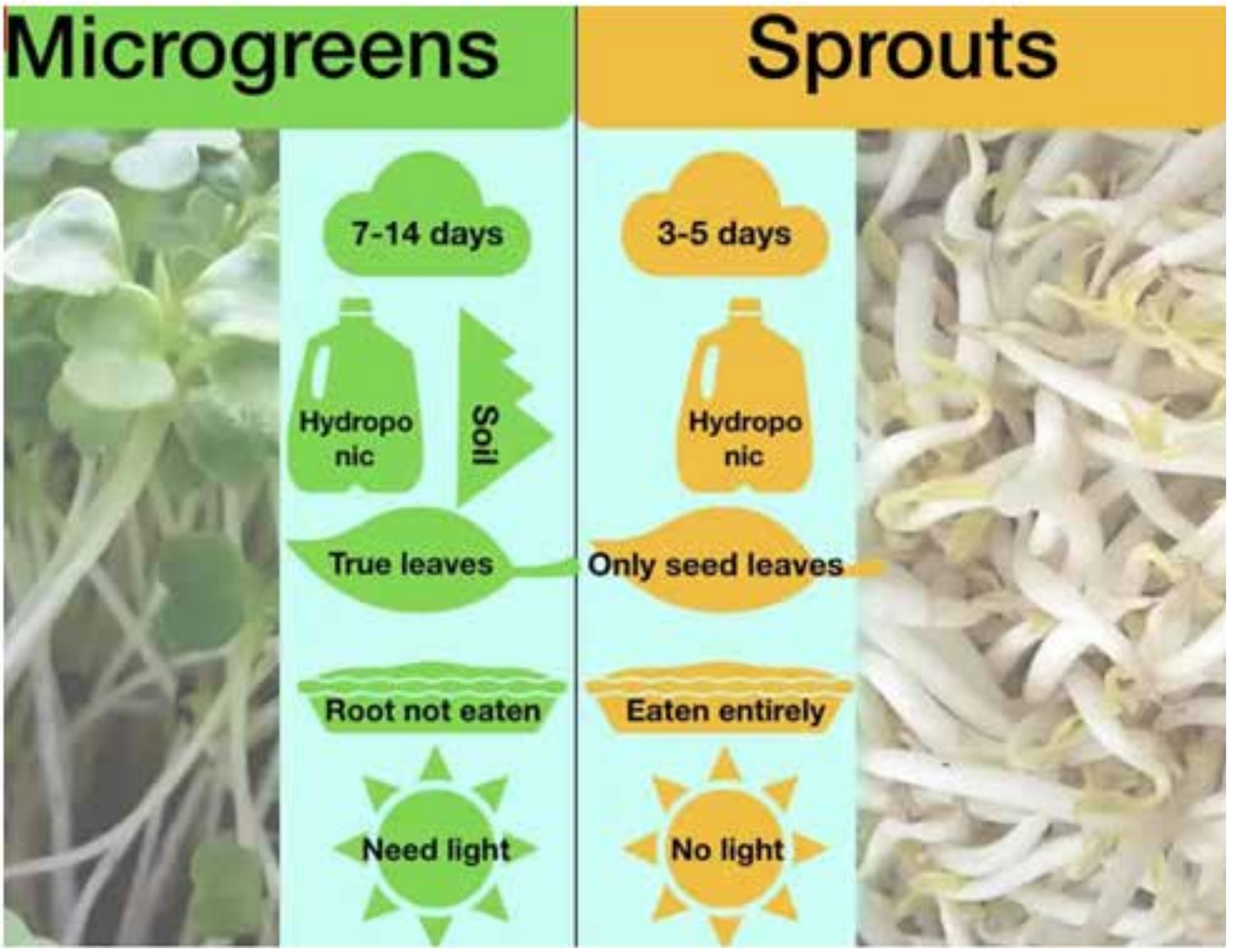
Microgreens have a higher concentration of nutrients than mature vegetables and herbs. Some microgreen varieties are having up to 40 times more nutrition than grown vegetables.

How to grow microgreens at home

Microgreen Seeds: Microgreens cannot be grown from regular seeds, one should use microgreen seeds only.

Potting Soil: Planting in soil is the best practice to get healthy & organic microgreens, the potting mixture should not contain any chemical or pesticide.

Pot/Tray: A container to grow microgreens can be a seed or regular planting tray or a vessel with 4-5 inches deep.



Brassicaceae family	Cauliflower, Broccoli, Cabbage, Watercress, Radish and Arugula
Asteraceae family	Lettuce, Endive, Chicory and Radicchio
Apiaceae family	Dill, Carrot, Fennel and Celery
Amaryllidaceae family	Garlic, Onion, Leek
Amaranthaceae family	Amaranth, Quinoa Swiss Chard, Beet and Spinach
Cucurbitaceae family	Melon, Cucumber and Squash

Light Source: Microgreens require an essential amount of sunlight /natural light for at least 3-4 hours a day. A bright windowsill or a balcony that receives sunlight will be a good spot for the plant.

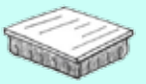
Water: Water is a necessary element for Microgreens. The soil being used is to be kept moist at all times. A hand sprinkler works best for the plant, due to its micro outlets that do not let open a huge downpour of water.

Health Benefits of Microgreens

The amount of vitamins, minerals and beneficial plant compounds are high in microgreens so eating green vegetables is associated with decreased danger from many diseases.

Heart disease: Microgreens have great content of antioxidants e.g. polyphenols which can reduce the risk of heart disease.

Steps by step cultivation of microgreens

Filling the tray / container with soil		Since the roots of Microgreens do not reach that deep, 3-4 inches soil height should be good enough.
Sow the seed		Microgreen seeds are to be spread on the soil surface. The spacing between the seeds does not need to be completely even, so hand sprinkling works fine.
Cover the seeds		Cover with a very thin layer of soil and gently pat the surface in order to make the seeds settle well in the container.
Damp the soil		Spray enough water over the soil surface in order to make the surface completely moist, but do not flood it with water.
Place the container at room temperature		Keep the container for about two days until germination occurs. Then choose a sunny spot to place the plant, where it receives a good amount of sunlight for at least 3-4 hours in a day
Sprinkle water twice		Sprinkle the water over the growing greens, twice a day. In 3-4 days' time, small leaves grow over the soil with little shoots at the bottom.
Harvesting Microgreens		Once the plants are 2-3 inches taller, they are ready to be harvested. Cut the microgreens with a pair of scissors or a sharp knife and cut the Microgreens, holding them vertically, from just over the roots.
Washing		Wash the harvested microgreens with cold running water and use it in a meal. Microgreens provide the best of nutrition when consumed fresh, right after the harvest. Dry them after washing and store in a paper wrap in the refrigerator

Alzheimer's disease: Antioxidant-rich foods, including polyphenols, can decrease probability of memory related disease such as Alzheimer

Diabetes: Presence of antioxidants can facilitate to lower risk of type 2 diabetes.

Certain type of cancers: Antioxidant-rich fruits and vegetables particularly containing polyphenols,may decrease danger of different kinds of cancer.

Chronic Disease: Inflammation

is a major indicator of disease in the body. Microgreens and vegetable intake in general is shown to reduce inflammation markers as well as lower the risk of several types of cancer

Microgreens is key weapon to fight with malnutrition due to higher concentration of nutrition. Pesticide residue free. It is a potential food for astronauts because it can be freshly harvested by the astronauts itself. It is good option for the agri- business startups.

Kalyani T.G.[1]
Dr. Reshmi C.R.[2]
[1]PhD Scholar, Department of Floriculture and Landscaping, College of Agriculture, Vellayani
[2]Assistant Professor, Department of Floriculture and Landscaping, College of Agriculture, Vellayani

MAGIC OF ORNAMENTAL GINGERS

TRANSFORM YOUR LANDSCAPES

Ornamental gingers comprise a wonderful group of plants that are closely related to edible gingers and belong to the order Zingiberales. These tropical and subtropical plants are known for their exquisite, brightly coloured flowers, which lend an enchanting charm to any landscape. Within this diverse group, some ginger varieties boast fragrant flowers, while others showcase foliage with aromatic properties. One notable characteristic of ornamental gingers is their extended flowering period, typically lasting around 5 to 6 months, making them highly sought-after for their


Variegated Spiral ginger


Butterfly ginger


Spiral ginger

Hidden ginger

Variegated Shell ginger

Shampoo ginger

Peacock ginger

sustained visual appeal in gardens. It is worth mentioning that those varieties that thrive in shadier conditions tend to excel when grown indoors. Adequate sunlight exposure is crucial to ensure optimal flowering.

Care and Management

Gingers grow well in warm humid climate. It is cultivated from sea

Beehive ginger

Dancing girl ginger

Torch ginger

Shell ginger (Alpinia)

level to an altitude of 1500 m above sea level. These plants can be grown under varying conditions from full shade to 90% sunlight. Ginger thrives best in well drained soils like sandy loam, clay loam, red loam or lateritic loam. A friable loam rich in humus is ideal. The growing medium of ginger plants must not be allowed to dry out. To keep the soil cool and moist, a mulch of dead leaves is placed around the base of the leaf-shoots.

The plants with resting fleshy rhizome (*Curcuma* spp., *Zingiber* spp., etc.) can be grown on a special bedding of 10-30 cm height. This can be prepared using a mixture of garden soil, sand and compost. The compost must be replaced 3-4 times a year. Most of the species are propagated vegetatively by division of the rhizome and cuttings of the aerial shoot.

Cuttings of aerial shoots are used in *Costus, Globba* and *Hedychium*. Bulbils which are produced abundantly on the inflorescence and stem are also used for cultivation. In *A. purpurata* the bulbils develop into seedlings before they are shed. Division is done by cutting and separating rhizomes into pieces containing two or more buds. A portion of rhizome with at least one old and one young aerial shoot constitutes a planting unit. Newly divided plants should be kept out of direct sun for a week or two.

Seeds also form an important planting material in the species of *Alpinia, Curcuma, Hedychium* etc. Mature seed capsules are to be selected from healthy plants. Immediately after collection, the husk is removed and the seeds are to be washed repeatedly in water for removing the mucilaginous coating. Then, the seeds are mixed with wood ash and shade dried for a day.

Some of the important plants under ornamental gingers is discussed below:

Shell ginger *(Alpinia)*: Alpinia are the largest genus in the ginger family with 250 species. This group of plants has major landscape value due to the different forms, varying heights, and their tropical foliage. Flowers are brightly and beautifully coloured. Some species are decorative for its variegated foliage viz, *Alpinia zerumbet* (variegated) and *A. sanderae*.

Spiral gingers *(Costus)*: They are called spiral gingers because of their spirally arranged leaves. They are very diverse group of gingers, from sun lovers to shade lovers, ranging in height from 3 to 8 ft. Flowers are non-fragrant, but long lasting. Some species are decorative for its variegated foliage like *Costusspeciosus* (variegated).

Hidden gingers *(Curcuma)*: Their ornamental spikes are produced basally or from the central part of the plant. Curcumas that bloom out of the top are being used extensively in the cut flower industry *(Curcuma alismatifolia, C. petiolata)*.

Dancing girl gingers *(Globba)*: These are small plants that reach 30 to 60 cm, prefer to grow in shady areas. They produce beautiful brightly coloured flowers *(Globbawinitii)*, which looks like a dancing girl. Globbas require morning or filtered sunlight. Direct light causes leaf scorching.

Butterfly gingers *(Hedychium)*: These are the most beautiful sweet-scented gingers in the family Zingiberaceae, the individual flowers resembling butterflies. Hedychium coronarium is widely cultivated. *H. flavescens, H. greenii, H. rubrum, H. coccineum, H. wardii, H. elwesii*, etc., are some of the beautiful butterfly gingers.

Peacock ginger *(Kaempferia)*: These areshade-loving plants have beautifully zoned patterns with silvers, blues, blacks, and shades of green, which make this plant very attractive even without flowers. Iridescent purple flowers are produced over the top of the plants. If this plant receives too much sun, the leaves will curl up in defence against the hot rays, so they are planted in dark shady places.

Zingiber: It is also known as "Ginger wort" or "Malaysian ginger". *Zingiber spectabile* is native to Southeast Asia, where it is grown as a medicinal herb. The plant is commonly known as "beehive ginger", due to its unusual inflorescences which resemble a beehive. The *Z. zerumbet* (shampoo ginger) inflorescence which resemble a compact cone, emerge from the base of the plants and start with green colour changing to red with age.

Torch ginger *(Etlingera elatior)*: Torch ginger, growing in large clumps 3-6 m high, is believed to be native of Indonesia. The spectacular inflorescence rises from the rhizome to a height of 2 to 3 ft or above. The individual flowers will appear from between the pinecone-like scales above the waxy bracts.

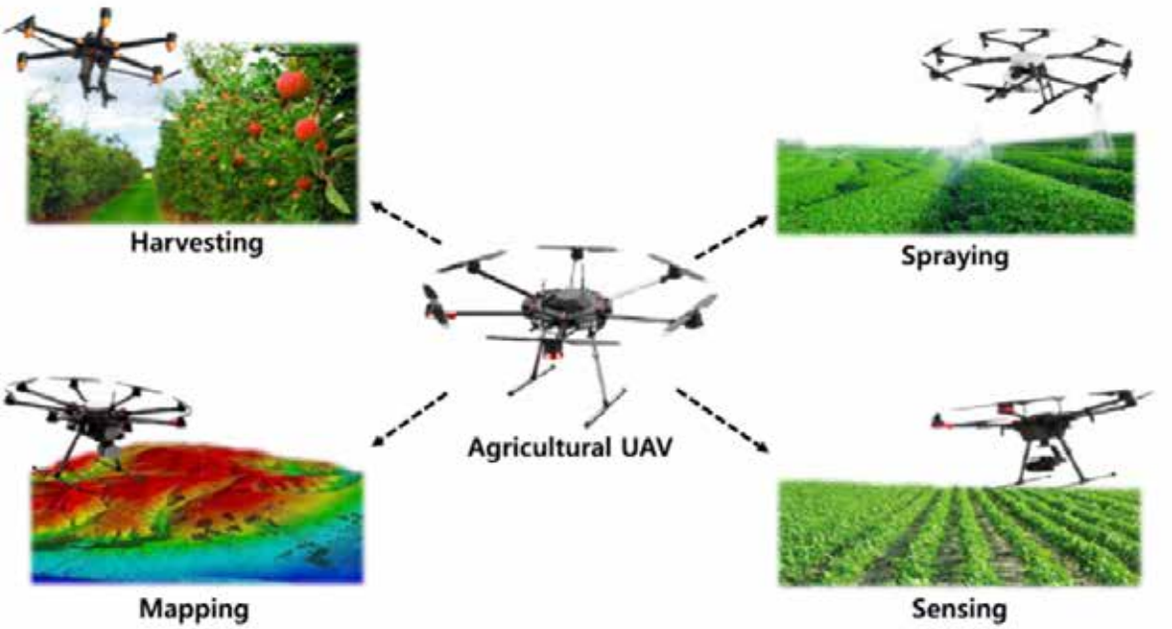
APPLICATION OF DRONE TECHNOLOGY IN HORTICULTURE CROPS

Nanda Kumar. K

It's very difficult for you to check out any sector of the economy without noticing the use of drones. In the agricultural sector, drones are used for a variety of tasks, which include spraying fertilizers, aerial surveillance, crop monitoring, land inspection, mapping, inspecting for damaged or rotting crops, and many more. Drones of various types are being examined to see which has the greatest potential in gardening, agriculture, and farming. Due to their multi-rotors, drones like quad copters are the best choice for crop fertilization. Fixed-wing drones are ideal for crop fertilization, but their huge structure, which necessitates a big landing area, gets in the way.

Some reports revealed that they expect the drone industry in the agricultural sector to grow from USD1.2 billion in 2019 to a whopping USD4.8 billion in 2024. All data obtained by the drones in farmlands is mostly used to make better agronomic decisions, which makes it part of the "precision agriculture" sector.

The use of drones has become a crucial part of large-scale precision farming operations



in several areas. The data gathered from what the drones record help farmers make better plans for planting and treatments to yield the best possible harvest. According to some reports, making use of precision farming systems has the tendency of increasing yields up to 5%, and that's a significant increase in a market that has slim profit margins.

Spraying of Fertilizer

The ability of drones to move around quickly to their intended destinations is one of the top uses of drones in agriculture. Drones having this capability can spray insecticides and fertilizers on crops to nourish them and give them the nutrients they require. Crops can be healthy and thrive with such supplements. Drone controllers have complete control over the drone spraying nutrients to keep worms, pests, and insects at bay and extend crop life.

Monitoring the soil health

Drones' powerful capabilities aid in the labor-intensive process of analyzing the health of the soil. UAVs (Unmanned aerial vehicles) gather and analyze data from monitoring systems that may be used to monitor, modify, and maintain the nature and health of the soil. Drone tech can also help the soil get the nutrients it needs to increase its health. Drones accomplish this task of monitoring the health of the soil through their data processing operations and 3D mapping.

Seeding process

Agriculture is a labor-intensive and time-consuming industry by definition, as it necessitates a high level of ability to carry out its activities. Seeding, in particular, necessitates human work because it's a process that consumes time. Drone technology is used to sow the seeds of several varieties of crops to make this laborious task easier. Lasers, sensors, tanks, and other features built into drones enable them to plant seeds swiftly and cleanly.

Examining the flaws

Another fantastic advantage of using drones to fertilize crops is their ability to assess, diagnose, and survey these crops for any inadequacies. Their cameras of high resolution and sensors, which are also equipped with lasers, aid in the speedy completion of various tasks. Unmanned Aerial Vehicles are also used to map these flaws in real-time, and the information

gathered and processed can be utilized to make additional crop decisions.

Drones for fertilizing crops

Drones and their uses have helped to simplify the time-consuming process of agricultural fertilization in general. Their entrepreneurial and powerful temperament greatly aids farmers in a variety of duties and operations. Drones and their uses have helped to simplify the time-consuming process of agricultural fertilization in general. Their entrepreneurial and powerful temperament greatly aids farmers in a variety of duties and operations.

What are some other agricultural applications for drones?

1. Drones, for starters, are great for monitoring and sensing techniques because they can quickly cover territory to check crop development and soil health. Drones are mostly used for this purpose since their sensors can detect the absorbance of a specific wavelength, resulting in a color contrast image that visibly reflects possibly problematic locations.

Ranchers have also employed drones to track livestock on ranches and check for any damaged fences, demonstrating that this monitoring capability not only provides for rapid processing of spatiotemporal information. Rangers have also employed night cameras and thermal imagers to locate any animals disturbing or attacking herds to better monitor cattle.

2. The second major use of drones in agriculture is to keep crops healthy by dispersing water, fertilizer, and pesticides. Drones coupled with spectroscopic and thermography technology can detect dry areas and address problems that traditional watering equipment may have missed. Drones, on the other hand, can detect equipment leaks and irrigation problems.

Drones can stitch thermographic photos together over time to detect the direction of water flow and locate geographical features that may affect water dispersion. Drones' accuracy and speed allow fertilizer to be delivered to precise

locations if crops aren't growing well enough, as well as the elimination of pests and pathogens by spraying pesticides from the drones themselves.

3. A third significant benefit of drones is that they can operate as mechanical pollinators. Although insect vectors are still the most important pollinators, drones may one day replace bees as the most essential pollinators. Although further research is needed in this area, researchers are optimistic that drones will be able to transport and disseminate pollen seeds in orchards and fields.

4. Another important aspect of drone application is the use of drones for agricultural research. Drones can cover broad areas damaged by natural catastrophis to find the reasons and implications of incidents, from infections to insurance claims. Drones are already being used to confirm claims in agricultural insurance surveys, and the quick response paired with high-resolution imaging allows for the collection of data on huge scales, which is difficult, if not impossible, to do on the same timescale with manual labor.

Drones are a good contender for enhancing agricultural techniques at a low cost because of these advantages. Aside from the financial benefits, optimizing fertilizer, pesticide, and water usage in important areas has various ecological and environmental benefits that would not be feasible otherwise.

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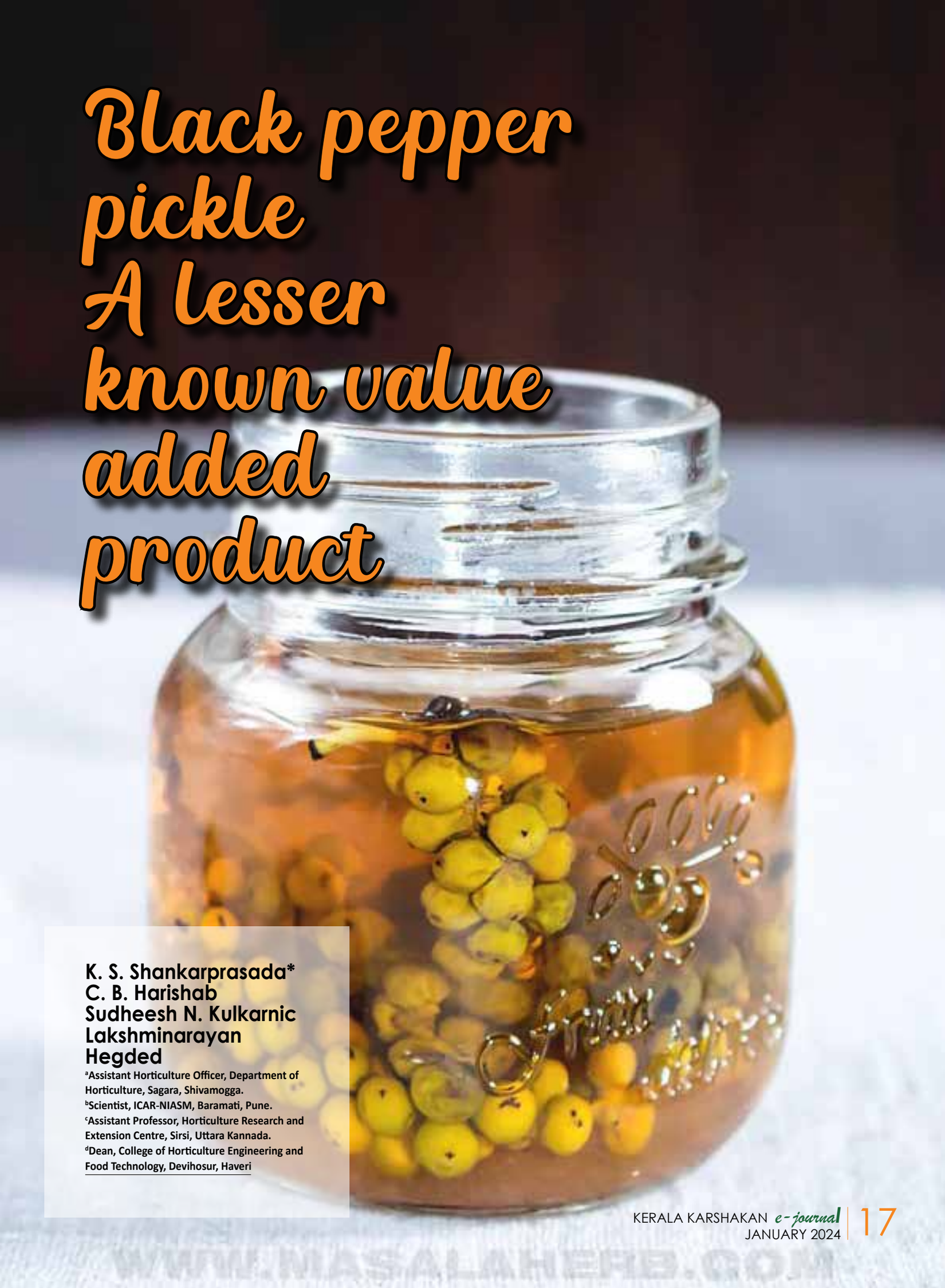
Black pepper pickle A lesser known value added product



K. S. Shankarprasada*
C. B. Harishab
Sudheesh N. Kulkarnic
Lakshminarayan Hegded

[a]Assistant Horticulture Officer, Department of Horticulture, Sagara, Shivamogga.
[b]Scientist, ICAR-NIASM, Baramati, Pune.
[c]Assistant Professor, Horticulture Research and Extension Centre, Sirsi, Uttara Kannada.
[d]Dean, College of Horticulture Engineering and Food Technology, Devihosur, Haveri

Black pepper is known as black gold and is the king of spices due to its versatile uses and health-promoting benefits. Black pepper is cultivated in an area of 3,09,335 ha in India, with 65,000 tons of production (Spices Board, 2022). In India, thousands of local cultivars with unique characters and flavours are available (Shankarprasad, 2021). The biting taste of pepper is due to a compound called piperine. Pepper has well-established medicinal properties, helps keep our body healthy, and builds strong immunity. The products containing black pepper, like 'Kashaya/Kashayam' and 'Pepper Rasam', got the limelight after the outbreak of the Covid-19 pandemic in India. Similarly, preparing golden milk (turmeric + milk) by adding a pinch of black pepper which is believed to increase the bioactivity of turmeric to boost immunity, became popular among the people.

Many entrepreneurs started producing different value-added products of pepper and got good customer responses. Many value-added products are already being prepared from peppercorns, like canned pepper, brined pepper, pepper powder, dehydrated pepper, pepper sauce, pepper blends etc. Pepper pickle is a mouth-watering product that is very tasty and healthy but not as popular as lime pickle, mango pickle or mixed vegetable pickles. In most of south India, meal is considered incomplete if pickle is absent. Each pickle has its flavour, but the exquisite flavour of the pepper pickle makes it incomparable with others.

Fig. 1: Black pepper pickle with jeerige mensau pepper cultivar leaves

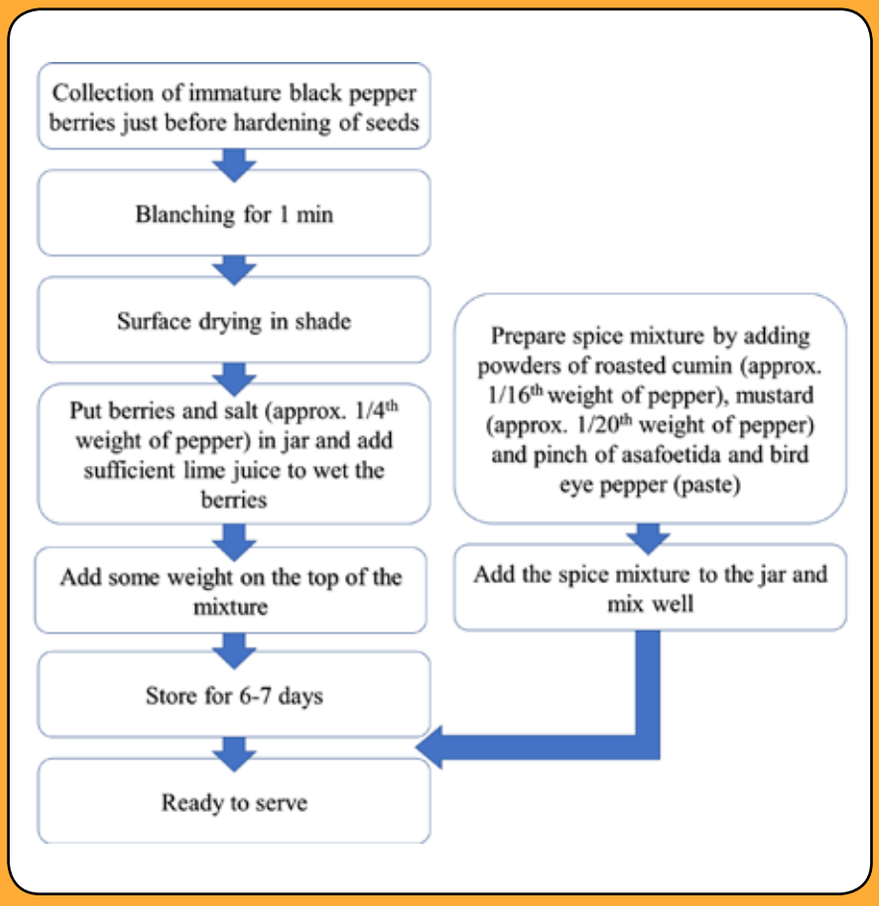


Fig. 2: Protocol for preparation of pepper pickle

A farm woman cum entrepreneur from 'Bilekal Huthgar' (A remote village 25km from Sirsi of Uttara Kannada district), Smt. Bharathi Mahabaleshwar Hegade has developed a unique flavoured pepper pickle called "Jeerige Kaalumenasu Pickle/ Jeerige Menasu Pickle" in Kannada. For the past five years, she has been in this venture of producing and marketing the unique pepper pickle. A local black pepper cultivar called "Jeerige menasu" produces peppercorns with amazing flavour, mostly similar to cumin and pepper blend used for making this pickle. After several trials and errors with many different cultivars of peppercorns for preparation of pickles, she identified this particular cultivar as the best one and pickles made from other cultivars are comparatively less tasty.

Later several protocols were applied to produce pickles using this cultivar. Finally, she standardized the procedure herself with the help from her family members. Lime juice, peppercorn, salt, cumin, mustard and asafoetida are the raw materials for this pickle. The immature berries (preferably during November last week or December first week) before hardening the seeds (checked by cutting the berry with finger nail) are used for pickling. The procedure has been given in figure-2 for those who wish to try on their own. The approximate quantities are mentioned in the procedure (as given by the inventor). The quantities can be altered as per one's taste preference.

Generally, the booking for this pepper pickle starts in November as the market for this pickle is not as vast as other pickles and has not been explored. Few buyers from Siddapur and Sirsi taluks (Karnataka) buy this pickle regularly, are highly impressed by its taste, and became regular customers.

It is priced at Rs. 700-1000/kg of a pickle. The price is highly reasonable compared to this pickle's delicate taste. If any research institute comes forward to provide improved modern technology to commercialize and scale up their business, this new product will take on the market. Our farmers should think in this entrepreneurial way to make more and more such innovative ideas to add value and make themselves self-reliant.

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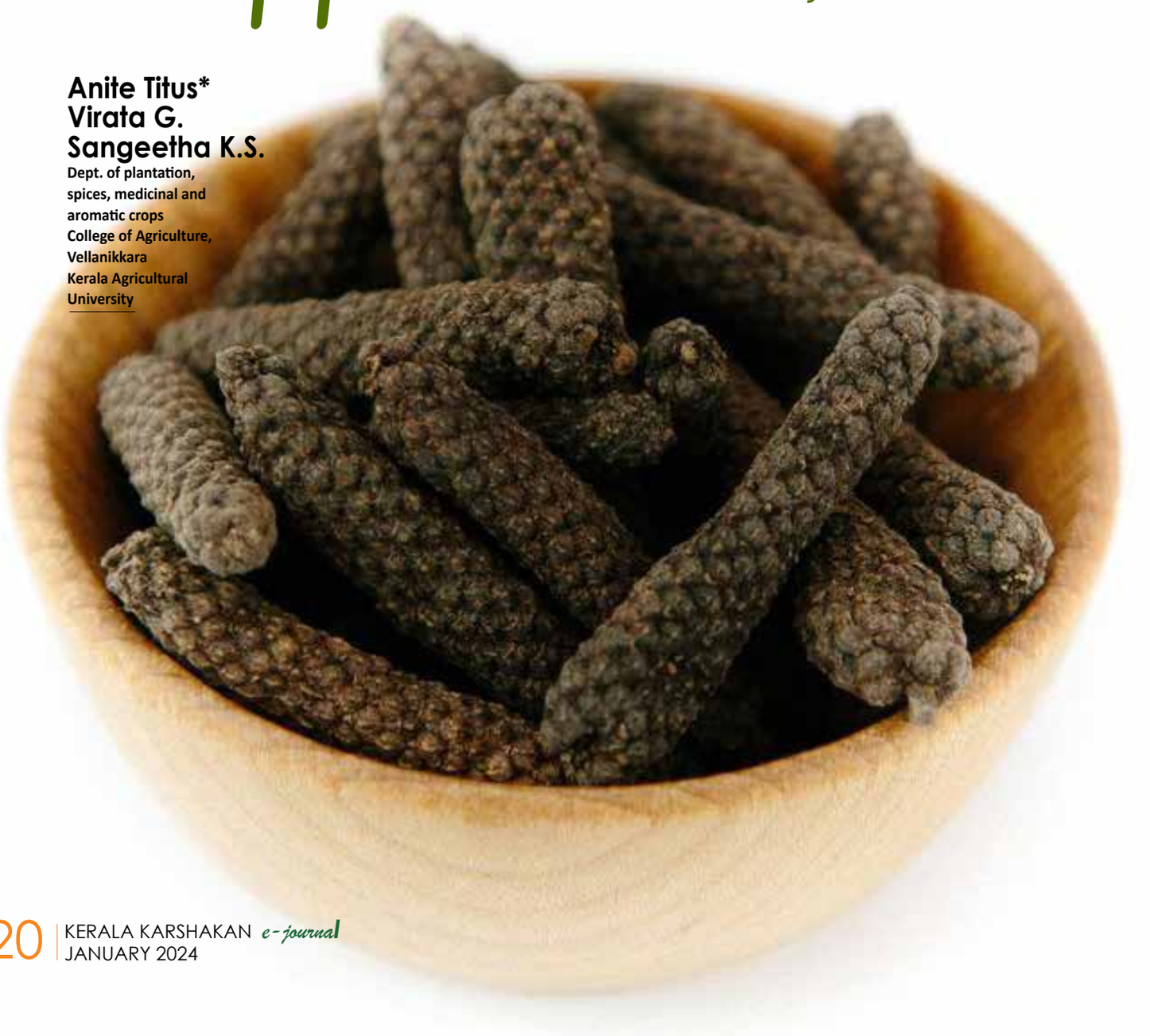
Thippili The Queen

Anite Titus*
Virata G.
Sangeetha K.S.
Dept. of plantation, spices, medicinal and aromatic crops
College of Agriculture, Vellanikkara
Kerala Agricultural University

Long pepper, *Piper longum* Linn.is the most extensively used medicinal plant in the Ayurvedic system of medicine belonging to the Piperaceae family. It is used in over 320 classical compound for medicinal and many modern herbal formulations. Hence, it is known as the 'queen' among the medicinal plants. The dried unripe spikes and the root in decoction are extensively used in acute and chronic bronchitis attended with cough and found to give gradual relief in all such cases. It is also used as a component of various modern herbal formulations for digestion, dyspepsia, asthma, bronchitis, chest congestion, *etc*. It is native to the Indo-Malaya region and found in tropical rain forests of India, Nepal, Indonesia, Malaysia, Sri Lanka, Timor, and the Philippines. In India, it grows in Assam, Khasi hills, the lower hills of West Bengal, the evergreen forests of Kerala, Karnataka and Tamil Nadu, Eastern Uttar Pradesh, Madhya Pradesh and Maharashtra.

Botany

Thippili is a slender, creeping perennial shrub that spreads on the ground and roots at the nodes. It grows and creeps over small shrubs, rocks, etc., but does not climb on trees like black



pepper or other wild peppers. The plant produces distinct dimorphic branches, i.e., orthotrops, the main branches creeping on the ground that have cordate leaves with long petioles, and the plagiotrops, the axillary branches that grow erect and produce leaves that are sessile or with short petioles. The orthotrops are vegetative and grow by the activity of the terminal bud, whereas the plagiotrops are fruiting branches, producing fruits (spikes) opposite to leaves, and the growth is sympodial. Leaves are simple, alternate, and variable in size and shape.

Plant is dioecious, *i.e.*, male and female plants are separate, and flowers are unisexual. Flowering is seen nearly throughout the year. The inflorescence is a spike. Flowers are numerous and closely packed, but bracts are orbicular, and fruit is a minute drupe embedded in a fleshy spike. Male spikes are much longer than the female spikes. Male flowers are minute with no perianth and have two stamens with short, broad filaments. Male spikes are long, slender, greenish during immature stages, and yellowish during maturity. Female spikes are short, thicker, stout flowers fused laterally. They are greenish when immature and turn deep black on maturity. Female flowers have no perianth, and stamens and ovaries are sunk into spikes with a single ovule; the style is concise with three to four-lobed stigmas. Fruiting is apomictic, and fruits are produced without pollination. Hence, male plants are not required for fruit production.

Soil and climate

Thippali thrives well in moist, moderately hot climate. It tolerates temperature up to 32°C and requires an annual rainfall of 250-350 cm, distributed evenly. It can be cultivated in fertile, organic matter rich, well-drained forest soil. Laterite soils with high organic matter content and moisture-holding capacity are also suitable for cultivation. In its natural habitat, it is an undershrub and, when cultivated, requires partial shade. It comes up very well as an intercrop in coconut and areca gardens. When long pepper is grown for its roots, loose soil (like sandy loam) should be selected for easy harvesting.

Varieties

Based on the size and taste, certain varieties are recognized in trade, such as Assam type which includes sualithippali (good quality and commonly used) and *aslithippali* (most pungent and superior in quality), Maharashtra type (*nonsorithippali*), Sri Lankan type (*cheemat*hippali, commonly cultivated clone of Kerala), West Bengal type (unda/golthippali) and wild type (*kattuthippali*).

Viswam is the only improved clonal selection of thippali, released by Kerala Agricultural University for commercial cultivation. It recorded 800-850 kg/ha of dry spikes under open conditions and 350-400 kg/ ha as inter crop in coconut gardens during the second year of planting.

Propagation

15-20 cm long three-four node vine cuttings from runner vines of female plants are commonly used for propagation. Single node-cuttings can also be rooted in poly bags. For rooting, cuttings are taken with leaves clipped off, leaving petiole, and planted in poly bags during March-April. Restricted irrigation may be given since excess irrigation makes it prone to *Phytophthora* infection and foot rot. Cuttings are ready for planting by May. Direct planting of cuttings in the field with the onset of rain is the common method adopted by growers. Micropropagation using nodal segments of mature plants in MS medium supplemented with 0.5 mg/1 BA and 0.5 mg/1 kinetin was successful.

Land preparation and field planting

Planting is done on ploughed land in conveniently sized raised beds, preferably 3 x 2.5 m. Pits are taken at60 x 60 cm spacing, and dried FYM is applied to each pit. Two rooted cuttings are planted in each pit. Drainage channels are opened to avoid water stagnation. In coconut gardens, beds can be spaced regularly between two rows of coconut.

Nutrient management

Longpepper requires heavy manuring. Poor growth is observed in soils of low fertility. Application of 20 tonnes/ha of FYM along with NPK @ 30:30:60 kg/ha produced the highest yield of dry spikes. During the first year, organic manure is applied in pits at the time of planting, and fertilizers are incorporated in beds. In subsequent years, manuring is done by spreading it in beds and covering it with soil with the onset of southwest monsoon.

Aftercare operations

Manual weeding is done during the first year when weed growth is noticed. After removing weeds, manure is spread in beds, and earthing

up is done. During summer, starting in January, irrigation is required once in a week. When grown as an intercrop, no additional irrigation is necessary if the main crop is irrigated. If the crop is irrigated during summer, flowering and fruiting will be protracted.It is mostly grown as an intercrop in subabul and eucalyptus plantations in Gujarat and coconut gardens in Kerala.

Pest and diseases

Mealybugs suck sap from healthy roots leading to yellowing and stunted growth. The severity is greater in summer. It can be controlled by systemic insecticide applications like Rogor. Adults and nymphs of *Helopeltistheivora* feed on tender foliage causing necrotic lesions around the feeding punctures and leaving shot holes on the lamina. Application of neem kernel extract at 0.25% concentration is effective.

During the monsoon, *Colletotrichum* spp. causes leaf and vine rotting. Colletotrichum spp. and Cercospora spp. cause necrotic spots and blight on leaves during warmer months. Sometimes, may cause partial or total crop loss. Spraying Bordeaux mixture (1%) during May and 2 to 3 subsequent sprays during the rainy season control the diseases. Besides, a virus-like disease characterised by yellowing and crinkling of the leaves, stunted growth, reduced spike size, and inferior quality has been observed.

Harvesting and Postharvest handling

Vines start bearing spikes six months after planting. Mature but unripe blackish-green colour spikes are collected two months after the formation of spikes as the spikes are the most pungent at this stage. In Kerala, three to four pickings are necessary when spikes mature. Harvested spikes are sundried for 4 to 5 days. The yield of dry spikes during the first year is around 400 kg/ha and it increases to 800 kg/ha in the third year. Dried spikes are stored in moisture proof containers. Usually, plants are replanted once in every five years as the productivity reaches a maximum in three or four years after planting and subsequently decreases. Besides spikes, dried thick stems and roots, commonly known as Piplamool, have medicinal value and are collected 18 months after planting or at the time of replanting. While harvesting, stems close to the ground are cut, roots are dug up, cleaned and heaped in shade for a day then cut into 2.5 to 5.0 cm long pieces. The average yield of roots is 500 kg/ha.

There are three grades of Piplamool. Grade I with thick roots and underground stem fetches a higher price than grade II or III which comprises either the roots, stems, or broken pieces.

Chemical composition

The spikes contain alkaloids piperine (4-5%) and piplatin, and two new alkaloids one of which is designated as alkaloid A and which is closely related to pellitorine; and three more new alkaloids-piperolactum A, piperolactam B, and piporadione. The roots contain the alkaloids piper longuminine (0.2-0.25%) and piper longumine (0.02%) besides piperine. Steam distillation of dried spikes yields 0.7 per cent essential oil with a spicy odour resembling pepper and ginger oil.

Adulteration

The genuine source of Indian long pepper is *Piper longum*. However, the spikes of certain other species are also traded as long pepper such as *Piper peepuloid*s, P. chaba (P. *officinarum, P. retrofactum*), and P. *mullesua*. All the above are mixed and often traded as Indian long pepper in the raw drug market.

Medicinal and therapeutic use

In India, thippali is mainly used in the preparation of pickles and health stimulants and also for imparting flavour and pungency to beverages. It is most commonly used as an expectorant to treat respiratory ailments such as asthma, bronchitis, cough, cold etc. and has aphrodisiac, analgesic and carminative properties. In Ayurvedic medicine, the herb is said to be a good rejuvenator and helps improve vitality; and is employed as a tonic to stimulate appetite. It is also being used against stomach ache, spleen diseases, tumors, indigestion, epilepsy, flatulence, gout, laryngitis etc.

This herb has nerve depressant and antagonistic effect on muscular spasms. When applied topically, it soothes and relieves muscular pains and inflammation. The essential oil has antibacterial and antihelminthic properties.

Sachin M. S [1]
Sambram C. [2]
Sindhu P. M.[3]
Harish M. C [4]

[1] Ph. D. Scholar, Dept. of Entomology, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga.
[2] M.Sc.Agri., Dept. of Entomology, University of Agricultural Sciences, Dharwad.
[3]Ph. D. Scholar, Division of Food Science and Post Harvest Technology, ICAR-IARI, New Delhi
[4] M.Sc.Agri., Dept. of Agronomy, University of Agricultural Sciences, GKVK, Bengaluru.

Winter worm summer grass Himalayan Gold

Introduction

Winter worm summer grass is a parasitic complex of a fungus (*Ophiocordyceps sinensis*) and the caterpillar (*Thitarodes* spp.) which belongs to the family Hepialidae. The caterpillar is initially infected by fungi in the spring and summer seasons, and turn into ''stiff worm'' in winter, so it is called as winter worm. In the next spring and summer seasons, the stroma germinates and then grows from the head of the larva, which is known as summer grass. The fungus–caterpillar complex resulting from fungal parasitism has a long history of use in traditional Chinese medicine (TCM) as well as in traditional Tibetan medicine for the treatment of asthma, bronchial

and lung inflammation, and other diseases. The hand-collected, naturally occurring fungus–caterpillar complex is highly valued by herbalists. Since this insect fungus complex is found in Himalayan region and highly valued in the market it is termed as 'Himalayan Gold'.

Though the fungus parasitizes on many insect species, The Himalayan bat moth or ghost moth remains as a potential host. It belongs to the genus *Thitarodes (Hepialus)*, family Hepialidae and the order Lepidoptera. Whereas the fungus *Ophiocordyceps sinensis* belongs to the family Ophiocordyceptaceae, order Hypocreales, class Sordiromycetes and the division Ascomycotina.

In interior mountain areas of Nepal it is locally known as Yarsha Gamboo means summer grass winter worm. Tibetians believe that during winter time it lives as a 'worm' and later as metamorphosis occurs at the start of the spring season, this worm transforms into a kind of grass. In Chinese it is called as Dong chong xia cao means winter worm summer grass and in Hindi it is called as Kheeda jadi, kheedaghas or kheedajhar. In English it is called by various names like winter worm summer grass, Himalayan Viagra, Caterpillar fungus or called by the name of fungus *Cordyceps sinensis* or *Ophiocordyceps sinensis*

(Ghanshyam and Manvitha, 2017).

Life cycle and process of infection

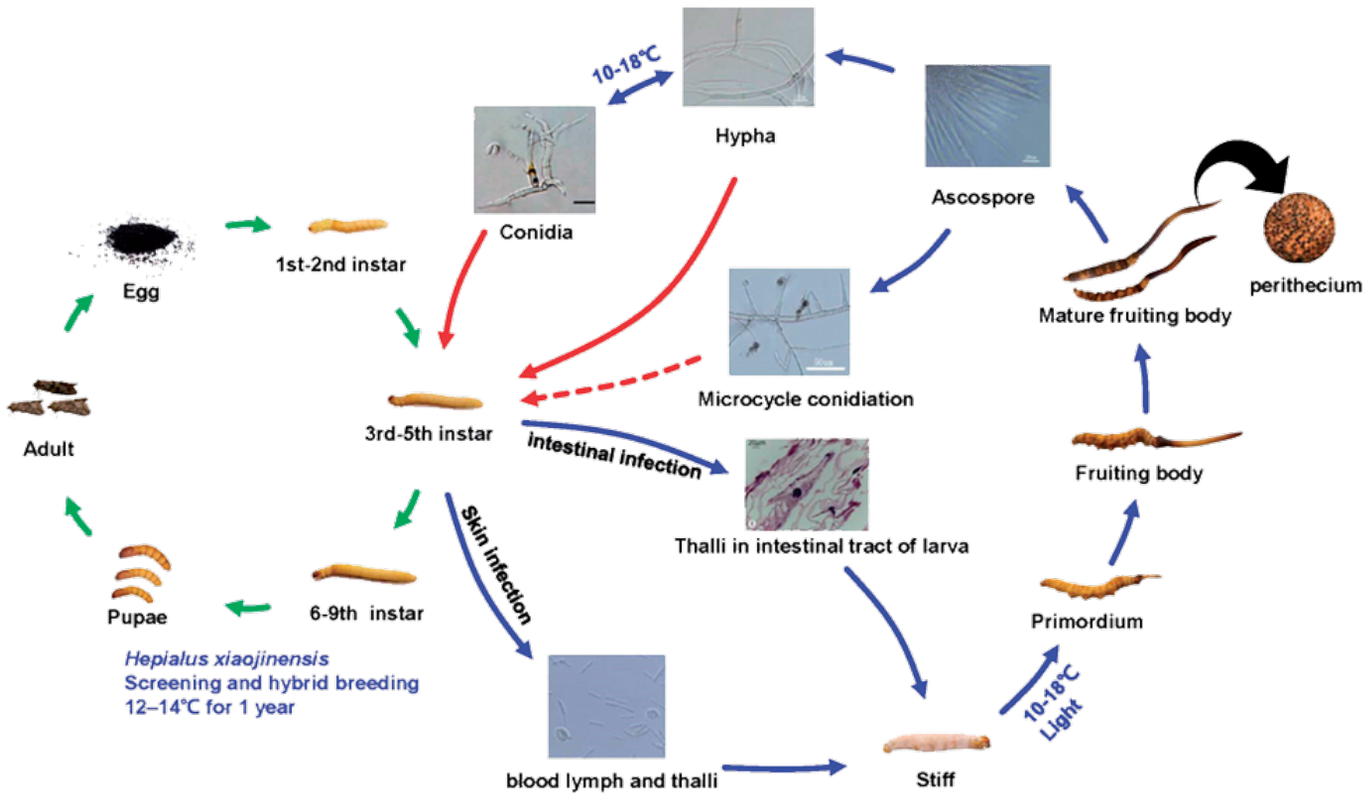
Life cycle of host insect

The winter worm summer grass's host insects, Hepialus, have undergone a complete metamorphosis. Its life cycle has four stages: egg, larva, pupa, and adult. All Hepialus species have a lengthy larval stage and a clear generational alternate, despite considerable variances in their biological and ecological characteristics. The life cycles of Hepialus insects typically take 3–4 years, sometimes even 4–5 years.

Between June and August, each female deposits about 500 eggs. Eggs develop throughout the course of roughly 30 to 40 days while being moisturised and incubated. The larvae have a hatchability of about 80%, and the chorion changes from being white during incubation to black.

There are six to eight instars in the larval stage, and the length of the larval development may vary depending on the instar. The larvae's survival rate in natural conditions is often less than 10% since they face several threats from natural enemies throughout their entire developing period. During the adult (or mature) larvae stage, the head capsule will change from milky white to light red or deep yellow with the larvae's growth. Typically, the larvae are dispersed in groups at a soil depth of 5 to 25 cm. Depending on the species involved, the transition from larvae to pupa takes 2-4 years. For example, *H. yushusis* larvae need to develop into pupae in roughly 996 days, *H. kangdingensis* larvae in 1000 days, and *H. gonggaensis* larvae in 875–1040 days. The larvae with different instars can always be found in the soil.

A portion of larvae develop into pupae at the end of each May, while the pupa stage for most of the larvae is



from June to July. When the temperature is between 10°C and 500°C and the relative humidity of the soil is between 40 and 45 percent, the pupa's developmental stage must last for 40 days. The peak period of emergence of adult varies depending on altitude. The Hepialus moth's colouring varies from light to dark from pre-pupa to emergence.

During the months of June to August, pupa frequently emerge daily between 17:00 hrs and 20:00 hrs. The amount of mature female insects is often more than that of adult male insects in most producing areas. In general, the number of mating is one for females and two to three for males, and the peak of mating generally varies with altitude. It takes 5 to 40 minutes from copulation to oviposition, and copulation helps the females' oviposition. Similar to mating, the peak of ovipositing also varies with the altitude. The females can only lay between 5-45 eggs in a nearby meadow after copulation. Although females live longer than males they pass away quickly after giving birth to their eggs. (Liu et. al., 2015).

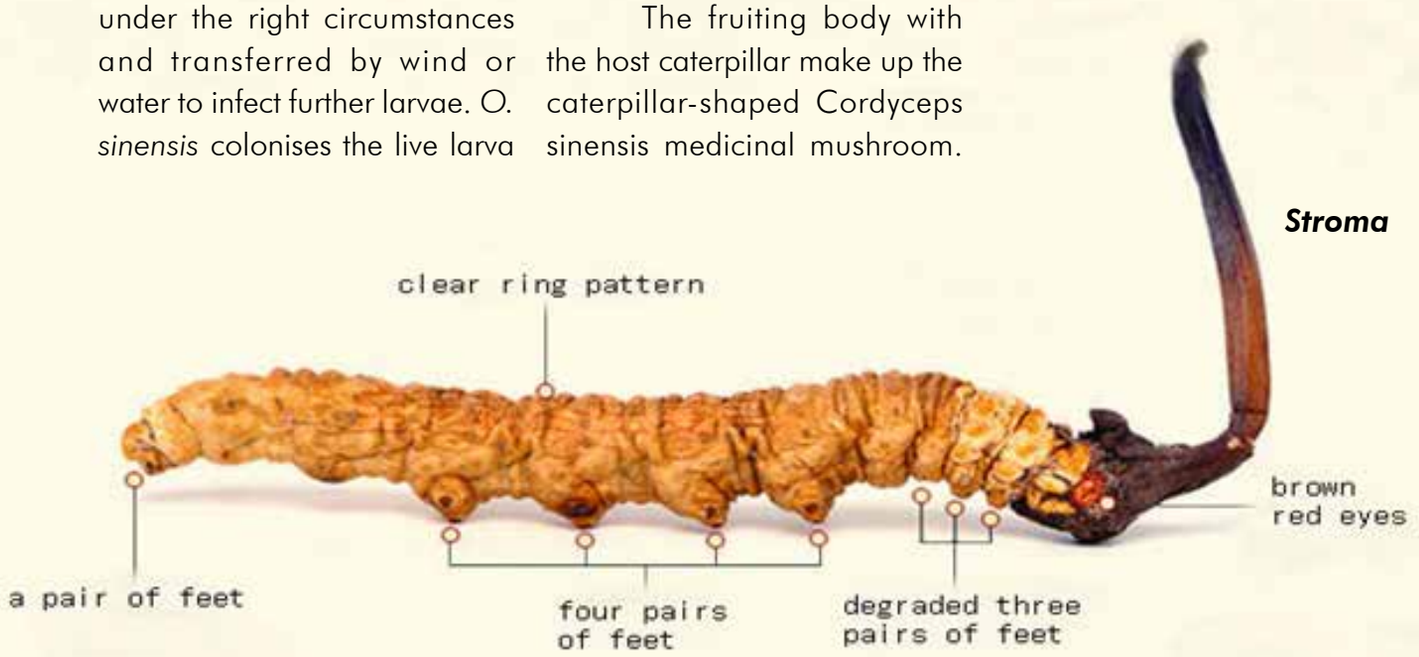
Process of infection

Due to the complex life cycle of the fungus, alpine habitat, and the short host insect lifespan, the infection cycle of the fungus that invades the host is challenging to study and understand. In the late autumn, the below-ground larvae may become infected with ascospores, conidia, and hyphae through the skin and intestine. The 4th to 5th instar larvae or the 3rd to 4th instar larvae that are shedding their old cuticles and developing new ones had the highest infection rates. The larvae in the subsequent instars are immune to infection. The fungus invades the larvae's hemocoel, breaks up into fusiform hyphae, and then grows via yeast-type budding to fill the hemocoel. It was confirmed that the larvae could experience skin and intestinal infection. The diseased larva crawls 2–5 cm beneath the soil's surface and then dies by facing its head upward. The larva gradually stiffens and is covered with mycelia on its remaining exoskeleton. Before the soil freezes, a little stroma bud typically breaks through the sclerotium's (host larvae)

head. The stalked fruiting body, with its head containing mature perithecia full of thread-like ascospores, emerges from the soil surface in the spring as the stroma bud expands. The ascospores can be discharged under the right circumstances and transferred by wind or water to infect further larvae. *O. sinensis* colonises the live larva of the host insects and then changes to necrotrophy when the larvae eventually die, proving that it is a facultative saprophyte rather than an obligate biotroph. (Li et al., 2019).

Morphological features

The fruiting body with the host caterpillar make up the caterpillar-shaped Cordyceps sinensis medicinal mushroom. The ascocarp, or fruiting body, of the C. sinensis mushroom begins at the base on an insect larval host (typically a Himalayan bat moth (Hepialus armonicanus) larva, though other insect hosts besides the bat moth are occasionally encountered), and ends at the club-like cap, which includes the stipe and stroma. When it is fresh, the stroma is almost twice as long as the caterpillar. Caterpillar fungus produces fruiting bodies with a head and sack-like components. The portions of the head come in various shapes, including circles, clubs, cotton swab sticks, coral reefs, noodles, and long ovals. The fruit body is dark brown to black, and the mycelium of the mushroom permeates the "root" of the organism, the larval body. The head, body, and legs of the root are worm-like and have numerous small, transverse creases. On the body of the root, there are around eight pairs of legs, and four of the middle pairs



Fungal endosclerotium

are more noticeable than the others. It has a thin lower portion and a somewhat thicker upper portion.

The fruiting bodies of *C. sinensis* were single, double, or triple in appearance as they emerged from the head of the larvae and ranged in length from 4 to 7 cm over the 3 to 4 centimetre caterpillar corpse. They were typically upright, stalked, and somewhat inflated at the tip. The colour varies widely red, yellow, purple, black, green, white, orange and olive. Typically, the young larva lives approximately 6 inches below ground, where it serves as the host plant upon which the *Cordyceps* grows. *Cordyceps sinensis* is a strange and extremely unusual sort of fungus since it parasitizes caterpillar bodies, consumes soft tissue, and mummifies insect larvae. Overall, the insect suffers as it completes its life cycle.

Importance

Constituents for medicinal significance of *Cordyceps sinensis*

- Cordycepin
- Adenosine
- Ergosterol
- Polysaccharides
- Cordyglucans
- Ergone
- Amino acids, zinc, vitamins & trace elements

Important pharmacological activities of *Cordyceps sinensis*

- Anti-asthmatic effect and anti-cancer agent
- Modulate immune responses
- Enhance hepatic energy
- Promote the secretion of adrenal Hormones
- Regulating blood pressure (high or low blood pressue), Anti-aging, lowering raised blood lipid levels, Strengthening the body's immunity
- Inhibit the growth of tumour cells
- Possess hypotensive and vasorelaxant activities
- Replenishment of body health
- Anti-oxidation activity
- Alleviates fasting hyperglycaemia and Immunoregulatory activity
- Anti-tumour activity and stimulating the immune system
- Anti-apoptotic property
- Enhancement on sexual performance and the restitution of impairment in sexual function
- Reduce fatigue phlegm and stops haemorrhages. Improves the respiratory function, Improves the functioning of the heart, Improves stamina and athletic performance.
- Anti-inflammatory property
- Hypoglycemic and Hypocholesterolemic activity
- Immunomodulator Property
- Improves pulmonary function and treat respiratory disease
- Antidepressant like activity
- Improves male reproductive dysfunction

Dietary uses of *Cordyceps sinensis* in Medicinal Dishes

- *Cordyceps* boiled with pork - Cures opium addiction, poisoning, Jaundice and tuberculosis
- *Cordyceps* cooked with duck - Potency of *Cordyceps* increased
- Cordyceps cooked with chicken or duck soup - Used for the treatment of respiratory diseases, renal dysfunction, hyperlipidemia and hyperglycemia
- Combination of *C. sinensis* with rhizome of *Dactylorhiza hatagirea*, honey and cow's milk - Used for a tonic and aphrodisiac
- *Cordyceps* mixed with alcohol or traditional green tea - Used for vitality and to cure stomach ailments
- Combination with daily dosage one dried *C. sinensis* with half litre of milk and two teaspoons of ghee for a week - Used as a tonic and used for the sexual stimulant

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Agar

A primitive bridging boon for farming microbiological activity

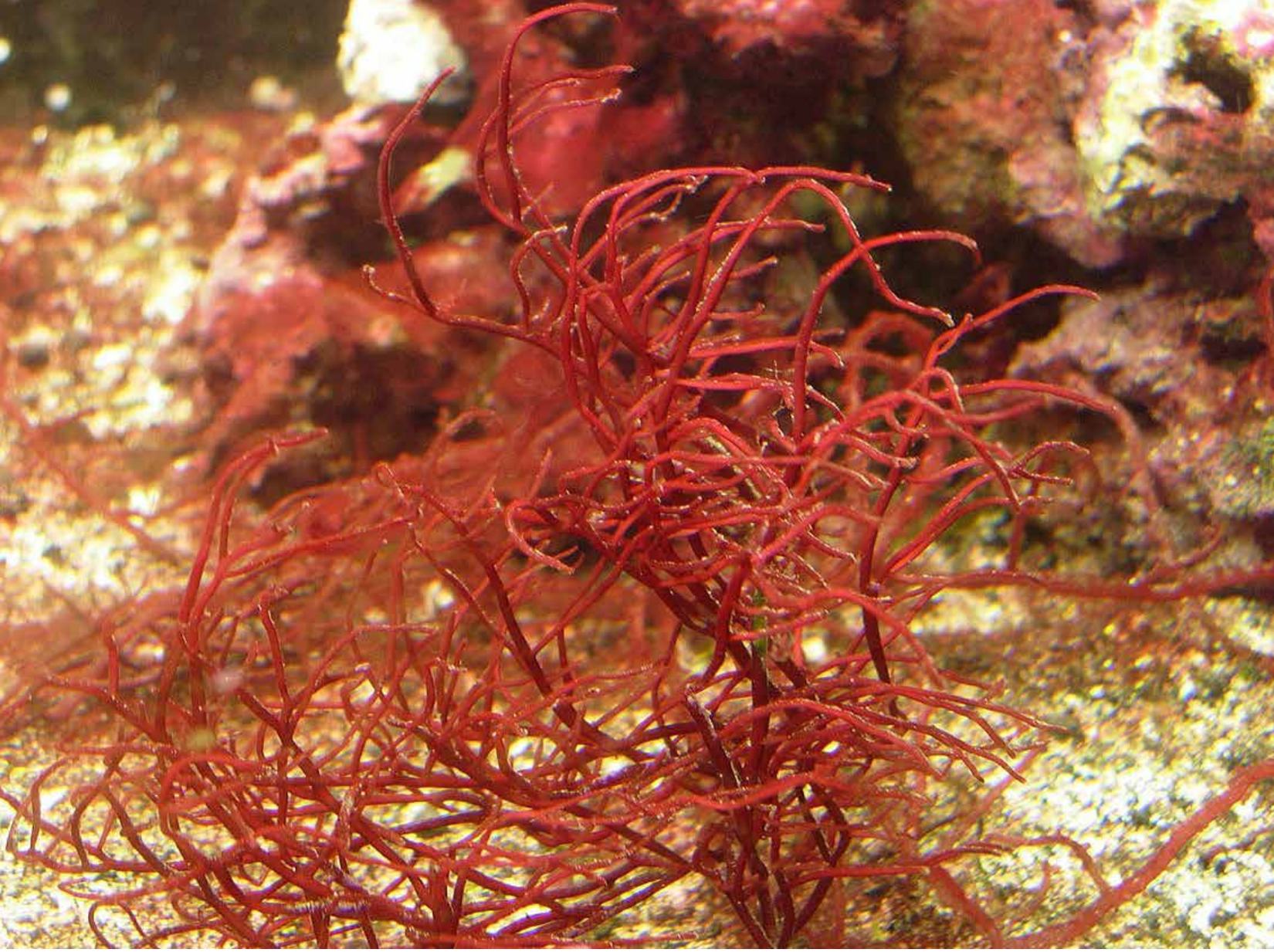
Sowmya B[1]
Niveditha H[2]
Shruti P Gondi[1]
[1]Research associates,
Natural farming project,
RHREC Kumbapur,
Dharwad-580005
[2]M.Tech Food Science
and Technology,
NIFTEM - Thanjavur

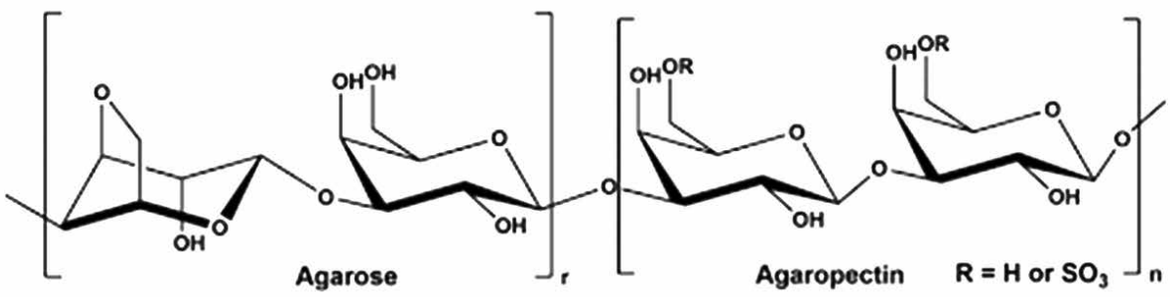
Introduction

In the world no modern microbiological laboratory can survive without agar and no satisfactory substitute has been found even with technological advances. Agar is a jelly like substance obtained from cell wall of red algae which belongs to the family of **Gelidiaceae** and **Gracilariaceae**. Agar comes from malay name of red algae i.e. Agar-Agar. It is also called as Kanten, Japanese isinglass, China grass, Ceylon moss or Jaffna moss.

History

Around 1658, agar was discovered accidently in Japan by innkeeper when some extract of seaweed was left outside the door of a mountain and frozen overnight. Anselme Payne, a French chemist subjected agar which was obtained from the marine algae Gelidium corneum for chemical analysis for the first time in 1859. Later in 1882 Fanny Hesse, the wife of Walther Hesse who is working as assistant to kotch suggested to use agar as solidifying agent in microbiology instead of gelatin.



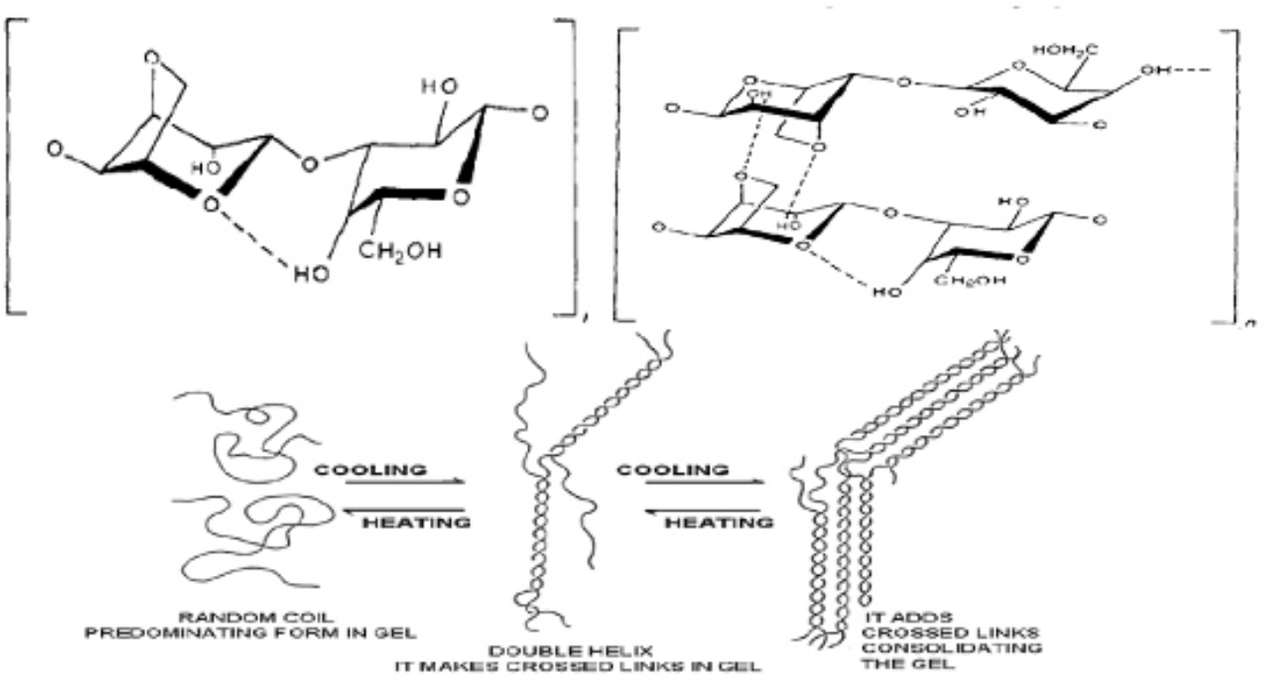


Chemical structure of Agarose and Agaropectin

Due to its importance in microbiology, its production increased quickly until Second World War. After the outbreak of Second World War, many countries established domestic agar industries in order to continue microbiological research. Agar production increased from 2,500 tons (during Second World War) to 10,000 tons (mid 1970) and then production become unstable due to its over-utilized seaweed populations.

Chemical structure and biosynthesis of agar

Agar is a complex mixture of polysaccharides composed of two major fractions viz., Agarose (neutral polymer) and Agaropectin (charged



Gelling Mechanism of agar

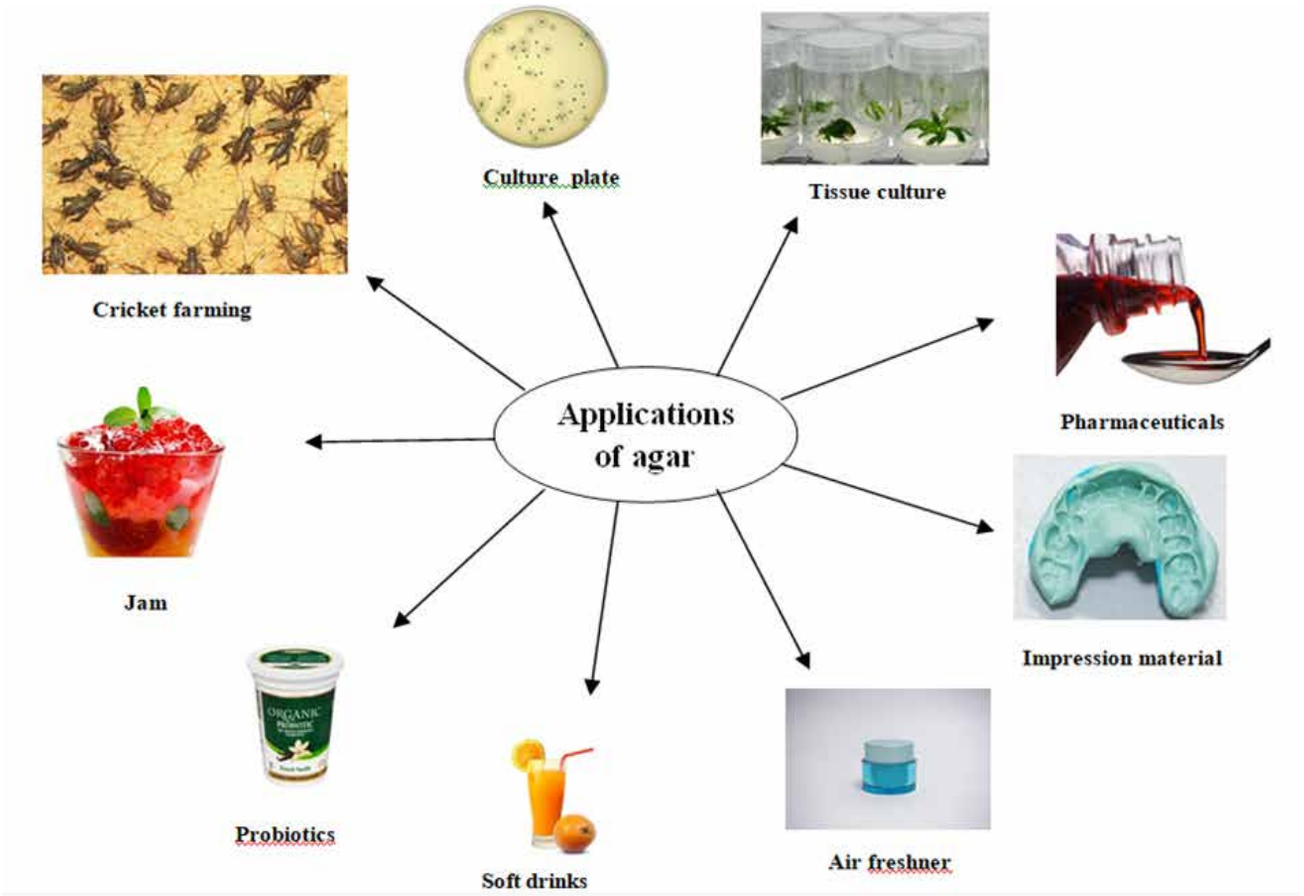
sulfated polymer). Agarose, the gelling fraction is a neutral linear molecule essentially free of sulfates, consisting of chains of repeating alternate units of D-galactose and 3, 6 anhydro-L-galactose units by glycosidic linkages. Agaropectin, the non-gelling fraction, is a sulfated polysaccharide (3% to 10% sulfate), composed of agarose and varying percentages of ester sulfate, D-glucuronic acid, and small amounts of pyruvic acid.

The agar biosynthesis begins with the glycosylation of alternating D- and L-galactose in the Golgi apparatus, followed by sulfation of agar at the early stage of biosynthesis, before the polymer is being transferred to the cell wall matrix. The sulfated L-galactose unit of agar at C-6 could be modified into 3, 6-anhydro-L-galactose at a later stage. Some of the putative enzymes involved in galactose formation were identified, but the enzymes which are responsible for agar polymerisation and side chain substitution on the galactan backbone are still unknown (Lee et al., 2017).

Extraction of agar

There are different methods used for extraction of agar such as, alkali extraction, acid extraction, hot water extraction, enzyme extraction, ultrasound assisted extraction and photo bleaching extraction. Among these most commonly used method of extraction is alkali extraction method which results in high gel strength but it is harmful for workers and environment. In order to overcome this disadvantage green extraction procedures like photo bleaching extraction and enzyme assisted extraction are used.

To avoid the alkali residue pollution during the alkaline extraction process and to deal with the problem of difficulty in filtration during enzymatic extraction of sulfated agar, a "green" extraction called Hydrogen peroxide assisted enzymatic method was developed. Agar was successfully extracted from *Gracillaria lemaneiformis*, and the sulfate content of agar from hydrogen peroxide assisted extraction (EHA) was higher than that of alkaline extraction. Moreover, the filtration efficiency and dehydration rate of EHA improved due to the decreased viscosity of extracts, covering the shortcomings



of the enzymatic extraction process (Chen et al., 2020).

Agarolytic activity

Some evidences witnessed some microorganisms can degrade agar. There are three ways of degrading agar by microorganisms. The first way is disruption of the double helical structure without the breakdown of the polymer. This limited activity does not produce any visible changes on the agar but can be detected when iodine fails to form the dark brown color with the gel. The second way is breaking down of the α-linkages of the agar molecule which give rise to oligosaccharides of the agarobiose series with 3, 6-anhydroL- galactose at the reducing end. The third way is by breaking down the β-linkages which give rise to the neo- agarobiose series of oligosaccharides with D-galactose at the reducing end. The enzymes involved in the second and third categories are called α-agarases and β-agarases respectively.

Examples: *Paenibacillus sp., Ammonibacillus agrariperforans, Alteromonas sp., Streptomyces coelicolor.*

Applications of agar

Agar is widely used because of its unique and special property like, it melts at 85°C and solidifies at 32°C to 40° C. So it is mostly preferred over gelatin and other seaweed extracts. Agar is very common vegetative substitute of gelatin, which is non- vegetarian. It is widely used in food industry because it does not possess any taste, odour or colour. It is also used in dental prosthetics, medical and pharmaceutical agent as laxative, emulsifying agent, biotechnological aid, electrophoresis, impression material and chromatography.

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Cecidochares connexa
an introduced biocontrol agent for Siam weed, *Chromolaena odorata*

K. Vanitha, T.N. Raviprasad, Rajashekara H.
ICAR- Directorate of Cashew Research, Puttur – 574 202, Karnataka

Chromolaena odorata (Asteraceae) is a vigorously growing dicotyledonous invasive weed species. It is native of tropical America but established as a serious weed in the wet/dry tropics of Africa and Asia.Historically, it was known as Siam weed. In Asia, it is a problem in crops like rubber, oil palm, coconut, tea, coffee, cashew, teak and other plantation crops, pastures, forests, road sides, river banks and vacant lands (Muniappan and Marutani, 1988). It is widely distributed in the regions with a rainfall of 200 cm and above, and temperature ranges from 20 to 37 °C (Timbilla and Braimah, 2002) and establishes well in humid tropics. It has a life span of more than three years. The plant can grow under a wide variety of agro-ecological conditions having prolific seed production capacity. The seeds are easily carried

Fig. 1. A view of *C. odorata* plants in a cashew plantation at Puttur, Karnataka

away by wind, water, and also dispersed through the people, animals and machineries.

It was introduced into Eastern India in mid 1800s and spread to Kerala after World War II (Bennett and Rao, 1968). It is well distributed in the north-eastern regions and Western Ghats. Its infestation resulted in suppression of Acacia catechu and Dalbergia sissoo regenerations in high forests in Assam (SenGupta, 1949). It hasoccupied pastures, marginal lands and open areas and has become a menace in coconut,rubber, oil palm, tea, teak, coffee, cardamom, cashew, citrus and other plantations, orchards and forests. During the dry season, it can be a serious fire risk in the forests.

As *C. odorata* has spread to many countries, attempts have been made by several countries to manage it, including biological control. In most countries, control is by slashing as the use of herbicides is beyond the means of most farmers. However, it is labour intensive and regrowth of weeds occurs. Biological control of *C. odorata* first began in 1966, with the agents introduced into West Africa. Later, different biological control agents were tried in different part of the world including Nigeria, Malaysia, India, Srilanka, Ghana, Guam, South Africa, Indonesia, Philippines, Papua New Guinea etc.

Fig. 2. Adult fly of C. connexa (Photo credit: K. Vanitha)

Classical biological control attempts made in India since 1970s are as follows,

- A host-specific hairy defoliator, *Pareuchaetes pseudoinsulata* Rego Barros (Lepidoptera: Arctiidae) was imported from Trinidad by the Commonwealth Institute of Biological Control (CIBC), Indian Station, Bangalore in 1970, it was released at Kodagu (Karnataka) and Kottayam (Kerala), unfortunately, it did not establish well.
- In 1984, a Sri Lankan strain of P. *pseudoinsulata was released* in Chickmangalur, Kodagu and Bangalore in Karnataka, and no establishment was observed.
- A seed feeding weevil, *Apionbrunneonigrum* Beguin-Billecoq (Coleoptera: Apionidae) was imported from Trinidad,and introduced in 1982. It was field released at Thrissur (Kerala) and Kodagu (Karnataka), but it also did not establish.

- Later, the stem gall fly, *Cecidochares connexa* (Macquart) (Diptera: Tephritidae) was introduced from Indonesia during 2002, and later it has spread to many regions which impacted reduction in growth rate of the weed.
- Of the biological agents that have established globally on *C. odorata*, *C. connexa* is by far the most effective.

Biology of *C. connexa*

Adults live for 9-12 days. Eggs are laid into new unopened terminal or axillary buds. Presence of black dead tissue in unopened leaves and holes on opposite opened leaves indicates the presence of eggs in the shoot. A female can lay up to 130 eggs. Eggs are elongate oval, pale white in colour and laid in groups. Upon hatching, the larvae tunnel into the stem tissues. Prior to pupation, mature larvae cut windows in the side of the galls, through which the adults emerge. Emergence windows are formed in 42-45 days (Bhumannavar and Ramani, 2006). One to 10 larvae can be found in a single gall (Sipayung and Chenon, 1994).The whole life cycle completes in 55 to 74 days (Bhumannavar and Ramani, 2006).

Host preference

Host-specificity tests conducted on more than 80 plant species over 18 families including Asteraceae, Euphorbiaceae, Leguminosae, Poaceae, Rubiaceae, Rutaceae, Solanaceae etc revealed that *C. connexa* could lay eggs and complete its life cycle only on *C. odorata* (Day and Riding, 2015). The tests proved its safety to other plants as also revealed in other parts of the world.

Symptoms of damage in *C. odorata*

The gall generally develops at the node where eggs are laid, which could be at the terminal or axillary buds. Initially, a small swelling is seen on 14 days after oviposition, and the gall gradually increases in size. A reduction in plant height can be noticed because of development of galls. Infested plants exhibit reduction in the number of branches per plant, number of

Fig. 3. Symptoms of damage by *C. connexa in C. odorata* (Arrow indicates emergence window for adult *C. connexa* (Photo credit: K. Vanitha)

panicles per plant, number of capitula per panicle and number of seeds per head, which are the characteristic features to arrest the growth and further reproduction.The galls formed slow and distort but do not arrest further growth of the stem. A female can produce a maximum of 50 galls.

Impact of *C.connexa*

In certain regions of the world, *C. connexa* has brought significant impact on *C.odorata*, where there were more than 20 galls per plant, dieback of branches and stems was noticeable. Plant death often occurred when gall numbers exceeded 100 per plant and brought substantial control (over 80% control) in Papua New Guinea (Zachariades et al., 2009) and East New Britain. But, the fly could not bring control of *C.odorata* in few other regions like West New Britain which could be due to cool weather prevailing over there (Day et al., 2010).

The observations in the cashew plantations of ICAR-DCR, Puttur, Karnataka also indicated that though there is good establishment of *C. connexa* on *C. odorata* resulting in galls, the control is not seen as the infested plants regenerate fast due to the rainfall received in the region. Thus, the climate should favour the development of *C. connexa* and should not support regeneration of *C. odorata* to bring successful management of this weed species.

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Kiriyath

The King Of Bitters

SREETHU M J
PhD Scholars,
|Department of Agronomy,
College of Agriculture,
Vellanikkara

Kiriyath's *(Andrographis paniculata)* place in history is said to have started with the Kiratas people, a smalltribe who lived in the forests of the Himalayan mountains. The earliest Ayurvedic sages named the plant accordingly, calling it kirata tikta, which means "the bitterherb of the Kirata people." Kiriyath has received additional names, bhunimba in Sanskrit for "neem of the earth," due to its bitter-like taste and its common name is "king of the bitters." It is a medicinal plant traded in high volume and prioritized under State Medicinal Plant Board, Kerala. It belongs to the family Acanthaceae and is widely used around the world.

It is an annual, branched, erect herb having a quadrangular stem with longitudinal furrows and wings on the angles of the younger parts. It prefers moist shady places, forests and wastelands Leaves are glabrous, opposite, simple,lanceolate, acute to acuminate at apex and green in colour with

reticulate venation. Flowers are small, having narrow corolla tube, whitish or light pink corolla.

Phytochemical Constituents

The plant contains four lactones namely dehydroandroghapholide,andrographolide, neo andrographolide and deoxy andrographolide. Andrographolide is a diterpene lactone, colourless and crystalline in appearance, and has highly bitter taste.

Cultivation

Seeds are to be soaked in water for 6 hours before sowing. Seeds are sown in nursery beds covered with suitable mulch and irrigated regularly till seedlings emerge (6-7 days). One month old seedlings are used for transplanting. Flowering starts from third month onwards. The best harvesting time is at 50 percent flowering or at 3 - 5 months age since the highest andrographolide content is found at this stage.The highest amount of andrographolide is present in the leaves while the seeds contain the lowest.

Medicinal Uses

The aqueous extract of Andrographis paniculata significantly increased the activities of antioxidant defense enzymes such as superoxide dismutase,catalase, and glutathione-S transferase and reduced glutathione content. It is used against acidity and liver complaints. Andrographis paniculata is used for treating diseases like fever and respiratory infections, and it shows antibacterial, anti-malarial, and anti-cancerous properties. It is also used as a medicine for the treatment of hypertension and diabetes. Andrographolide inhibits the proliferation of different cell lines including leukaemia, breast cancer, lung cancer, and melanoma cells. Chewing of the freshleaves reduces diabetes and hypertension.

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Taxonomic	Classification
Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Order	Caryophyllales
Family	Amaranthaceae
Genus	*Gomphrena*
Species	*globosa*
Binomial name	*Gomphrena globosa L.*

Vernacular	Names
Hindi	Gulemakhamal
Kannada	Adike huva, bilirudraakshi huva, kaashigonde, rudrakshi huva. Kaashi rudrakshi huva
Marathi	Butamy, gomdo, jaapharee
Malayalam	Vadamalli, wadapu
Tamil	Atiyomakacceti, atiyomakam, civappuvatamallikai, vatanakappu
Telugu	Bandu malli, rudraakshi poolu, Kashi poolu
Manipuri	Chengkruk

Globe Amaranth

(Gomphrena globosa L)

Flowers with Vibrant Colors

Gopika Manjunath[1]
Jadhav Sonali Ravsaheb[1]
Kamble Payal Ganesh[1]
Fazleen Fatima[2]
Gowthami R[3]
Subhash Chander[3]

[1]V.G. Shivdare College of Arts, Commerce and Science, Solapur, Maharashtra
[2]Sam Higginbottom Univeristy of Agriculture, Technology and Sciences, Uttar Pradesh, India
[3]ICAR-National Bureau of Plant Genetic Resources, New Delhi

Nature is bestowed with great diversity of ornamental flower species with diverse uses. Several species are known for its ornamental value, beautiful size and color flowers, keeping quality, economic importance, cultivation significance, pharmaceutical importance, importance in food and cosmetic industry, cultural significance etc. These specific uses of the ornamental flower crops led to the commercial cultivation of many species and few remains underutilized. The genus Gomphrena is the major group of angiosperms in the family Amaranthaceae with ~156 species (http://www.worldfloraonline.org/) which are known for its ornamental value and its importance in the field of pharmacological

and food industry. Among several species, *Gomphrena globosa* is one of the species with immense potential with wide uses like cultivated as ornamental crop, possess immense medicinal value viz., antioxidant activity, antimicrobial activity, cytotoxic activity, anti-hypertensive activity, cardiovascular effects, anti-cancer activity, analgesic activity, anti-inflammatory activity and natural blood coagulant. The pigments extracted from the flowers have been used in the food industry as a coloring agent. The plant is native of America, spread widely to Asia. The species is one of the traditionally important flower crops grown mainly for their loose flowers in different parts of the country. In flower market, it fetches good value due to the importance of attractive colored flowers and uses as loose flower, garland making, dye extraction etc. Due to the heat and drought tolerant nature of this species, the species grows well under full sun and regular moisture.

Botanical description

Plant: The species is a tropical annual plant with a height of 1- 2 ft and plant has bushy appearance. It is an outcrossing species pollinated by butterflies, bees and other insects. Gomphrena tolerates poor soils, heat and drought, and was once a favorite in British gardens.

Stem: Stems are branched, upright and stiff.

Synonyms

Amaranthoides globosa (L.) M.Gómez
Amaranthoides globosus M.Gómez
Amaranthoides globosus var. albiflorus M.Gómez
Gomphrena eriopoda Gillies ex Moq.
Gomphrena globosa var. albiflora Moq.
Gomphrena globosa var. aureiflora Stuchlik
Gomphrena globosa var. carnea Moq.
Gomphrena rubra hort. ex Moq.
Gomphrena tumida Seidl ex Opiz
Xeraea globosa (L.) Kuntze

Leaves: The leaves are opposite, oblong, ~ 10-15 cm in length and wooly-white when young, becoming sparsely white-hairy as they age.

Flowers: Flowers are globular in shape, but actually consist of numerous individual flowers. The most common color is magenta, but there are also white and pale mauve varieties. The flower heads are ~2.5-3.7 cm diameter. The individual flowers in the flower heads are inconspicuous, but the stiff and papery bracts results in the bulk structure of the flower head. Flower heads produced in different colors shades, viz. white, pink, and purple.

Fruits: Fruit is called capsule which are oblong, compressed with ~ 2 to 2.4 mm in size

Seeds: Seeds are ovoid, brown, shiny and almost smooth.

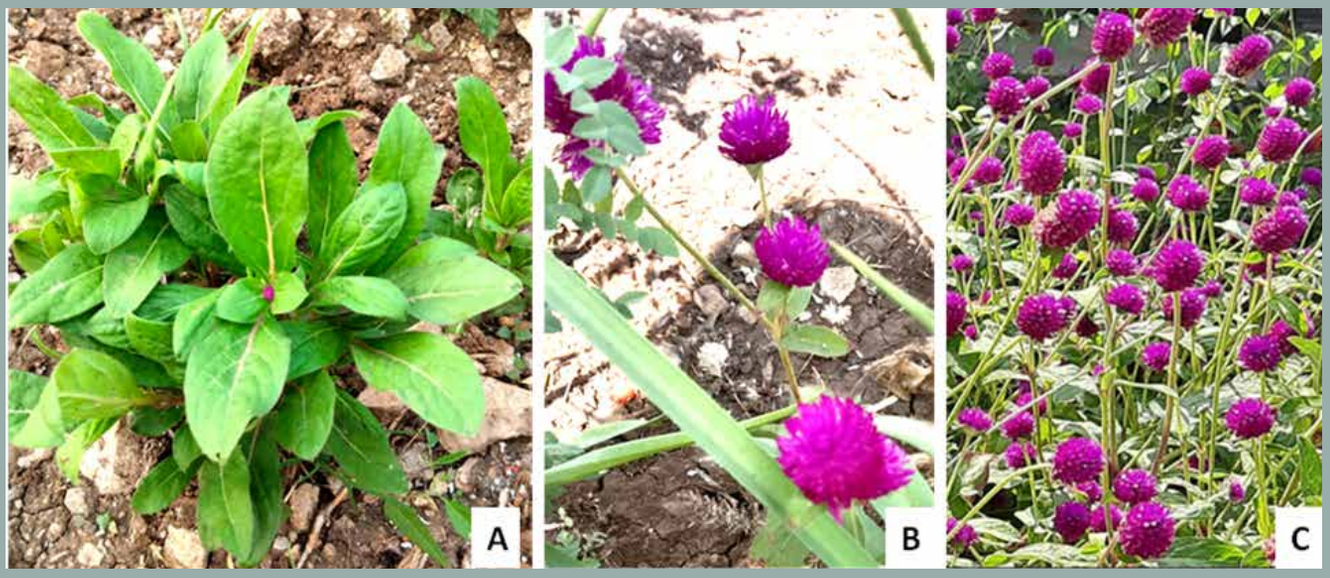

Figure 1. Globe Amaranth (A) Plant and (B-C) Flowers

Phytochemical constituents and pharmacological activities

Gomphrena globosa possess several phytochemicals, viz. saponins, alkaloids, reducing sugars, coumarins, catecholamines, tannins, lactones, and quinalones, steroids, triterpinoids and essential oil. Flavonoids were the main phenolic compounds and a major phenol was kaempferol 3-O-rutinoside and other flavonoids include derivatives of quercetin, kaempferol and isorhamnetin (Roriz et al., 2014). Dinda et al. (2004) identified sterols such as campesterol, β-sitosterol and stigmasterol, friedelin and epi-friedelinol, stigmasterol-β-D- glucoside and gomphsterol from aerial parts. They also observed friedelin, allantoin and chrysoeriol-7-o-β- D- glucoside from flowers. The species posses antioxidant activity (Hamiduzzaman & Azam, 2012), antimicrobial activity (Hamiduzzaman & Azam, 2012), cytotoxic activity (Hamiduzzaman & Azam, 2012), antihypertensive activity (Arcanjo et al., 2011), cardiovascular effects (Arcanjo et al., 2011), anti-cancer activity (Latha et al., 2013), analgesic activity (Hamiduzzaman, 2013), anti-inflammatory activity (Andrade et al., 2012), natural blood coagulant (Upadhyaya and

Saikia, 2011).

Ethnobotanical importance

The parts of this species, viz. plant, leaves, flowers and roots are used in folk remedy for oliguria, heat and empacho, cough, diabetes, kidney problems, hoarseness, bronchitis and other respiratory disorders. In South-America, the decoction of the plant is used as an abortifacient.

Phytoremediation

The species also absorbs atmospheric sulfides, which can be used as organic sulfur fertilizer to balance insufficient soil sulfur content (Ilyas and Arsia, 2014). Signes-Pastor *et al.,* (2015), reported the arsenic tolerant nature of *G. globosa,* as the species grew and bloomed well, without showing any phytotoxic signs under different arsenic concentrations. Hence, this species can be used in a crop rotation system in arsenic-contaminated agricultural soils to improve both the soil and also farmers income.

Food industry

Gomphrena globosa flowers reported to contain betacyanin used in food industry for coloring (Roriz *et al.*, 2014). In addition to coloring ability, betacyanin are natural pigments that has antioxidant properties. The main betacyanins identified in this species are Gomphrenine, isogomphrenin II and isogomphrenin III and other four structural types of betacyanin, viz. betanin, gomphrenin, amaranthine and bougainvillein have also been reported (Roriz *et al.,* 2014, 2018).

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DISEASES OF MINT AND ITS MANAGEMENT

Bhukya Srinivas[1*]
[1]M.Sc. (Agri.), Department of Plant Pathology, NMCA, NAU, Navsari, Gujarat, India

A variety of fungi can cause illnesses in mint plants. Powdery mildew, wilt, rust, leaf blight and stolon rot are common fungal diseases.A few essential elements are included in efficient disease control plans for mint growing. Plant spacing guidelines, crop rotation, and well-drained soil are examples of cultural and preventive techniques that can reduce the likelihood of illness. Timely implementation of control measures necessitates regular monitoring and early discovery.Sustainable and environmentally favorable alternatives are provided by biological control techniques, such as the use of natural predators and beneficial microbes.In addition, choosing cultivars of mint that are resistant to disease is a proactive way to manage illness. Crop resilience can be improved and the requirement for chemical treatments can be greatly decreased via genetic resistance. A comprehensive and long-lasting strategy for safeguarding mint crops can be found in integrated pest management techniques, which combine a number of disease control techniques.

Keywords
Mentha, *Verticillium*, cleistothecia, chlamydospore, uredospores

In the Indo-Gangetic plains, mints (*Mentha* spp.) are a group of aromatic plants that belong to the Lamiaceae family and are recognized as the most significant cash crop. India, China, Brazil, Japan, and the United States are just a few of the tropical and subtropical nations in the world where mints are grown. Over a hectare of land in the central and northern regions of the Indo-Gangetic plains is cultivated by Indian farmers as a bonus crop. In the conventional food-based cropping system, the crop coexisted harmoniously with other crops such as cowpea, pigeon pea, okra, maize, carrot, onion, and spinach. The same is

true for intercropping it with some legumes and sugarcane.

In recent years, mint has become more widely grown throughout India, particularly in the north and north-western regions like Madhya Pradesh, but it still occupies the largest area under commercial cultivation in Uttar Pradesh (the Terai region). Medicinal, food, cosmetic, and fragrance industries use Japanese mint essential oil for its menthol, menthyl acetate, menthone, and terpene content. Using less menthol but with a sweeter flavor and aroma, peppermint oil is used in tooth paste, chewing gum, candies, premium liquors, medications, and other medicinal preparations. Mainly used as a flavoring, spearmint oil contains carvone and limonene. Although bergamot mint oil has a greater linayl acetate content and linalool, it is mostly utilized in flavoring and fragrance.Given the severity of the mint disease, the goal of this study provided valuable insights to determine the potential management strategies.

List of diseases of mint

Powdery mildew

Causal organism: *Erysiphe cichoracearum*

There have been reports of severe powdery mildew from Argentina, Russia and India. The disease-induced defoliation can cause a 20% reduction in the output of essential oil. Japanese mint was the subject of the first report of this ailment in India in 1962 by Ganguly and Pandotra.

Symptoms

A brownish discoloration on the corresponding lower surface before the advent of the powdery phase are the key signs of the disease, which are little chlorotic patches that appear on the surface. The upper parts of the remaining leaves generally develop round, white, powdery spots later on. Many perithecia are produced by these white patches, which eventually turn purplish black. Severe cases have significant defoliation.

In soil contaminated plant detritus, pathogens persist in cleistothecia. Primary infection fungi are obligate parasites, caused by the ascospores from cleistothecia.Secondary spread is by the wind-borne conidia.

Management

Crop rotation with non-host crop, avoid dense planting.Remove infected plants and do not apply water from above.

Wilt

Causal organism: *Verticillium albo-altrum*

A significant issue with mints, particularly peppermint in the United States, since the early 1900s has been verticillium wilt. The causative organisms in M. piperita and *M. cardiaca* are *Verticillium dahliae* and *V. alboatrum var. menthae*.

Symptoms

Dwarfing, unilateral branch development,

Erysiphe cichoracearum

Verticillium albo-altrum

leaf defoliation, wilting and eventually plant death are the usual symptoms of the illness.

Primary source is by the soil, roots, and stolons that are used as seed material are the routes by which the pathogen spreads. As a chlamydospore, it might live for a number of years, and secondary spread is by irrigation or precipitation, macro-micro conidia with rainwater facilitate the secondary spread in fields.

Management

The occurrence of Verticillium wilt is decreased by using healthy planting material and inverting the soil during the summer. The greatest percentage of viable, disease-free rhizomes are produced when mint rhizomes are heat treated at 47°C for 55 minutes or 48°C for 35 minutes.

Rust

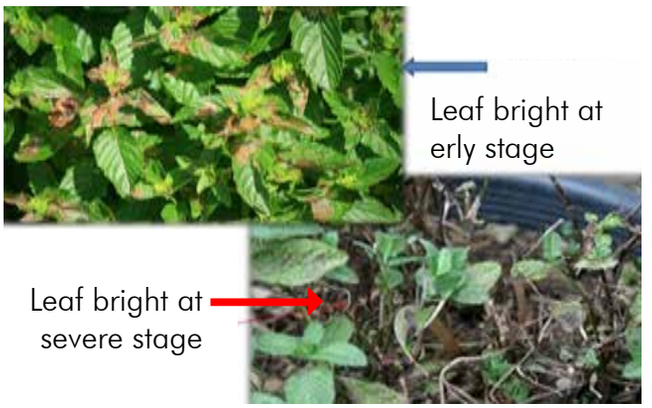
Causal organism: Puccinia menthae

When left unchecked, the rust fungus completely defoliates mint plants, making it the most serious disease threat. While native spearmint looks to be less susceptible to rust attack than Scottish spearmint does, both are susceptible to severe oil loss if the rust is not controlled. This disease primarily affects standing crops in Jammu, emerging nearly toward the end of the agricultural season and causing negligible to no harm.

Symptoms

On the undersides of the leaves, brown circular pustules first develop, then the leaves defoliate and yellow. Stems contain black spore stage (teliospores), whereas yellow spore stage (uredospores) is found in reddish blisters on new shoots. Top section of the stem enlargement is indicative of the telial stage. It is macrocyclic, with five spore stages and an aerial stage that can be systemic in plants. It is autoecious,

Puccinia menthae



finishing its complex life cycle on a single host. The uredospores that this fungus typically leaves behind on the host plant's runners and plant detritus. Many uredospores found in rust pustules allow the host plant to become infected when the right circumstances are met. At a later stage, the rust fungus also produces telia, which are thick-walled teliospores that can withstand harsh circumstances.

Management

The primary method of preventing this disease is the use of materials free from infection. Hot water treatment for planting materials. The disease's ability to spread is further inhibited and the rust inoculum is decreased by removing older mint plants that have infection. For the control of rust, rabing or burning is required.

Leaf blight

Causal organism: *Alternaria alternata*

Reports of leaf blight on *M. arvensis* and *M. piperita* have come from India. This blight causes the host to become severely defoliated, which results in financial losses. Although it is common in the drier summer months, the disease is most severe in India during the monsoon season.

Symptoms

The disease's primary signs and symptoms are the development of dark brown, concentric zones encircling the pale-yellow border, round to oval, or slightly irregular, patches on the top surface of the leaves. Subsequently, these patches combine, grow and cover the whole leaf or a section of it, which causes the leaves to fall off.

Primary source is by the pathogen that survives in the dead leaves as dormant mycelium. Secondary spread is by the air borne conidia.

Management

Cut down the soil moisture and remove any sick plants. The disease can be effectively controlled by misting plants with copper fungicides.

Stolon rot

Causal organism: *Macrophomina phaseolina (Rhizoctonia bataticola)*

M. cardiaca (Green, 1961), *M. arvensis* and M. spicata (Hussain and Janardhan, 1965) were the first species to exhibit stolon rot, also referred to as stolon decay.The complicated illness known as stolon rot is caused by R. solani and *R. bataticola*.

Symptoms

The yellowing of the leaves and the plants slowed growth are the two main signs.The plants begin to wilt early which causes the above-ground section to die.Early on, pinkish brown lesions are visible on underground stolons, which eventually develop into dark brown to black patches.The stolons that are impacted, either completely or in part, begin to softly decay as a result of these patches getting bigger.

Management

Utilizing wholesome planting materials. The disease can be controlled by methods including crop rotation and deep summer plowing.Stay away from over-irrigation.Moreover, applying *Trichoderma sp*. to the soil and burning the affected plants can aid in the management of the illness.

Summary

The prevention and management of numerous mint illnesses can be achieved through consistent observation and suitable maintenance, which includes upholding optimal plant cleanliness and growth conditions. Finding the exact disease that is destroying your mint is crucial, as is taking the necessary precautions to lessen its effects.

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