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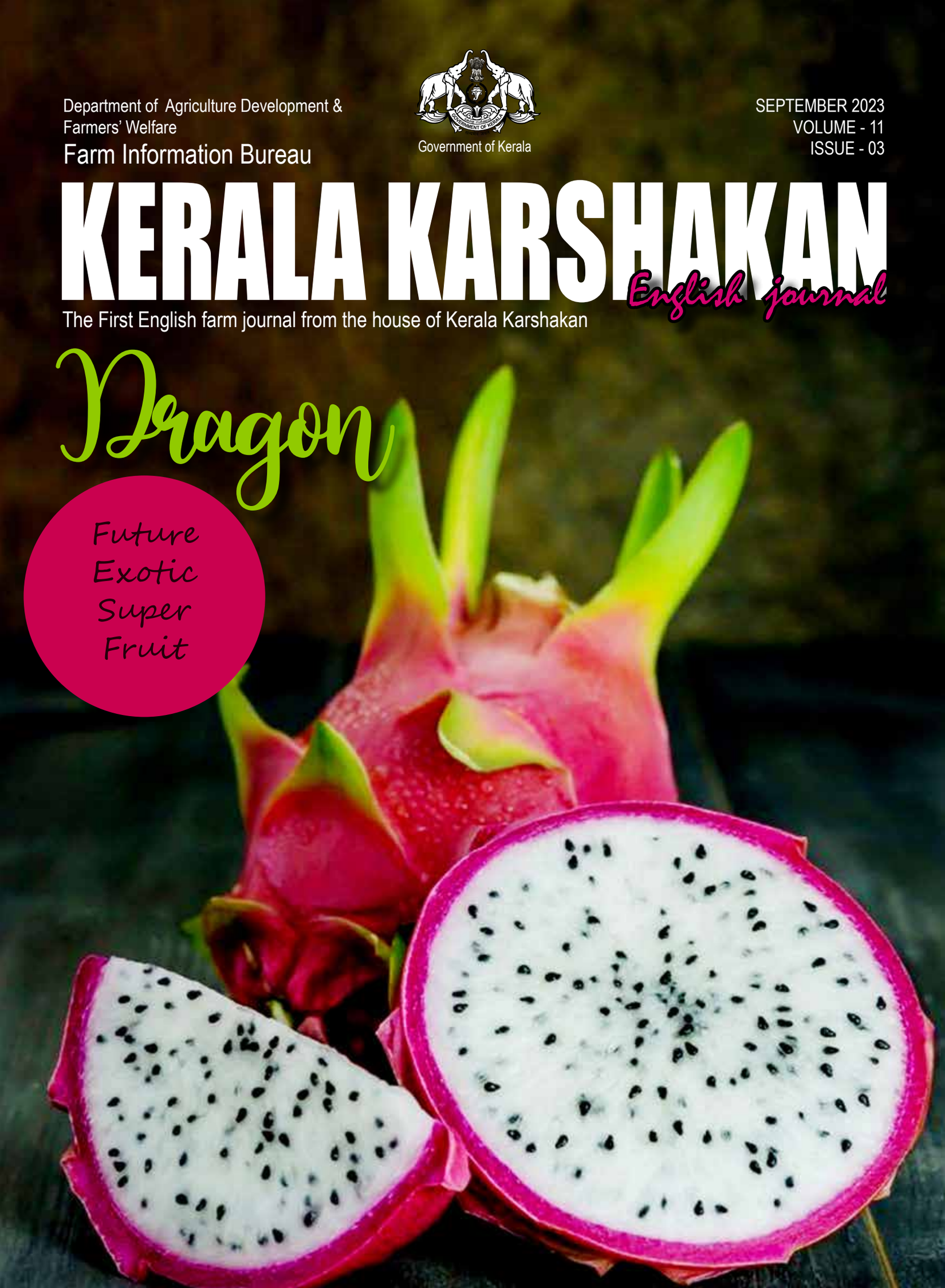
KERALA KARSHAKAN

English journal

The First English farm journal from the house of Kerala Karshakan

Dragon

Future Exotic Super Fruit



INSIDE

KERALA KARSHAKAN
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04 **ANTIOXIDANTS A BOON TO PLANTS AND HUMANS HEALTH**
K. ManojKumar, S. Nadaradjan, Premkumar Adhimoolam, K. Ilakkia, M.Vaishnavi

07 **CASHEW NUT SHELL LIQUID: AN ALTERNATE FUEL FOR DIESEL ENGINE**
Babli Mog[1*], J. D. Adiga[1], Mohana G.S[1], Shamsudheen M[1], V. Thondaiman[1], Veena G. L[1], Manjesh G.N[1], Bhagya H. P[1], Vanitha K[1], Manjunatha K[1]

12 **BAJRA NAPIER HYBRID: A YEAR-ROUND FODDER CROP**
Greeshma. U[1*], Usha C Thomas[2]

16 **LET'S TRY THE VARIETIES!**
Jicky Chacko

20 **BHRINGARAJ HERBAL ELIXIR FOR HAIR AND WELL BEING**
Anite Titus*, Sangeetha K.S.

ATTENTION AUTHORS

Articles for Kerala Karshakan e-journal should be certified by head of the institution concerned stating that the article is original and has not been published anywhere. Reference should also be included wherever relevant.

12

24 **UNTAPPED PANDANUS BECOMING A POTENTIAL THREAT**
Dr. Pradeep B. , Dr. P. S Manoj

27 **"FLORAL ILLUSION: PSEUDO COPULATION IN ORCHID"**
Nagajyothi G N[1], Prateeksha C T[2]

33 **DRAGON - FUTURE EXOTIC SUPER FRUIT**
Dr.M.Ananthi[1], Dr.S.Umesh Kanna[2]

39 **OPTIONS FOR PLANT PROTECTION UNDER NATURAL FARMING SYSTEM**
Raghavendra K.V.[1], Rajna S.[2], Rekha Balodi[1], S.K. Singh[1], Subhash Chander[1]

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ANTIOXIDANTS
A BOON TO PLANTS AND HUMAN HEALTH

An antioxidant is a molecule that inhibits the oxidation of other molecules. Oxidation is a chemical reaction that transfers electrons or hydrogen from a substance to an oxidizing agent. Oxidation reactions can produce free radicals and it can start chain reactions as shown in Fig 1. When the chain reaction occurs in a cell, it can cause damage or death to the cell. Antioxidants terminate these chain reactions by removing free radical intermediates, and inhibit other oxidation reactions. They do this by being oxidized themselves, so antioxidants are often reducing agents such as thiols, ascorbic acid, or polyphenols. Substituted phenols and

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derivatives of phenylenediamine are common antioxidants used to inhibit gum formation in gasoline (petrol). This article describes various aspects of antioxidants in plants and human as follows

Oxidative damage

- Oxidation reactions can produce free radicals.
- A free radical is a highly reactive species containing an unpaired electron.
- Free radicals can damage food by removal of an electron.
- Antioxidant molecules 'mop up' free radicals.

Though oxidation reactions are crucial for both plant and animal metabolic processes, they can also be damaging. Plants and animals maintain complex systems of multiple types of antioxidants, such as glutathione, Vitamin C, Vitamin A, and Vitamin E as well as enzymes such as catalase, superoxide dismutase and various peroxidases. Insufficient levels of antioxidants, or inhibition of the antioxidant enzymes, cause oxidative stress and may damage or kill cells. Oxidative stress is damage to cell structure and cell function by highly reactive oxygen-containing molecules. Oxidative stress seems to play a significant role in many human diseases, including cancers. The use of antioxidants in pharmacology is intensively studied, particularly as treatments for stroke and neurodegenerative diseases. For these reasons, oxidative stress can be considered to be both cause and the consequence of some diseases.

a. Antioxidants in Humans

In Humans, antioxidants are widely used in dietary supplements and have been investigated for the prevention of diseases such as cancer, coronary heart disease and even altitude sickness. Although initial studies suggested that antioxidant supplements might promote health, later large clinical trials with a limited number of antioxidants detected no benefit and even suggested that excess supplementation with certain putative antioxidants may be harmful. Antioxidants also have many industrial uses, such as preservatives in food and cosmetics and to prevent the degradation of rubber and gasoline.

Antioxidants are found in vegetables, fruits, grain cereals, eggs, meat, legumes and nuts. Some antioxidants, such as lycopene and ascorbic acid, can be destroyed by long-term storage or prolonged cooking of food. Polyphenolic antioxidants in foods such as whole-wheat and tea are more stable. The effects of cooking and food processing are complex, as these processes can also increase the bioavailability of antioxidants, such as some carotenoids in vegetables. Processed food contains fewer antioxidants than fresh and uncooked foods, as preparation exposes food to oxygen. Other compounds in the diet can alter the levels of antioxidants by acting as pro-oxidants. Here, consuming the compound causes oxidative stress, which the body responds to by inducing higher levels of antioxidant defenses such as antioxidant enzymes. Some of these compounds, such as isothiocyanates and curcumin, may be chemo preventive agents that either block the transformation of abnormal cells into cancerous cells, or even kill existing cancer cells as in Fig 2.

b.Antioxidants as Food preservatives:

Antioxidants are used as food additives to guard against food deterioration. Exposure to oxygen and sunlight are the two main factors in the oxidation of food, so food is preserved by keeping in the dark and sealing it in containers or even coating it in wax, as with cucumbers. However, as oxygen is also important for plant respiration, storing plant materials in anaerobic

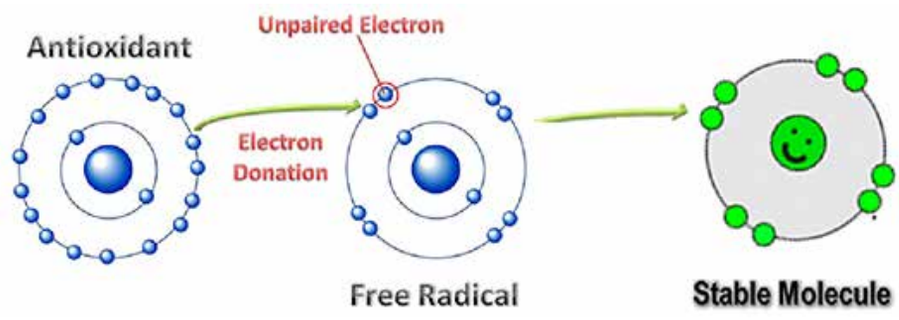

Fig. 1 Mechanism behind antioxidant activity

Table 1: Common Antioxidants in Plants and animals

Tocopherols	Ascorbic acid
Nordihydroguaretic Acid (NDGA)	Carotenoids
Sesamol	Glutathione
Gossypol	Tocopherol
Butylated Hydroxy Anisole (BHA)	CAT-Catalase
Butylated Hydroxy Toluene (BHT)	SOD-Superoxide dismutase
Propyl Gallate (PG)	Ascorbate peroxidase
Tertiary Butyl Hydroquinone (TBHQ)	GR: glutathione reductase

conditions produces unpleasant flavors and unappealing colors. Consequently, packaging of fresh fruits and vegetables contains 8% atmospheric oxygen. Unlike bacterial or fungal spoilage, oxidation reactions occur relatively rapidly in frozen or refrigerated food. Hence, Antioxidants are considered an important class of preservatives.

The most common molecules attacked by oxidation are unsaturated fats; oxidation causes them to turn rancid. Since oxidized lipids are often discolored and usually have unpleasant tastes such as metallic or sulfurous flavors, it is important to avoid oxidation in fat-rich foods. Some fatty foods such as olive oil are partially protected from oxidation by their natural content of antioxidants, but remain sensitive to photooxidation. Antioxidant preservatives are also added to fat-based cosmetics such as lipstick and moisturizers to prevent rancidity.

c. Antioxidants in Plants

Plant antioxidants are a natural reservoir of bioactive compounds. They play important roles in plant acclimation and adaptation to environmental challenges. As sedentary organisms, plants cannot escape from environmental challenges, originating from natural origin (e.g., temperature, water availability, soil composition, pests...) or from anthropogenic practices (e.g., destruction of habitats, pollution). Diverse abiotic factors, like pollution as well as nutrient deficiency, temperature regimes (heat/cold), water supply (drought/flooding), light intensity, day/night rhythms and radiation, modify the balance between production and scavenging of reactive oxygen species (ROS) and induce a phenomenon well known as oxidative stress. Although ROS are crucial for normal plant growth and development, and play important roles in signal transduction, they are also able to induce cellular damage. Therefore, maintaining the oxidative balance is crucial for plant stress adaptation. To prevent oxidative damage, plants possess an extensive antioxidant defense system consisting of enzymes and metabolites. Many of the plant secondary metabolites display biological activity against insects, fungi and other microorganisms forming the basis for their medicinal use. Both, the quantity and quality of secondary metabolites are determined by intrinsic plant characteristics (e.g., developmental stage) as in Fig3.

Conclusion:

Hence, Anti-oxidants improve tolerance to free radicals in both Plant and Humans. This information is expected to contribute in research activities of antioxidant both in plants and human.

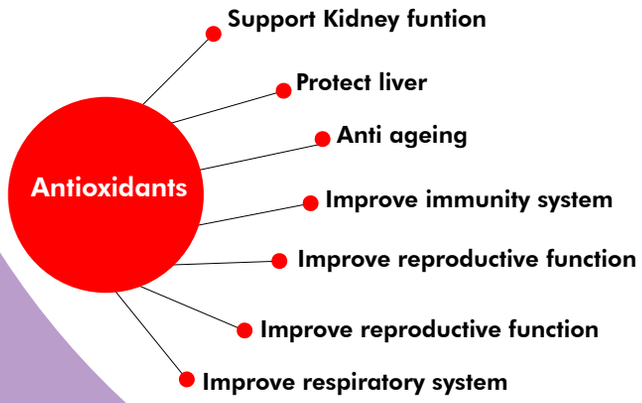

Fig. 2 Antioxidants in Humans

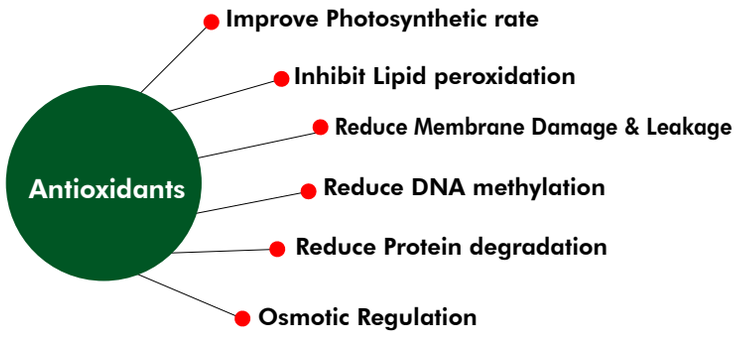

Fig. 3 Antioxidants in Plants

Cashew nut shell liquid

an alternate fuel for diesel engine

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Introduction

The cashew *(Anacardium occidentale L.)*, a tropical nut tree, gained economic importance worldwide due to its delicious kernel. In the world, approximately 5.7 million hectares are used for cashew plantations (Paula et al., 2020). The benefits offered by the kernel, apple, nut and wood produced by cashew trees are the main reason for its wider cultivation in most countries.Cashew nut is the main commercial product obtained from cashew and generates foreign exchange revenues for countries that produce it for commercial reasons (Ike et al., 2021). However, there are several byproducts of cashew nut such as cashew nut shell liquid (CNSL) having several industrial applications.

Cashew Nut Shell Liquid (CNSL) CNSL is a byproduct of the cashew kernel. In the inner part of the cashew nut, there is a kernel, which makes up the edible part of the nut. The external part of the cashew nut (shell)contains the mesocarp, which is filled with a dark liquid, CNSL.CNSL accounts for 20–25% of the nut's weight

Waste

- As a Waste, it is harmful to the environment as its improper disposal can cause lot of problems to humanity

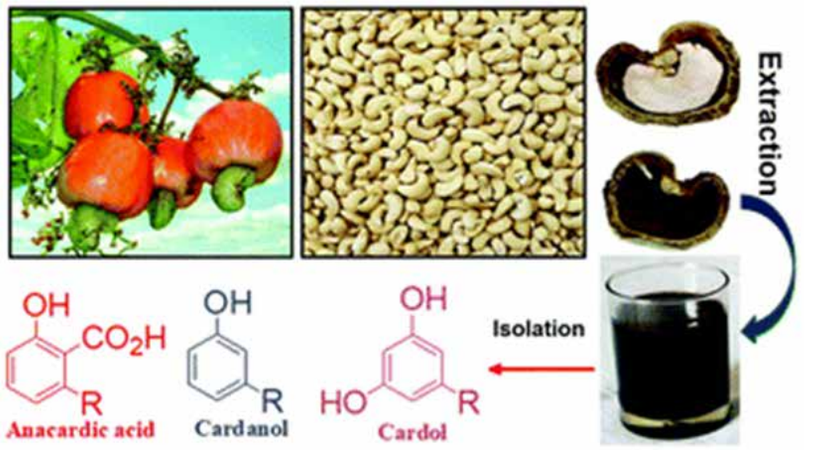
Clean Fuel

- As a fuel, it has a worth equivalent to that of diesel. Its value should be similar to that of diesel

Power

- Useful for industries to power engines. In diesel engines, it combusts well and produces reduced emissions

Schematic diagram representing the uses of CNSL (Source: Michael et al, 2022)



Schematic diagram representing CNSL extraction(Source: James Mgaya, et al, 2019)

(Scaldaferri et al, 2019).CNSL is an inedible feedstock rich in substituted phenols, including anacardic acid, cardanol, cardol and 2-methyl cardol. At temperatures above 180°C, anacardic acid undergoes a decarboxylation reaction and is converted into cardanol, thus producing technical grade CNSL. The CNSL oil contains 68–95% cardanol, 3.8–19% cardol, 1.2–4.1% 2-methyl cardol and1.1–1.8% anacardic acid.

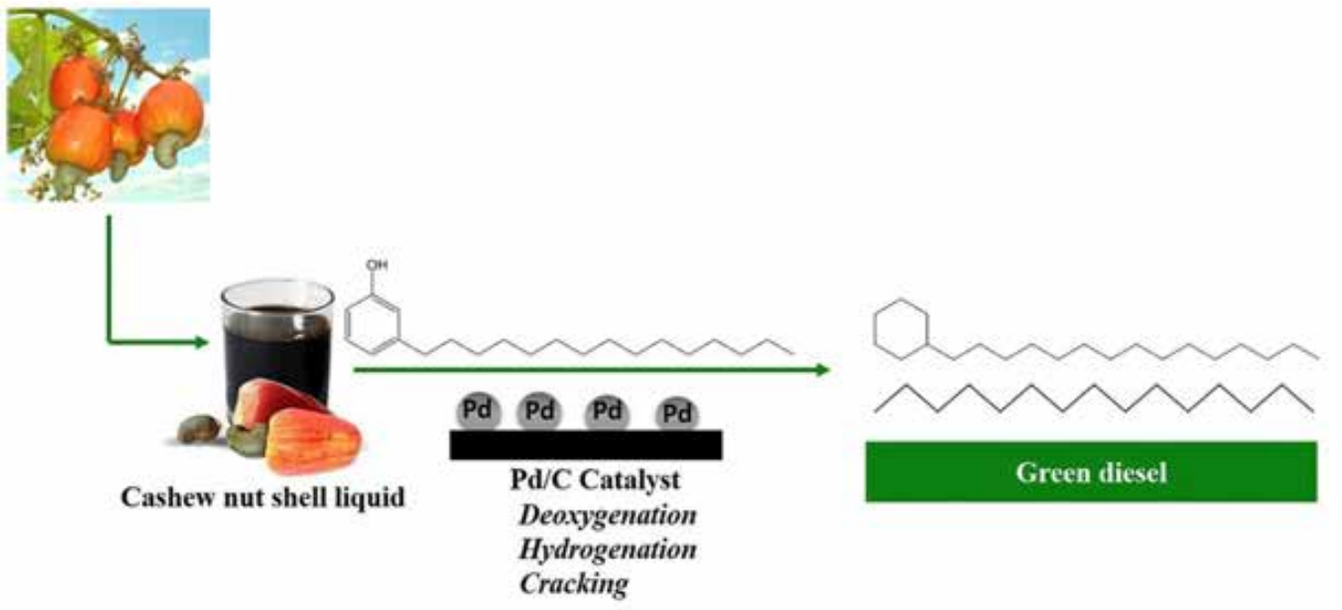
CNSL and its components have been used in numerous studies as feedstock for the development of environmentally friendly products because they are classified as a natural and renewable raw resource (Zombe et al., 2022). CNSL is also used as a core material for the creation of polyols and polyurethanes, as well as a bioadditive to help reduce the environmental effect of crude oil fuels (Jeyavishnu et al., 2021). It can be used as a natural substitute for commercially available mineral oils and synthetic oils in the industry (Bhaumik et al., 2019). The current surge in the prices of petrochemical feedstocks, conjoined with concerns about environmental issues and the continued reduction of natural fossil reserves make CNSL as a sustainable option for providing renewable energy.

CNSL also serves as a primary component in biodiesel production. It is a renewable, non-carcinogenic fuel that is free of sulfur, and also lowers the release of toxic gases. Biodiesel can be made from both plant and animal biomass. Common biomasses used for biodiesel production include edible oils, non-edible oils, cooking oils and algae. Due to the debate on the scarcity of food that may arise from biodiesel production using edible crops, non-edible feedstocks are now prioritized for biodiesel production. Furthermore, the feedstock used as raw material for the production of biodiesel represents up to 80% of the total cost. All of these reasons make CNSL a good resource for the production of biodiesel.

Cashew nut shell liquid extraction

The techniques commonly used in obtaining CNSL from cashew nut shell involve three basic procedures. Mechanical extraction involves inserting the natural cashew nut shells into a hydraulic press and applying high pressure to release the CNSL. It is easy to use, saves time and is effective. The purity of CNSL derived from cashew nut shell is around 85% by weight and the proportion of CNSL derived from them is up to 21%. Thermal extraction involves roasting the cashew nut shells in drums or baths at temperatures between 180 and 185°C. CNSL oozes out of the shells during roasting making them brittle. This approach obtains up to 90% of CNSL due to the high temperature bath.When compared to other extraction methods, Solvent extraction method yields a high amount of oil. This method uses a solvent to extract the oil from the shell which can be done using the Soxhlet process or by maceration. The common solvents often employed are n-Hexane, Pentane, Ether.

After the extraction, CNSL is divided into two categories: technical CNSL (tCNSL), which is produced by industrially burning the nuts at high temperatures and contains cardanol (60-65%), cardol (15-20%), polymeric material (10%) and trace amounts of methyl cardol; natural CNSL (iCNSL), which is



Schematic diagram representing biodiesel synthesis from CNSL (Source from Scaldaferri et al, 2019)

extracted using solvents and its main components are anacardic acid (62.9%, cardol (23.98%), and cardanol (Chatterjee et al., 2017). An estimate of 3.3 kg of cashew nut shell is needed to make 1 kg of CNSL and approximately 20% of the nutshell oil is found in raw cashew nut (Kumar et al., 2018).

Biodiesel Synthesis using Cashew Nut Shell Liquid

The most widely used technique for the synthesis of biodiesel from non-edible oil, such as cashew nut shell liquid as well as animal fats, is transesterification.In industrial biodiesel manufacturing facilities, transesterification by alkaline catalysis is the predominant method. In the transesterification reaction, reactants oil triglycerides and alcohol are reacted in the presence of a catalyst. This reaction leads to the formation of fatty acid methyl esters and glycerol. The catalysts commonly used are either acidic or alkaline. In addition to transesterification, other alternative methods can be used for biodiesel production. This includes pyrolysis, blending, and micro emulsification. The transesterification process has many advantages over other conventional biodiesel synthesis processes, including being environmentally friendly, having a moderate chemical reaction and suitable for variety of feedstocks.

Performance of Cashew Nut Shell Liquid blended biodiesel

Studies have indicated that blending 20% CNSL by volume with 80% diesel yields a fuel that works optimally in diesel engines. The physiochemical properties of Cashew nut shell liquid bio diesel (CNSLBD) and diesel vary and are indicated below.

There are several studies indicating the performance of CNSLBD with conventional diesel in order to find a substitute fuel that uses CNSL as biodiesel and reduces the problems caused by environmental degradation. Carbon monoxide (CO) emissions from CNSLBD were less than diesel at lower loads. Hydrocarbon (HC) emissions decreased at full load, but at lower loads, high HC pollutants were discovered(Karikalan et al., 2021).

Advantages of Cashew Nut Shell Liquid over Conventional Diesel

Diesel is the most widely utilized fossil fuel due to its high heating power and combustion features. World energy consumption is expected to increase by 50% by 2050(Ravanipour et al., 202). Moreover, fossil fuels cause environmental hazards including damage to forests and plants, increasing corrosion, affecting human and animal health, greenhouse gas effects, water

Properties	Diese 1	CNSKBD	Reference
Kinematie Viseosity at 40^{0}C(mm^2/s)	2.51	4.28	Devaraj et al., 2020
Density at 150C (gm/cc)	0.8200	0.844	Radhakrishnan et al, 2018
Cetane index	47	52	Devaraj et al.,2020
Calorific Value (kj/kg)	42957	37510	Radhakrishnan et al, 2018
Latent Heat of Vaporization (kj/kg)	256	685.1	Devaraj et al., 2017
Flash Point(^{0}C)	48	140	Rameshbabu and Senthikumar, 2021
Iodine Value(g/100g oil sample)	65	-	Pandian et al., 2018
Water Content (wt%)	0.001	0.11	Pandian et al., 2018

Physicochemical Properties of CNSLBD and Diesel (Source: Michael et al, 2022)

and soil pollution, coupled with wet and dry deposition of inorganic pollution etc. These reasons led to the need to introduce an alternative fuel that will effectively combat these issues.

CNSL is a relatively economically viable feedstock for biodiesel production. Studies have reported that the cost of biodiesel production from CNSL is cheap compared to other commonly used natural feedstocks such as Karanja oil, Jatropha oil, Neem Oil, Mahua Oil and Castor oil. The cost of CNSL and CNSLBD was estimated to be 0.26 US dollars per litre and 0.85 US dollars per litre respectively (Vedharaj et al., 2015). This low cost can be attributed to the fact that CNSL is a waste that can be obtained from cashew factories, unlike other vegetable oils that require total original extraction or preparation.Generally, the main benefit of using biodiesel is that it emits less CO, HC, particulate matter, polycyclic aromatic hydro- carbon compounds, and nitrite polycyclic aromatic hydrocarbon compounds in the exhaust (Kasiraman et al., 2012). Moreover, CNSL oil is more affordable than other types of vegetable oil, which is a significant benefit for the manufacturing of biodiesel. CNSL can supplement or replace current biodiesel crops like Jatropha and it can help increase farmers' revenue. Studies have reported that CNSLBD has better BTE and BSFC than Jatropha-based biodiesel. It also performs well in terms of hydro carbon (HC) and nitrogen oxide (NOX) emission reduction (Pugazthenthi et al. (2017).

Future research thrust

Beyond using non-edible feedstock for biofuel production, research has shifted into the total valorization of waste to create a circular bioeconomy. The performance and emission profile of CNSLBD should be investigated in a compression ignition engine with a deactivated cylinder, as well as a combustion engine with variable valve actuation.

Investigating the spray pattern of the fuel should be part of the core focus of future research. More work should be done to examine the compatibility of fuel with internal combustion engines integrated with emerging technologies. Improving the fuel yield produced from CNSL by optimizing the biodiesel conversion process and specifically enhancing the extraction techniques used in obtaining the liquid from the cashew nuts should be further explored.

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Bajra

Napier hybrid

A YEAR - ROUND FODDER CROP

INTRODUCTION

India is basically an agricultural country with two-third of rural population depending on it for their livelihood. Livestock is the sub-sector of agriculture which contributes about 5.2 per cent to total GDP and 28.63 per cent to the agriculture GDP (GOI, 2022).

Livestock plays an important role in nutritional security, particularly of small and marginal farmers. India is the world leader in milk production, although animal productivity is low (1538 kg/ year) compared to global average (2238 kg year-1), which can be linked to malnutrition due to huge deficit of animal feed (Vijay et al., 2018). This is mainly due to improper nutrition, inadequate health-care and management. Being the leader in cattle and buffalo population, current fodder production in our country is not able to meet the requirement of fodder. Farmers are growing grasses and legumes including hybrid napier grass, guinea grass, paragrass, velvet bean, stylo, etc. in many areas. The area covered by permanent pastures and other grazing land is 10.34 M ha (GOI, 2021) and has been decreasing over time. The fodder availability is 400.6 mt with a requirement of 1097 mt and there is a deficit gap of nearly 63.5 percent (Roy et al., 2019).

To meet the green and dry fodder requirements of animals throughout the year, cultivation of perennial grasses in forage-based cropping sequences has become popular among dairy farmers in India (Singh et al., 2002). Among various perennial grasses, interspecific hybrid between bajra and napier grass called as BN hybrid *(Pennisetum glaucum x Pennisetum purpureum)* is most popular in irrigated areas due to its wider adaptability under different agroclimatic condition, low cost of cultivation, resistance to insect-pest-disease, tolerance to grazing/damages by wild animals, propagation by vegetative materials (rooted slips or stem cuttings) and high response towards manure/ fertilizer applications along with timely irrigations/rainfall (Singh et al., 2018).

Napier grass is a native of tropical Africa and introduced in India in 1912. After two to three decades of its cultivation in India, Napier grass *(Pennisetum purpureum)* was intercrossed with African Bajra *(Pennisetum typhoidium)* to form Pusa Giant Napier which combines some qualities of bajra like succulency, leafiness, fine texture, palatability, fast growing and drought resistant ability with outstanding yield potential and perennial nature of napier grass. It is comparatively less hairy, less fibrous and grows faster producing more tillers, numerous large greener leaves with less serrated leaf margins, softer leaf sheaths.Combined characters of high productivity and good palatability makes Bajra Napier hybrid an ideal fodder crop for round the year fodder production.

The crop has diversified uses and acts as a nutritious feed for livestock as it contains nearly 10.2% crude protein, 30.5% Crude fibre, 2.1% ether extract, 41% nitrogen free extract, 16.2% ash, 0.5% calcium and 0.4% phosphorus.

Once planted, it can give 8-10 cuts in a year and if managed properly, it can provide fodder for 5-6 years. The farmers are also able to reap the benefits for a decade with proper agronomic management and maintenance of moisture level and nutrient management.

CULTIVATION PRACTICES OF BN HYBRID

Climate:

Hybrid napier grows best in deep, well drained loams with a pH of 4.5-8.2 (mean 6.2) and a moist warm environment. Crop remains dormant if temperature is below 15°C and produces best growth between 25 and 40°C. The growth ceases at 10°C.The optimum temperature for growth is 31^{0}C. It normally grows in areas with rainfall >1,000 mm. It can tolerate moderate drought as the root system is very deep. It is susceptible to prolonged flooding or water logging and also to frost. It is not recommended for the hilly areas due to its susceptibility to frost and limitations of sunlight as well as of optimum temperature. However, Napier grass survives in moisture deficit conditions for short duration and with the commencement of rain it regenerate again.

Soil requirements:

It can grow in all types of soil. However, deep fertile soil having good moisture holding capacity and adequate drainage is most favourable for its optimum growth and development.

Land Preparation:

The land is thoroughly prepared generally by 2-3 ploughing followed by planking. It is a long duration crop; hence periodical tillage activities like other crops are not possible after the crop occupies the field. Plantings can also be done on flat beds.

Sowing time:

Planting is done with the

Improved varieties

Area of cultivavtion	Varieties
Central India, North East Hills and Northern Hills	IGFRI Hybrid Napier-3, IGFRI-5, Yashwant (RBN-9)
Whole country	Pusa Giant, IGFR-10 and NB-21
Tamil nadu, Karnataka, AP and Gujarat	CO-1, CO-2, CO-3, TSHL-1 (Telangana Dasharath), KKM-1
Punjab, Haryana, Gujarat	Bajra Napier Hybrid PBN 351, CO-6(TNCN1280), IGPISH as BBS Hybrid-1 (VTPH-3), PBN-83, PBN 233, APBN-1
Kerala	Suguna, Supriya and Susthira
RRS Dharwad	Sampoorna (DHN 6)

onset of southwest monsoon. This crop can be cultivated throughout the year under Indian condition.

Seed rate:

Being a sterile hybrid, it does not produce viable seeds although it could initiate an inflorescence or spike.So, the grass is propagated by rooted slips and stem cuttings. Cuttings of moderately mature stems (3 months old) and preferable from the lower two thirds of the stem length sprout better than the older stems

Sowing method:

Stem or root cuttings are generally used for propagation of this crop with a spacing of 60 x 60 cm for pure crop. In intercropping system, spacing is adjusted to accommodate the companion crops. While planting, two nodes are buried inside the soil and one node is exposed outside. Planting should be done in slanting position (45° angle) with 5-7.5 cm below the soil to ensure maximum establishment.

Intercropping:

Hybrid napier and leguminous crop can be planted in 1:3 ratio, to take 4-5 cuttings of napier and 1-2 cuttings of leguminous crop. During winter as napier remains dormant so intercropping with lucerne or berseem can be done to regulate continuous fodder supply and nurse the napier plants by protecting them from frost and also improves soil fertility.

Manures and fertilizers:

25t/ha of FYM, 50kg/ ha of P^2O^5 and K_2O each to be applied at the time of final land preparation. Apply N @ 200 kg/ ha in two or three split doses after every cut as topdressing.

Water management:

This grass is very hardy in nature and does not require irrigation during monsoon season if rains are normal and well distributed. The field should be provided with good drainage during the rainy season, as the crop cannot withstand water stagnation. Frequency of irrigation depends upon the rainfall and weather conditions.

Harvesting:

First cutting should be done 75 days after planting and subsequent cuts with an interval of four to six weeks or at about 1.5-meter height since, nutritional value of the crop diminishes if the crop grows beyond this.

Crop should be cut 15 cm above the ground level inorder to ensure quicker regeneration from the basal buds. Annually at least six to eight cuts are possible.

Yield:

An average green fodder yield of 200-250 t/ha per year can be taken from 6-8 cuttings.

Utility:

The excess fodder can be chaffed and converted to silage along with legume fodder. The grass fodder can also be used after making hay during dry summer periods. The quality of the silage or hay remains more or less the same as green fodder. In addition, the crop serves as a firebreak and windbreak.

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Lets Try The Varieties!

"There are no miracles in agricultural production."
-Norman E Borlaug

KAU Manuvarna

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Before the way back to home for the Onam holidays, I just stopped at the seed counter besides the Alumni gateway of our college. Mom had already given a complete list of seeds and seedlings for her vegetable garden. A few months later, followed the joy of graciously accepting her compliments on behalf of Kerala Agriculture University; for the bumper yield and added advantages.

Have you ever wondered why some seeds or seedlings are exceptional in the field with visible advantages. Some of them might be unaffected by diseases, while some fail to survive in the drought. There are others with giant yield, but give up in the battle of survival of the fittest. Can you imagine the possibility of grabbing most of the superior traits in the same garden. Since it is a reality in this 21st century, let's extend our imaginations and launch our journey behind these desirable varieties.

A crop variety can be defined as an assemblage of cultivated plants with clearly distinguishable characteristics, with an ability to

KAU Mithila

retain these characteristics when reproduced. Crop varietal improvement is one of the supreme foundation for enhancement of Agriculture as a whole. Since, science remains as an obedient child in the hands of a scientist, this had been made possible through research and extension in agriculture. With consistent efforts of eminent scientists from various departments, Kerala Agricultural University has released almost 343 varieties of crops till date. In this journey, they employed a wide range of techniques including hybridization and selection, heterosis breeding, selection from local collection, interspecific hybridization, clonal selection, etc. It would be a lot more interesting to look into the noval contributions from our Kerala Agriculture University (KAU). Let's get acquainted with some of the latest varieties of crops released from KAU.

Cherthala long

Rice

Rice being one of the most important staple crop of our diet, had undergone most abundant variety improvements since 1970s. The recent developments in this crop includes two varieties; namely 'KAU Mithila' from Regional Agricultural Research Station, Pilicode, Kasargod and 'KAU Manuvarna' from Agricultural Research Station, Mannuthy. The former is a hybrid of Jaya and Orkayama, while

'KAU Nithya' (winged bean)

Suruchi'(Cluster bean)

the latter is the result of selection after hybridization between Jyothy and Swarnaprabha. KAU Mithila is an organic variety with outstanding qualities like high yield of 5.2 t/ha, saline and flood tolerant, resistant to sheath blight, leaf folder and gall midge. KAU Manuvarna is a short duration (128-138 days) variety with tolerance to salinity, having high amylose content and resistant to stem borer, leaf folder and gall midge.

Vegetables

The latest release of vegetable varieties are the five stars namely; 'KRH-1'(ridgegourd), 'KAU Nithya' (winged bean), 'KAU Deepika'(yard long bean), 'KAU Vaika'(amaranthus) and 'KAU Suruchi'(cluster bean). The ridgegourd variety was developed by College of Horticulture, Vellanikkara and the four other vegetable varieties from College of Agriculture, Vellayani. KAU Nithya, KAU Deepika and KAU Suruchi are notable for their low incidence of pests and diseases. All the five of them also shows their supremacy in the amount of yield. KRH-1 is the first hybrid from KAU in the ridgegourd and is highly heterotic in nature. It was developed by heterosis breeding through three line method, exploiting cytoplasmic genetic male sterility system, while the other four recent vegetable varieties were selections from local collections. KAU Deepika and KAU Nithya are particularly suitable for homesteads of Kerala.

Plantation crops

'Kerasulabha',the coconut variety and 'KAU Nihara', the cashew variety are the latest release of plantation crops from KAU. KAU Nihara is remarkably the first dwarf type cashew variety released in our

'KAU Nihara' (cashew)

'KAU Vaika'(amaranthus)

'KAU Deepika'(yard long bean)

Kerasulabha (Coconut)

country. It is a selection of local collection from Thaliparambu and produces an average yield of 1.25 t/ha. The credit for releasing both these plantation varieties remains with the Regional Agricultural Research Station, Pilicode, Kasaragod. Kerasulabha, a selection from Philippines Lono (PCE 61), produces higher average yield of 88.72 nuts/palm/year; seems an added advantage for our coconut state of Kerala. Hopefully, it could exhibit better performance even under unfavourable conditions.

Spices

The Pepper Research Station in Panniyur, Kannur remains one of the best scientific laboratory of pepper varieties in our state. The latest release from this research station is 'Panniyur 10' which is a climate resilient variety tolerant to Phytopthora infection. Producing a higher average yield of 2.3kg/vine; it also contains high piperine, high oleoresin and higher bulk density.

Medicinal plants

The 'Bhoomika' variety of vetiver is the latest advancement from Aromatic and Medicinal Plants Research Station, Odakkali, Ernakulam. It is highly superior to most of the existing varieties due to the non-flowering nature, higher oil content in roots, better tolerance and an efficient barrier to check soil erosion. It also brings about a significant root yield of 200 kg/100m^2

Forage crops

With an average yield of 300 t/ha, 'Susthira' variety of bajra napier hybrid is the latest improvement in forages. It was released as a result of interspecific hybridization followed by clonal selection at College of Agriculture, Vellayani, Trivandrum. It is a hybrid variety from *Pennisetum americanum* and *Pennisetum purpureum*. Its prominent traits include higher average yield of 300 t/ha, high tillering, high crude protein and crude fibre content.

Conclusion

The passion for research of Kerala Agricultural University is flowing blissfully along with the never ending tides of evolving Science. The hardwork and determination of the eminent Scientists and the Professors behind the scientific outbreaks are the strong pillars for these achievements. Agriculture had evolved from cultivation to profession following the waves of civilization over a time period of about 12,000 years. The bond between Science and Agriculture was strengthened by masterbrains like Norman E. Borlaug and M.S Swaminathan; hopefully continued by our Agricultural Scientists.

'Panniyur 10'(Pepper)

'Bhoomika' (vetiver)

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Bhringaraj

Herbal elixir for hair and well being

Medicinal plants (Volume II). National Medicinal Plant Board, New Delhi, 121p. Bhringaraj, known as false daisy, Kayyunni (Malayalam), and Karisalankanni (Tamil), scientifically *Eclipta prostrata L.* is an important medicinal herb belonging to the Asteraceae family. It is popularly known as the "King of hairs," and used in indigenous systems of

medicine as a hepatoprotective drug. It is one of the most common weeds, native to Asia but is now extensively distributed in tropical, subtropical, and warm temperate regions worldwide. Most commonly found in waste places, marshy lands, hedges, and roadsides, particularly in the more tropical parts of the country. In Kerala, it is widely distributed in moist places. It has been widely used since ancient times in many medicinal systems of the world, commonly in Chinese and Indian medicine, to cure several diseases. It has a wide range of biological activities such as anticancer, antimicrobial, hair growth promoting, hepatoprotective, and neuroprotective activities. The juice is given with honey to treat upper respiratory congestion in children. The hair oil is prepared by boiling the fresh leaves with either coconut or sesame oil, rendering the hair black and lustrous.

It is an annual erect or prostrate, branched herb (20-90 cm high), occasionally roots at lower nodes. The stem is cylindrical or flat, rough because of short white hairs, with distinct nodes greenish and occasionally brownish. Leaves are opposite, sessile to sub-sessile 2.2 to 8.5 cm long, 1.2-2.3 cm wide, oblong, lanceolate, sub-entire, acute to sub-acute, and strigose with appressed hairs on both surfaces. Flowers are white, organized solitary or two on unequal axillary peduncles. Flowering stalks arise from the axis of the leaf. Involucre bracts are about 8 in number, ovate, obtuse, or acute, and strigose with oppressed hairs. Ray flowers are white, ligulate, with tiny spreading ligules. Disc flowers are tubular. Corolla is often four-toothed. Stamens are five, with epipetalous filaments, and anthers are united into a tube with an obtuse base. Pistil is bicarpellary. The ovary is inferior and unilocular, with one basal ovule. Fruit is one-seeded, cuneate, achenial cypsela with a narrow wing and brownish. Each flower head produces multiple achenes that turn light brown to black as they mature and fall, leaving behind small cup-like structures. A single plant can produce over 17,000 seeds in one growing season. Roots are fibrous with a shallow taproot.

It grows widely in a variety of soils, viz. sandy to clay soil, and commonly on damp wastelands, low waterlogged areas, roadsides, paddy, and other crop fields, preferably in a warm climate with a temperature range of 25°C to 35°C is ideal for its growth and development. It germinates over various pH, salt, and temperature conditions and is preferentially greater in warm, moist soils. It is not drought-tolerant and germinates poorly in dry soils.

It can be propagated through seeds as well as stem cuttings. Freshly collected mature seeds have good germination (75-85%) in well-prepared nurseries. Seeds are sown in raised nursery beds (1x3x0.15m) for raising seedlings. Soil is prepared to a depth of 30cm and mixed with farmyard manure at 2kg/m^2. Seeds are sown and gently covered with soil and watered. Almost 450-500g seeds or 25,000 propagules plus 10% for gap filling are required for one hectare. 45-60 days old seedlings are ready for transplanting to the main

field. It can also be propagated vegetatively through 10-15cm long terminal stem cuttings with 5-6 nodes. Cuttings can be planted either in well-prepared nursery beds or polythene bags. 4-5 week old rooted cuttings can be transplanted to the main field. The main field is ploughed and harrowed several times to prepare the soil to a fine tilth. The field is kept levelled and weed free by removing the grass stubbles and roots. Good drainage is provided to avoid waterlogging during rains. The seedlings or rooted cuttings can be transplanted into the field at a spacing of 20x20cm. Adequate fertilizer application improves growth and herbage yield. Manual weeding is preferable whenever necessary. No major pests are reported. Occasionally, defoliating insects attack and damage the crop. Yellowing, leaf blight, and gall formation are the major diseases.

It is a three-month duration crop. The best time and stage for harvesting is 90 days after transplanting or at the early flowering stage. Harvesting is done by plucking the plant out from the ground, then chopping the roots. Care should be taken not to heap or pack the fresh wet plant material as it may lead to fungal infection during storage. So, the plants are cleaned, shade dried, packed in gunny bags, and kept in a cool and dry place. Cutting plants into moderate size pieces aids in shade drying. Proper drying

is essential to avoid microbial attack and decomposition. Seeds are collected when they begin to turn black. On average, 6000kg of dried herbage yield can be obtained from a hectare.

Chemical composition and uses

The plant is characterized by the presence of an array of phytochemicals, including alkaloids, coumestan derivatives, triterpenesaponins, steroidal saponins, triterpenes, steroids, steroidal alkaloids, flavonoids, phenolic acids, thiophene derivatives, and many other compounds. The major alkaloids like ecliptine and nicotine, bio-active steroidal alkaloids like verazine, dehydroverazine, and ecliptalbine, coumarins like wedelolactone and its derivative, demethylwedelolactone, and demethylwedelolactone-7-glucoside, sterols like phytosterol, β-glucoside of phytosterol, daucosterol, and stigmasterol-3-O-glucoside and Flavonoids like apigenin, luteolin, and luteolin-7-glucoside were identified. Wedelolactone, a major coumestan ingredient of *E. prostrata*, exerts hepatoprotective activity.

Fresh herb is chiefly used as a tonic, deobstruent in hepatic and spleen enlargement, and in various skin diseases. It is bitter, reduces kapha and vata, and is a good rejuvenator. It helps cure night blindness, eye diseases, and headaches. The root is emetic and purgative. The plant is considered an astringent, anodyne, absorbent, antiseptic, febrifuge, anti-myotoxic, antihemorrhagic, antiproliferative, antioxidant, antitumor, antihyperglycemic, antimicrobial, antihyperlipidemic, antivenom potential, anti-HIV, larvicidal, and antidementia activities. Bhringaraj is commonly used as a scalp tonic to promote hair growth and as a deobstruent to promote bile flow and protect the liver parenchymatous tissue in viral hepatitis and other conditions involving hepatic enlargement. Fresh leaf juice improves appetite, stimulates digestion, and treats edema, fevers, liver disorders, and rheumatic joint pains. Most commonly used for hair oil, hair dyes, and kajal preparations in Kerala.

Several studies were conducted to identify the traditional hair growth-promoting, blackening, and strengthening properties of Bhringaraj. Pigmented C57/BL6 mice are the most commonly used models for hair growth promotion studies. According to Datta et al. (2009), the methanol extract of the whole plant exhibited dose-dependent hair growth-promoting potential when tested in C57/BL6 mice. In another study, it was found that the topical application of the petroleum ether extract (incorporated into an ointment base in a concentration of 5%) on shaved denuded skin of rats after 30 days reduced the time required for hair growth initiation and complete hair growth and increased the number of anagenic hair follicles, which were better than 2% minoxidil treatment.

Thus, Bhringaraj, a small herbaceous medicinal plant, has great therapeutic potential and diversified uses. It offers many prospects for traditional and modern medicine and potential herbal therapy for many diseases.

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Untapped pandanus becoming a potential threat

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Pandanus, also called screw pine (Thazhampoo or Pookaithain Malayalam) generally grows along coastal regions, marshy places and in forests of tropical and subtropical regions. Pandanus flower is highly valued in perfume industry owing to its pleasant fragrance. The fragrance of the flower is known to last longer; hence it was used in boxes with cloths in earlier days when commercial perfumes were not available so as to give cloths a pleasing fragrance. It is also used

Fig. 1 Pandanus growing in paddy field

Fig.2 Pandanus growing along the sides of brook

by ladies in their hair for its smell. The flower is not generally used in temples and is forbidden for religious rituals as it is believed to be cursed by Lord Shiva for becoming a false witness of Lord Brahma in his lie as per Hindu mythology.

The plant belongs to Pandanaceae family and the genus has nearly 750 species of which *Pandanus tectorius* is one of the least exploited dominant plant species among the coastal vegetation of India. The common species found in Kerala is *Pandanus odorifer*. It grows along bank of rivers, ponds, canals, brooks etc. Due to the fibrous nature of leaves, it has been used in weaving industry in several parts of the country. Some other species are recommended for treating various ailments in Indian Ayurvedic medicines. Most species grow as small shrubs with broad canopy having less than one metre height to medium sized trees of 20m. They have many thick stilt roots near the base which provide support to top heavy leaves fruit and branches.They grow profusely in swampy, wet areas with enough water availability. Hence are naturally found along streams, riverbanks, canals and even in paddy fields (Fig.1 and 2). Few species are found near beaches and some species even occupy higher altitudes where water is available. Pandanus is also planted as bio-fence to prevent soil erosion along the river margins. Its roots are known to grip the soil tightly and new suckers or plantlets sprout from the base protecting river margins. The plant also bears fruits which on ripening fall down, this can float in water and will spread to other areas. Pandanus fruits though have less demand and takers;it is rich in carotenoid and has beneficial effects against diabetes heart disease, and cancer.

Pandanus leaves are armed with spines along the margins. This protects them from other grazing animals and human. The pricks from the spines are considered to be very painful. They grow mostly in swampy areas along margins of canals and rivers which makes them less accessible. Due to these facts only a trained or skilled person can cut their leaves even with protective coverings.

Pandanus leaves were of great demand and were used for making baskets, mats and other handicraft items. The mature leaves from the plant are cut, sliced into fine strips after removing the spiny edges and later weaved to mats and other handicrafts. Different colour dyes are used to make them more attractive. The mats were considered to be very durable and were a preferred item before the advent of synthetic plastic mats. Now there are hardly any takers for pandanus leaves. The natural fibre extracted from the leaves act as raw material for textile industry apart from its use in paper and bioenergy industry. The cellulose fibre extract from pandanus leaves is used as reinforcement in polymer composites globally. Presently there is a growing demand for natural fibres as people

are becoming aware of the negative environmental impact of synthetic fibres and the damage it may cause to human health. Synthetic polymers production utilises a large amount of energy which produces environmental pollutants during the production and recycling of synthetic composites

In Kerala the use of pandanus leaves have reduced drastically with the diminishing number of traditional weavers who were skilled in cutting and making handicrafts and mats out of it. There are no commercial fibre extractors available in Kerala, although literatures say it has great potential globally. As a result, the natural and planted pandanus plants along margins are growing profusely into the rivers and canals from margins obstructing the flow of water (Fig.3). People are reluctant to go near the plant because of its thorny nature. The plastic waste which gets entangled on the leaves when water flows add to the woes. There are many instances of flash floods in Kerala even during moderate downpours. Most of these are caused by blockage of drains, canals, rivulets and brooks. Pandanus overgrowth along margins is blocking the flow of water in many canals and rivulets causing floods.

Pandanus has multiple uses especially its leaves. The under-exploitation and lack of awareness on its potential has raised a new threat in the form of floods. It is highly essential to formulate new strategies for effectively utilizing the plant for revenue generation or else it will become a threat.

Fig.3 Pandanus growing in brook

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"Floral illusion Pseudo copulation in Orchid"

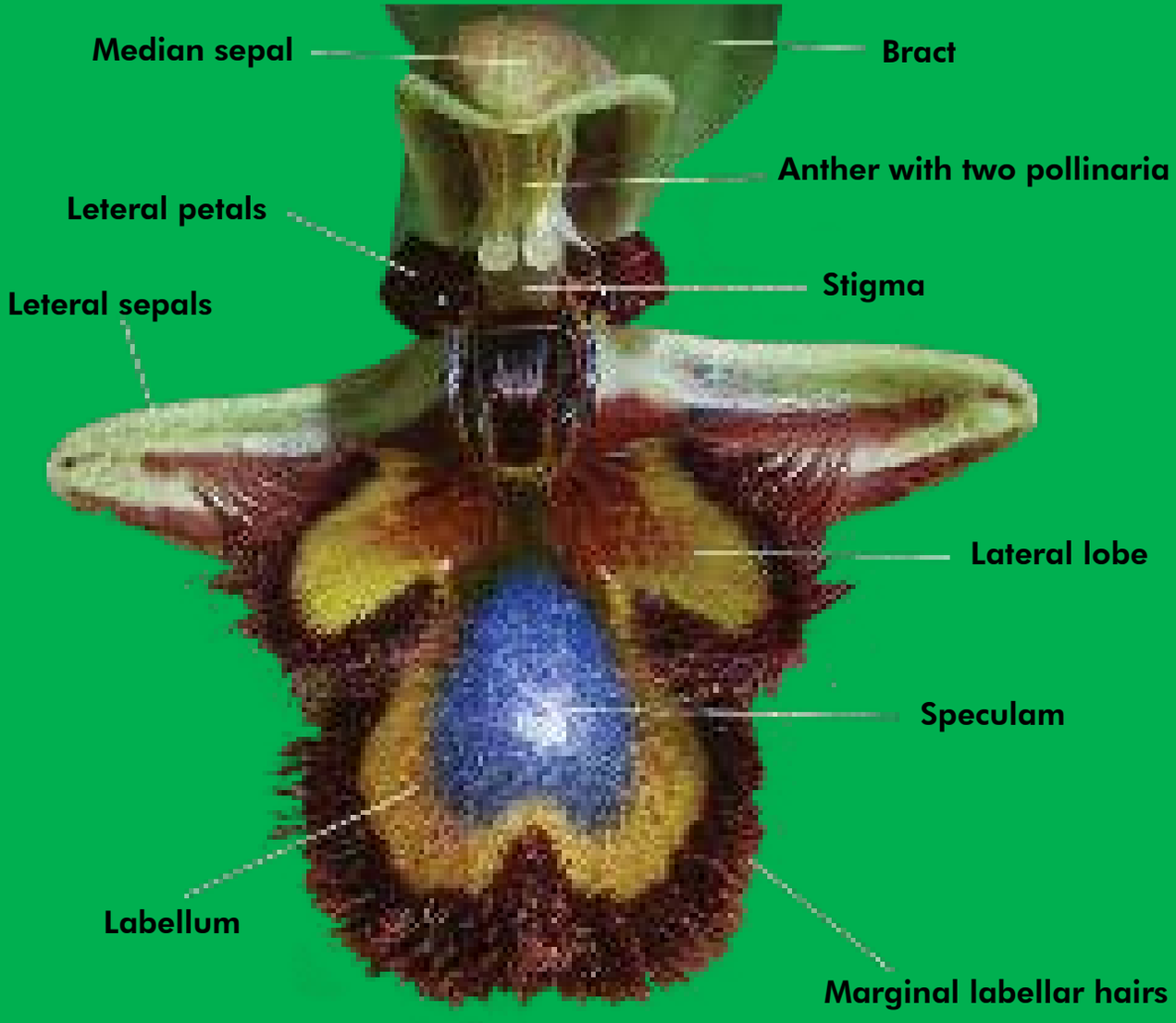
bee orchid

Pseudocopulation is a behaviour similar to copulation serves as a reproductive function of one or both participants but do not involve actual sexual union between the individuals. It is mostly observed in pollinators attempting to copulate with a flower. This type of sexual deception observed in orchids for efficient pollination.

Orchids have complex and specialized flowers with elaborate structures and colour patterns that closely resemble female insects or their pheromones. The reproductive structures like sepals, petals or labellum, that are indistinguishable from the insect's natural pheromones, secrete certain chemicals from glands (osmophores). Orchids display a vast array of floral morphologies and pollination mechanisms, unparalleled in any other angiosperm family. Among

the most fascinating pollination syndromes is sexual deception, also known as pseudocopulation, in which the flower lures male insects by mimicking the sexual pheromones and appearance of their females. In most cases of sexual deception, pollination occurs when the insect attempts (unsuccessfully) to copulate with the flower and brushes against the column (gynostemium). During the act, pollinator has a pollinium attached to its body, which it transfers to the stigma of another flower when it attempts another 'copulation'.

sawfly-orchid



floral parts of orchid

The intricate structures and specialized adaptations of orchid flowers aid in attracting and manipulating their targeted pollinators. Some of the floral modifications are:

Labellum: The labellum, known as the lip, is a modified petal that often exhibits adaptations for pseudo copulation. It can be highly specialized in shape, coloration and texture to resemble the body parts of female insect. The labellum may have distinct markings, patterns or structures that mimic the appearance of wings, abdomens or other insect body parts.

Column: The column is a unique structure formed by fusion of male reproductive organs (stamen) and the female reproductive organ (pistil). In pseudocopulatory orchids, the column often exhibits specific adaptations. The position, shape and texture of the column can facilitate precise contact with the pollinator during pseudocopulation

Pseudo-pollen or pollinia: Orchids typically produce pollinia, which are masses of pollen grains bound together. In pseudocopulatory species, the pollinia may have specialized structures or adaptations that aid in attachment to the pollinator's body. These structures ensure efficient transfer of pollen during pseudo copulation

Nectar guides: Nectar guides are visual cues present on the flowers that guide pollinators towards the nectar-producing structures. In pseudocopulatory orchids, the nectar guides may be modified to resemble the body parts or markings of female insects. These visual cues helps to attract and manipulate the pollinators, enhancing the success of pseudo copulation

Scent-producing structures: Orchids have specialized structures, such as scent glands or modified petals, that produce and release specific scents. These scents mimic the pheromones emitted by female insects, further

deceiving and attracting the targeted male pollinators

Factors impact onpseudo copulation:

- To employ pseudocopulation often have specialized flowers with complex structures. These structures may include petal modifications, such as lip-like structures or elaborate shapes, which resemble the body parts of female insects
- The coloration and pattern should match similar to the colour of female insect,

wasp orchid

bumble bee orchid

effectively fooling male insects into thinking they have found a potential mate

- Flower should emit scents that mimic the pheromones released by female insects. The production and release of these scents at the right time and in the right quantities are crucial for attracting male insects. The chemical composition and timing of scent emission need to match the pheromones released by female insects to effectively lure male pollinators
- The pollen should be strategically positioned on a structure within the flower, often called the column or reproductive column. When a male insect lands on the flower and attempts to copulate, it comes in contact with the column, leading to pollen transfer
- As the male insect engages with the flower, its body parts, such as legs or mouthparts, come into contact with the reproductive column and the pollen. The pollen grains may have specialized structures that allow them to stick to the insect's body
- Higher genetic diversity may have a better chance of matching the specific preferences of their targeted pollinators and increasing their success in pseudo copulation
- Once the male insect leaves the flower, it may visit another flower of the same species, attracted by its deceptive appearance and scent. As it lands on the second flower, the pollen attached to its body inadvertently brushes against the stigma of the new flower, facilitating pollination

In some Australian orchid genera, the labellum (the specialized median petal of orchids) imitates the wingless female insect and is attached to the rest of the flower by a flexible hinge; pollination occurs when the male insect tries to fly away with the female decoy and swings against the column. The morphology of the labellum serves as a visual cue for male insects. Pollen is transferred to the abdomen when a male pollinator attempts to copulate with the orchid. Most orchids that utilize pseudo copulation are in the genus Ophrys. The genus has approximately 130 species, which can be divided into 10 macrospecies. About 1/3 of orchid species offer pollinators no food reward and rely on sexual deception. Orchid pollination by pseudo copulation has been well documented in genus Ophrys

from the Orchideae commonly referred to as bee orchids.

With in the *Ophrys genus*, there are numerous species that exhibit pseudo copulation with specific pollinators are:

***Ophrys apifera* (Bee Orchid):** This species mimics female bees, primarily the *Andrena nigroaenea* and Andrena ovatula species

***Ophrys bombuliflora* (Bumblebee Orchid):** This orchid imitates bumble bees, such as *Bombus terrestris* and *Bombus pascuorum*

***Ophrys speculum* (Mirror Orchid):** This species resembles female solitary bees, specifically the *Eucera longicornis*

***Ophrys tenthredinifera* (Sawfly Orchid):** This orchid exhibits pseudo copulation with male sawflies, particularly the species *Rhogogaster viridis*

Wasps: Orchids mimic the appearance and behaviour of female wasps, attracting male wasps that mistake the flower for a potential mate and aid in pollination

Advantages of Pseudo copulation

Efficient pollination: Pseudo *copulation ensures* efficient pollination by specifically attracting and manipulating the intended pollinators. By mimicking the appearance, scent and other cues of female insects, orchids can lure male insects that are actively seeking mates. As the male insects attempt to copulate with the orchid flower, they inadvertently transfer pollen from one flower to another, facilitating cross-pollination and increasing the chances of successful fertilization

Specificity and accuracy: Increase the precision of pollination and reduce the chances of pollen wastage on incompatible flowers

Increased visitation rates: The deceptive signals produced by orchids, including visual cues and scent mimicry, attracts male pollinators activity. This increased visitation rate enhances the opportunities for successful pollination and lead to higher reproductive output.

Synchronization with pollinator behaviour: Orchids engage in pseudo copulation are often synchronized with the mating behaviours. By flowering and releasing their deceptive signals at the same time as female insects, orchids increase the likelihood of encountering receptive male insects searching for mates. This synchronization maximizes the chances of successful pollination by aligning the orchid's reproductive cycle with that of its pollinators

Artificial pseudo copulation, also known as synthetic pseudo copulation or mechanical pollination, is a technique that can be used to facilitate pollination in orchids. It involves mimicking the cues and mechanisms of pseudo copulation to artificially transfer pollen between flowers. While it may not replicate the precise intricacies of natural pseudo copulation.

Artificial pseudo copulation methodsare

Hand pollination: Manual transferring of pollens from the anther (male reproductive structure) of one flower to the stigma (female reproductive structure) of another flower using brush, cotton swab or fine forceps. This method is often employed in orchid cultivation, especially for hybridization purposes or in situations where natural pollinators are absent or unreliable

Vibrational pollination: Orchid species require specific vibrations in some species to trigger pollen release and facilitate pollination.

Scent and visual cues: In some cases, synthetic pheromones or chemical compounds that resemble the scent of female insects can be applied to orchid flowers to attract male pollinators. Additionally, specific colours, patterns or shapes can be used to visually mimic female insects, increasing the likelihood of attracting pollinators

Disadvantages of artificial pseudo copulation

- Artificial pseudo copulation, particularly when performed repeatedly or within a limited pool of individuals, may lead to reduced genetic diversity as it bypasses the natural genetic mixing that occurs through cross-pollination by diverse pollinators
- Artificial means of attracting pollinators may not perfectly replicate the exact cues, scents and behaviours that attract the targeted pollinators. As a result, the effectiveness in attracting the desired pollinators may be diminished, leading to lower pollination success rates compared to natural pseudo copulation
- Artificial pseudo copulation, such as hand pollination, can be time-consuming and labour-intensive, may not be feasible on a large scale as human intervention is necessary to ensure successful pollination

Dragon

Future Exotic Super Fruit

Our nature is surrounded with wide variety of plants and many of them are having medicinal properties. These medicinal plants have been playing an essential role in the development of human culture. They contain the substances that provide nourishment essential for maintenance of life and for growth. The use of medicinal plants has attained a commanding role in Humen

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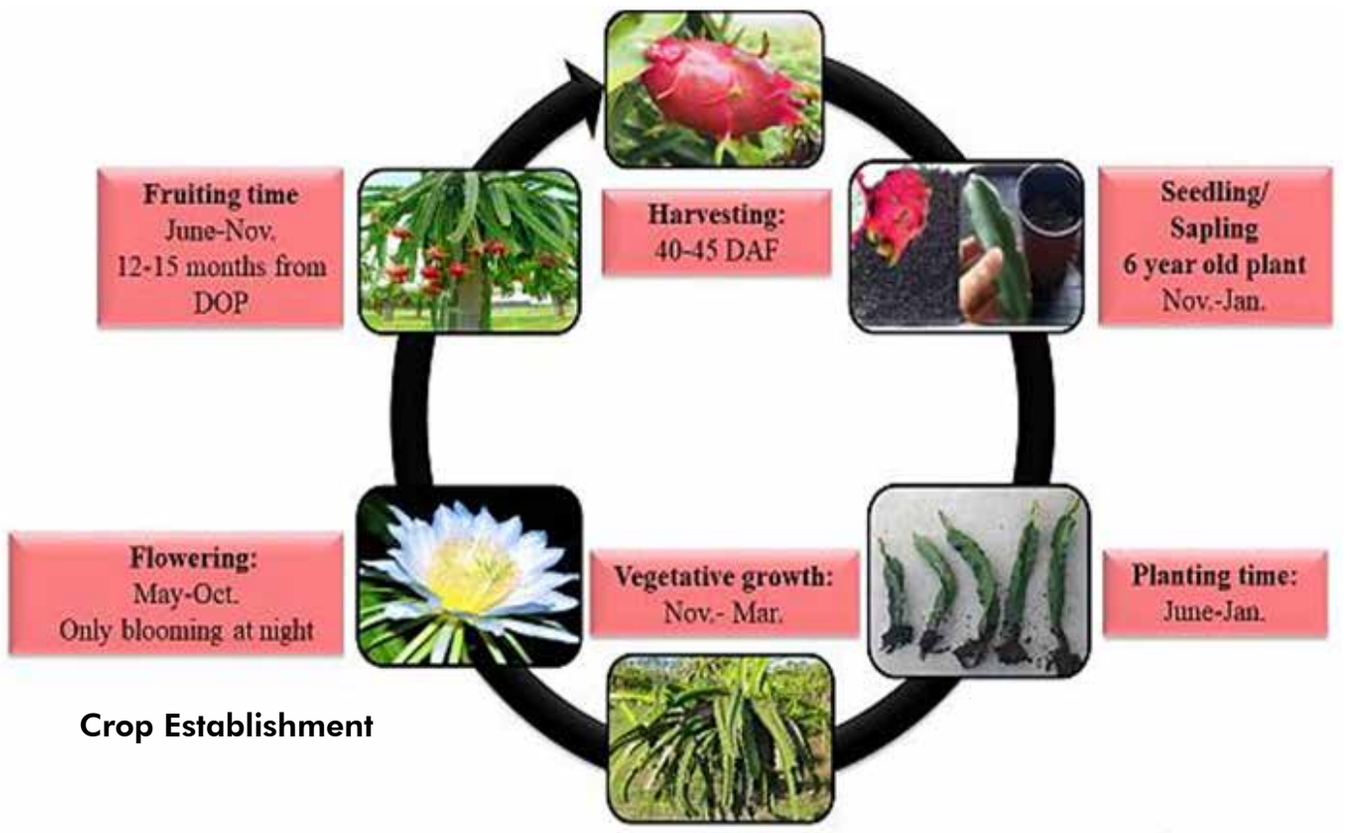
Popular types

Hylocereus undatus	• Also known as Pitahaya. • Variety has a white flesh with pink skin and green scale. • Edible black seeds	
Hylocereus costaricensis	• Violet red flesh and pink skin • It's also known as Costa Rican Pitaya • It's native to Costa Rica • The fruit is magenta and the seeds are pear shaped	
Hylocereus megalanthus	• Native to South America. • White flesh with yellow skin	
Hylocereus polyrhizus	• Also known as Red Pitaya. • Variety has a red flesh with its pink skin. • Native to Mexico. • Most popular type now grown in many countries	



Crop Establishment

Dragon Flower

health system all over the world. *Hylocereus undatus* is typically the most cultivated vine cactus belonging to the family of Cactaceae, originating natively from Mexico and America. Commonly, it is well known under the name of "dragon fruit" or "pitaya". It is a long day plant with beautiful night blooming flower that is nick named as "Noble Woman" or "Queen of the Night". Fruit is named as pitaya because of the bracts or scales on the fruit skin and hence the name of pitaya means ''the scaly fruit''. Besides its attractive coloration, the fruits of *Hylocereus undatus* are being prevailed globally because of its rich source of polyphenolic components and their antioxidant activity. *Hylocereus undatus* contain carbohydrates, crude fiber, vitamin C, flavonoids, thiamine and polyphenol.

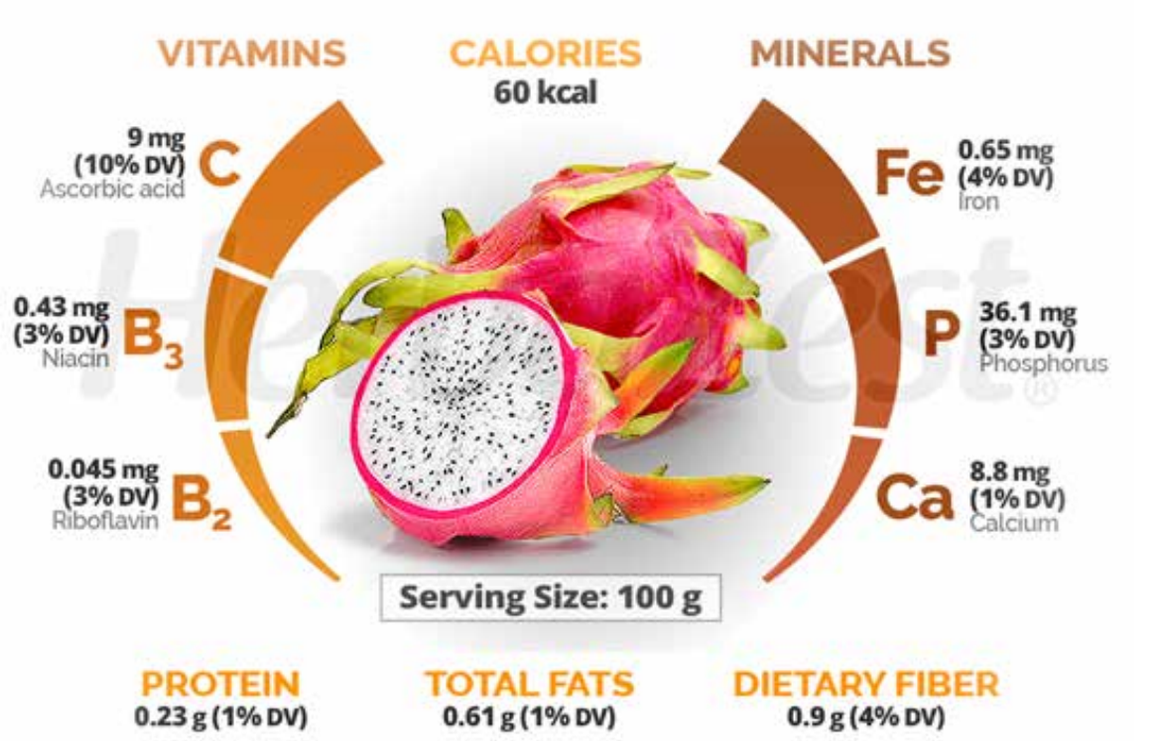
Global leading suppliers and market

Major dragon fruit supplier countries:

- Asia: Vietnam, China, Thailand, Taiwan, Indonesia, Malaysia, Philippines, Cambodia, India and Sri Lanka.
- Middle East and Europe: Israel, Switzerland and EU.
- America: Mexico, Colombia, Ecuador, Guatemala and Costa Rica.

Why becoming popular?

- The biggest advantage of this crop is once it planted, it will grow for about 20 years.
- One hectare could accommodate 1000 to 2000 plants.
- The agronomic practices are easy and less expensive.
- Tolerant to the arid environment.
- Adaptive to various marginal soil conditions.
- It bears fruit in the second year after planting.
- Attains full production within five years.
- Maintenance cost is low.
- Low requirement of water and tillage practices.
- Plant cuttings can be used for further propagation/resale.
- Dragon fruits have excellent demand in local & export markets.
- Aftercare is minimal due to fewer pest and disease attacks.
- Fast return perennial crop.



Time of pruning: Just after end of harvesting season (Dec-Jan)

- It has great nutritional and health benefits value.

Botanical characteristics

- *Hylocereus undatus* is a climbing vine cactus species of the family Cactaceae. It is is a fast growing, epiphytic or xerophytic.
- It is one of 15 accepted *Hylocereus* species. While many of these have ornamental value because of their flowers, only five are important as fruit producers.
- Stems are triangular, 3-sided, although sometimes 4- or 5-sided, green, fleshy, jointed, many branched. Each stem segment has 3 flat wavy ribs and corneous margins may be spineless or have 1-3 small spines. Stems scandent, creeping, sprawling or clambering, up to 10 m long. Aerial roots, which are able to absorb water, are produced on the underside of stems and provide anchorage for stems on vertical surfaces.
- Flowers are 25-30 cm long, 15-17 cm wide, nocturnal, scented and hermaphroditic; however, some cultivars are self-compatible. Flowers are typically white in colour and bell shaped, stamens and lobed stigmas are cream coloured.
- Fruit is a fleshy berry, oblong to ovoid, up to 6-12 cm long, 4-9 cm thick, red with large bracteoles, pulp white, edible, embedded with many small black seeds.Average fruit weight is 350-400 g, although may weigh up to 900 g.

Nutritional importance

The fruit is a rich source of nutrients and minerals such as vitamin B1, vitamin B2, vitamin B3 and vitamin C, protein, fat, carbohydrate, crude fiber, flavonoid, thiamin, niacin, pyridoxine, kobalamin, phenolic, betacyanins, polyphenol

and carotene.

Propagation

The *H. undatus* is most often propagated through cuttings, obtained by severing foot-long, lateral branches at a stem segment. Making a slant cut on the stem end to be inserted into the soil to improve rooting. Cutting should be cured in a cool, dry area for 5-7 days before planting. Mature stems are preferred for cutting, as they are more resistant to insect and snail damage. Cutting may be planted directly in the field or in pots using a well-drained potting medium.

Pruning

During the first several years after planting, corrective / structural pruning is performed. Main stems and branch stems are allowed to develop around the support, while any lateral growth and plant components facing the ground are removed. Pruning should be advocated for any damaged and entangled branches. Post harvest pruning promotes the development of new young shoots, which will bear flowers the following year.

Trellis system

It is a climbing cactus, it requires a support

Dragon Plant

system for successful cultivation. Dragon fruit has an economic life span of about 20 years, and during full bearing time, plants are ladden with fruits, therefore the support system must be sufficiently strong and durable. Therefore, 2 m tall poles with a square/rectangular plate at the top can be utilized to support the plants.

Irrigation

During dry conditions, dragon fruit should be irrigated twice a week to maintain soil moisture and prevent oversaturation. Although the plant is drought tolerant, uneven soil moisture can cause splitting offruits. Excessive watering and rain can cause flower drop and fruit rot.

Flowering

The cylindrical shaped flower buds emerge from stem margins develops into light green flowers. The flowers start opening in evening (6.30- 7.30pm) and completes opening of flower by around 10.00 pm and start closing by 2.00 am approximately. The number of flushes varies from five to six. Fruit is ready to harvest within 30-50 days after flowering (pollination).

Harvesting

Flowering can begin as early as the second year, with a possible yield attained in the third or fourth year. Between 30 - 50 days after flowering, the ripened fruits can be collected. Fruit picking begins in June and might last until December or January in some cases.

Health Benefits

- Reduces Risk of Diabetes
- Reduces Risks of Cancer
- Helps Boost Immunity
- Improves Digestion
- Improves Heart Health
- Fights against Ageing Skin
- Good for Hair and eyes
- Healthy Bones

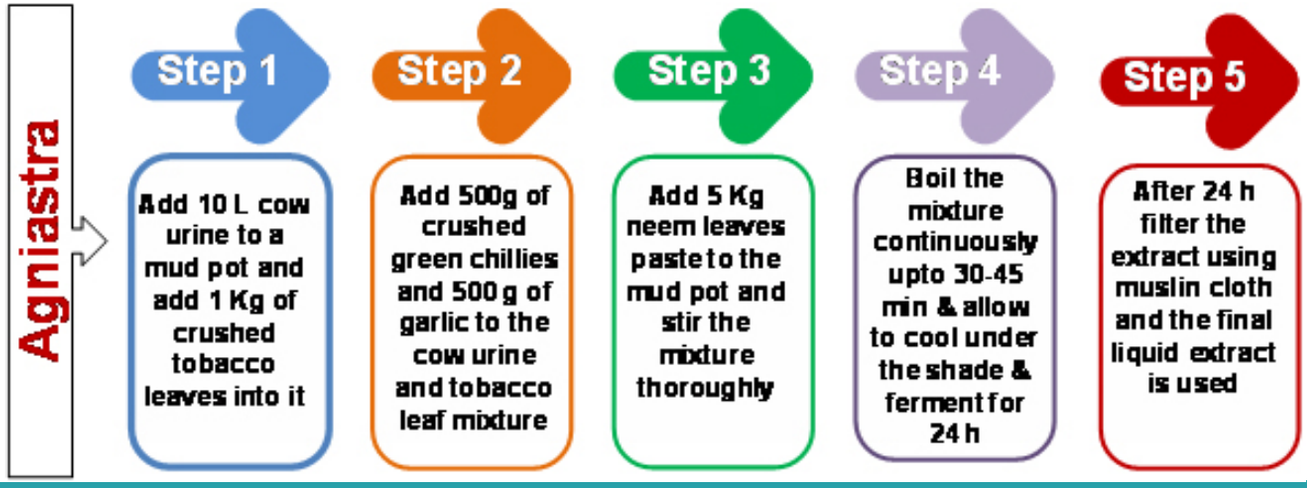
Options for Plant Protection under Natural Farming System

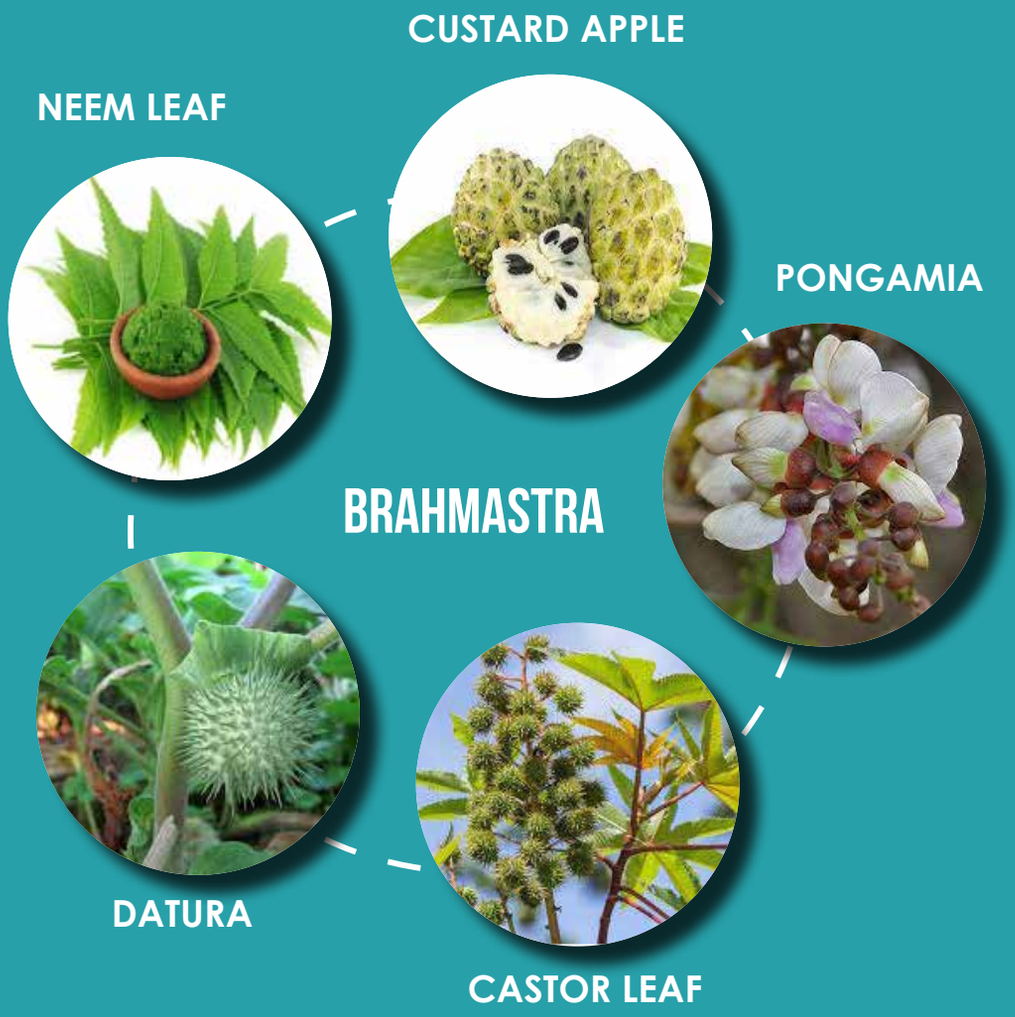
Pests are a persistent problem in all the farming systems, posing a threat to crop's quality and growth. Farmers typically rely on instantaneous pest management techniques, mostly application of synthetic chemical pesticides, to protect their crops from insect attack.

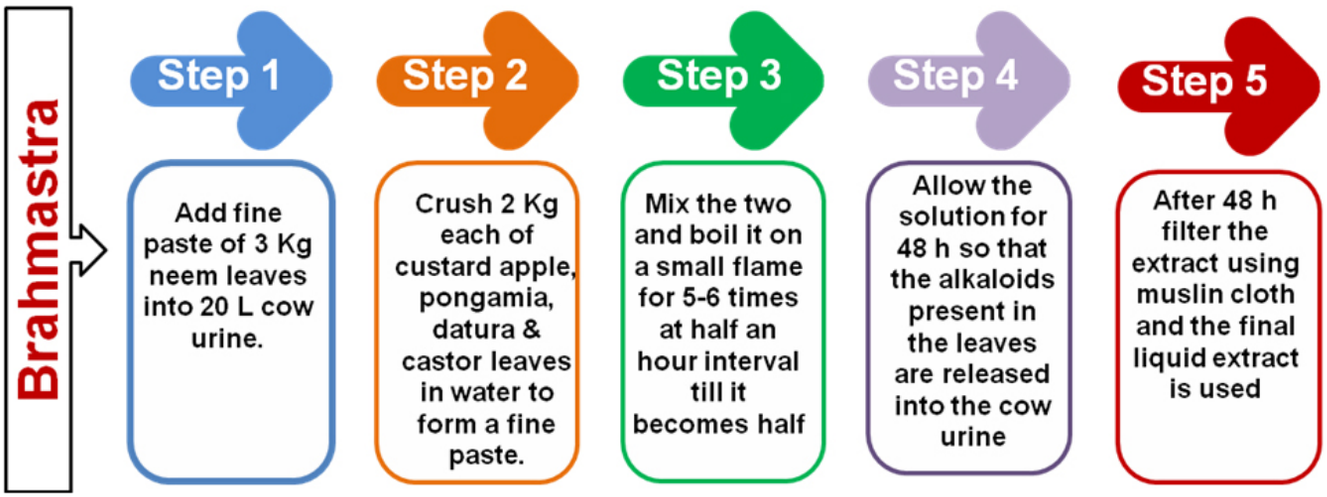
Insecticide resistance is one issue that arises from continued use of synthetic insecticides, not withstanding their effectiveness. Synthetic pesticides used excessively or improperly can have detrimental consequences on biodiversity by poisoning non-targeted organisms and posing harmful effects on people, the environment, and humans. Chronic human diseases have been linked to constituent chemical molecules of synthetic pesticides, either as a result of exposure or ingestion. Because the majority of synthetic insecticides are difficult to biodegrade, they build up in the environment, polluting soil and ground water in addition to thinning the ozone layer. Alternative chemical-free farming systems are now more necessary than ever because of the

drawbacks of improper and excessive usage of synthetic pesticides. The appropriate sustainable farming systems as an alternative to the synthetic chemical pesticide dependent farming system is natural farming. A chemical-free farming system roots from traditional culture, natural farming incorporates contemporary ecological knowledge, resource recycling, and on farm resource optimisation. It is mostly based on the recycling of biomass on-site, with a particular focus on mulching the biomass, using cow dung and urine formulations on-site, preserving soil aeration, and avoiding the use of any synthetic chemical inputs. It is anticipated that natural farming will lessen reliance on commercial or purchased inputs.

Insect pest management is a challenging task under such sustainable and chemical-free







framework systems, requiring effective plant protection materials capable of keeping the pest population under control while also safeguarding the yields and quality of farm produce without any abnormal deviations. Many plant/animal products and minerals are insecticidal, which means they are toxic to insects. Bio-pesticides are compounds (insect poisons) that occur naturally and are extracted or generated from plants/animals or minerals. They are also referred to as natural pesticides. These Botanical insecticides are used as alternatives to synthetic organic materials under sustainable crop production systems. In general, they act swiftly, disintegrate quickly, and have little

mammalian toxicity. This article discusses few such eco-friendly and effective alternatives to synthetic chemical insecticides for insect pest management under natural farming conditions.

1. Agniastra

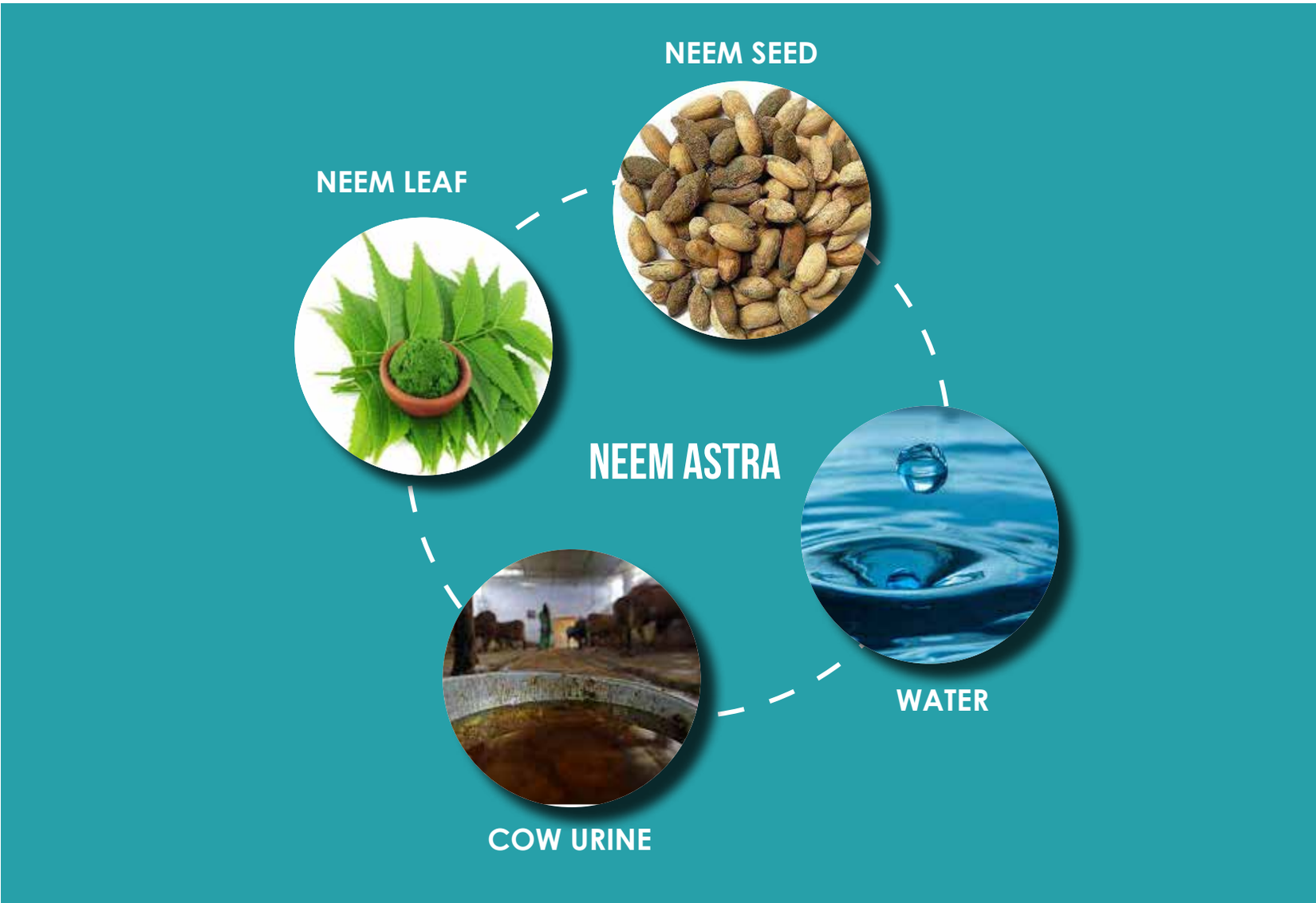
A comprehensive natural insecticide prepared using the traditional Indian pest management method. Agniastra is an extremely effective bio-pesticide against pests such as stem borer, fruit borer, leaf roller and pod borer. It also provides nutrition to the plants. It increases the chlorophyll content in the leaves as well as enhances the plant's general health. It is recommended for use on vegetables, fruit trees, flowering plants and other agricultural crops. Farmers can prepare this liquid solution in their own home or community by their own as mentioned below;

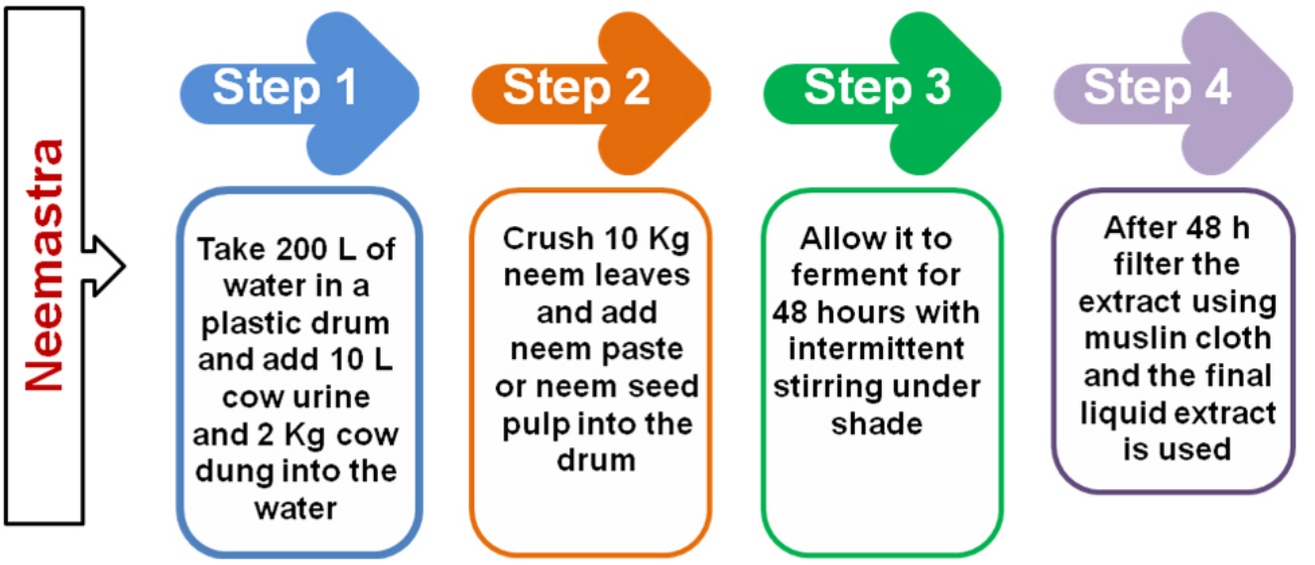
Ingredients:

- Indigenous or desi cow's urine (cow urine is the main ingredient in preparing organic cultures and bio-pesticides) : 10 L
- Tobacco leaves : 1 Kg
- Green chillies : 500 g
- Garlic : 500 g
- Neem leaves paste : 5 Kg

Preparation Procedure

- Add 10 L cow urine to a mud pot
- Add 1 Kg of crushed tobacco leaves into the cow urine kept in a mud pot
- Add 500g of crushed green chillies and 500 g of garlic to the cow urine and tobacco leaf mixture
- Add 5 Kg neem leaves paste to the pot and stir the mixture thoroughly
- Boil the mixed solution well continuously up to 30-45 min and allow it to cool under the shade.
- Allow the solution to ferment for 24 hrs.
- Filter the extract using muslin cloth after 24





hrs and the final extract is ready to use in the field.

Note:

- Agniastra or any liquid bio-pesticide in general should be kept under the shade and the mouth of the container covered with a plastic mosquito net or wire mesh to prevent houseflies laying eggs and the formation of maggots in the bio-pesticide solutions.
- Agniastra can be used as a foliar spray and do not add any other chemicals with Agniastra.
- The ideal time of spraying Agniastra is morning 6:00AM - 9:00AM and evening 4:00PM - 6.30PM.

Dosage:

- 15 to 20 L of Agniastra diluted in 500 L of water per hectare can be used as the foliar spray on the standing crop. This ratio may vary depending upon the severity of insect pest attack as follows:
- 100 L of water +3 L of Agniastra
- 15 L of water +500 ml of Agniastra
- 10 L of water + 300 ml of Agniastra
- Agniastra can be sprayed on the crops using knapsack or power sprayers.
- Agniastra can also be used as preventive pesticide against foliar insect pests.

2. Brahmastra

Brahmastra is a natural insecticide against large and small insects such as stem borer, pod borer, fruit borer and sucking insect pests like aphids, whiteflies, jassids, etc. The Brahmastra liquid natural insecticide mixture can be made by farmers easily at home.

Ingredients:

- Indigenous or desi cow's urine: 20 L
- Neem (*Azadirachta indica*) leaves: 3 Kg
- Custard apple (*Annona squamosa*) leaves: 2 Kg
- Pongamia or karanja (*Pongamia pinnata*) leaves: 2 Kg
- Datura (*Datura stramonium*) leaves : 2 Kg
- Castor (*Ricinus communis*) leaves : 2 Kg

Preparation Procedure:

- Add fine paste of 3 Kg neem leaves into 20 L cow urine.
- Crush 2 Kg custard apple leaf, 2 Kg pongamia or karanja leaf, 2 Kg datura leaves and 2 Kg castor leaves in water to form a fine paste.
- Mix the two and boil it on a small flame for 5-6 times at half an hour interval till it becomes half
- Allow the solution for 48 hours so that the alkaloids present in the leaves are released into the cow urine
- Filter the extract using muslin cloth after 48 hrs and the final extract is ready to use in the field. If required for future use, it is better to store in pots (earthen pots) or plastic drums under shade. The solution may be stored for use up to 6 months.

Dosage

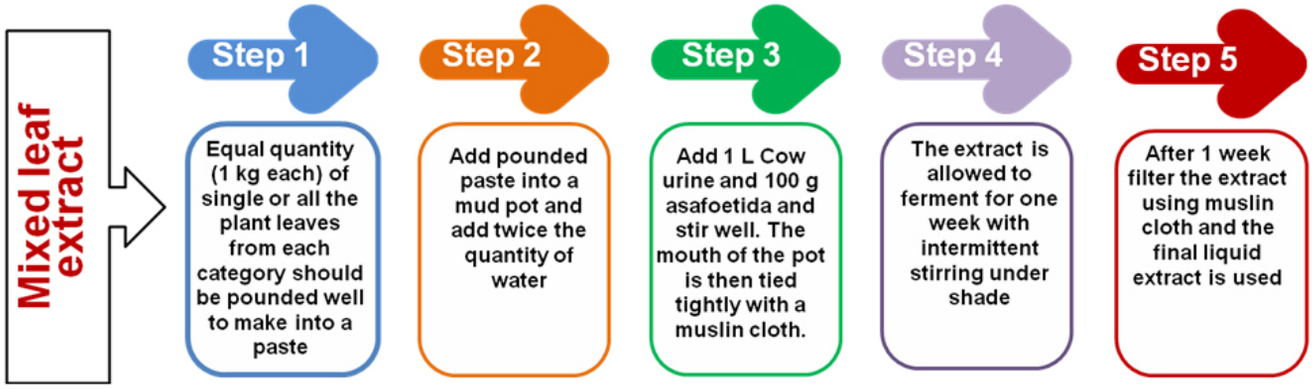
- 15 to 20 L of Brahmastra diluted in 500 L of

water per hectare can be used as the foliar spray on the standing crop. This ratio may vary depending upon the severity of insect pest attack as follows:

- 100 L of water +3 L of Brahmastra
- 15 L of water +500 ml of Brahmastra
- 10 L of water + 300 ml of Brahmastra
- Brahmastra can be sprayed on the crops using knapsack or power sprayers.
- Brahmastra can also be used as preventive pesticide against foliar insect pests.

3. Neemastra

Neemastra is used for preventive and curative insect pest management under natural farming system. This also helps to reducing the proliferation of phytophagous insect pests.



Neemastra is very easy to prepare and effective repellant and bio-pesticide against insect pests. It is used against sucking pests viz., aphids, thrips, jassids, whiteflies, mealy bugs, etc. and defoliators viz., leaf eating caterpillars, leaf folders, webbers, etc.

Ingredients

- Indigenous or desi cow's urine: 10 L
- Indigenous or desi cow's dung: 2 Kg
- Neem (Azadirachta indica) leaves or neem seed pulp: 10 Kg
- Water : 200 L

Preparation Procedure

- Take 200 L of water in a plastic drum and add 10 L cow urine and 2 Kg cow dung into the water
- Crush 10 Kg neem leaves to form a paste and add neem paste or neem seed pulp into the drum
- Then, with a long stick, stir it clockwise and

cover it with a gunny bag. Allow it to ferment for 48 hours with intermittent stirring under shade because it should not be exposed to either sunshine or rain.

- Filter the extract using muslin cloth after 48 hrs and the final extract is ready to use in the field. It may be stored for use up to 6 months.

Note: The final filtrate should not be diluted with water during storage period.

Dosage

- Spraying of 5% Neemastra using Knapsack or power sprayers on crops is effective against sucking insects (aphids, thrips, jassids, whiteflies, mealy bugs, etc.) and defoliators (leaf eating caterpillars, leaf folders, webbers, etc.)
- Neemastra can also be used as preventive pesticide against foliar insect pests.

4. Dashaparni ark

Dashaparni ark serves as a stand-in (substitute) for Agniastra, Bramhastra and Neemastra. It is used to manage all types of insect pests and is used based on the level of infestation.

Ingredients:

- Neem (*Azadirachta indica*) leaves : 5 kg
- Nochi or Nirgundi (*Vitex negundo*) leaves : 2 Kg
- Eswaramooli (*Aristolochia indica*) leaves : 2 Kg
- Papaya (*Carica papaya*) leaves : 2 Kg
- Guduchi / giloy or Amritha balli (*Tinospora cordifolia*) leaves : 2 Kg
- Custard Apple (*Annona squamosa*) leaves : 2 Kg
- Pongamia or karanja (*Pongamia pinnata*) leaves : 2 Kg
- Castor (*Ricinus communis*) leaves : 2 Kg
- Nerium (*Nerium oleander / Nerium indicum*) leaves : 2 Kg
- Calotropis (*Calotropis gigantean / Calotropis procera*) leaves : 2 kg
- Green chilli paste : 2 Kg
- Garlic paste : 250 g
- Ginger paste : 200 g
- Turmeric powder : 500 g
- Asafoetida :10 g
- Tobacco powder : 1 Kg
- Indigenous or desi cow's dung : 3 Kg
- Indigenous or desi cow's urine : 20 L
- Plastic drum : 400 L Capacity
- Water : 200 L

Preparation Procedure

- Take 200 L of water in a plastic drum and add 20 L of cow urine and 2 Kg of cow dung. Mix it well and cover the mouth of the drum with muslin cloth or gunny bag and keep aside for 2-3 hours.
- Add 200 gram of ginger paste, 500 g of turmeric powder, 10 g of Asafoetida into the mixture. Stir it well and keep aside overnight covering the mouth of the drum with muslin cloth or gunny bag.
- Second day morning, add 2 Kg of green chilli paste, 1 Kg tobacco powder and 500 g of garlic paste and stirred well with wooden stick. Keep the mixtures aside overnight covering the mouth of the drum with muslin cloth or gunny bag for 24 hours under shade.
- Third day morning, crush the leaves of 10 different plant leaves (from the list given above) to a fine pastes and add the same to the mixture already present in the plastic drum.
- Stir thoroughly and mouth of the drum with muslin cloth or gunny bag. Keep the mixture for 30-40 days for fermentation so that the alkaloids present in the leaves will get dissolve in the mixture. Stir twice a day
- Filter the mixture after 40 days with a muslin cloth and the final extract is ready to use in the field.

Dosage

- Spraying of 6-7 L of Dashaparni mixed in 500 L of water per hectare is effective against insect pests like aphids, whiteflies, mealy bugs, fruit borers, stem borer, cut worms, leaf eating caterpillars, ash weevils, flea beetles, etc.
- Dashaparni can also be used as preventive pesticide against foliar insect pests.

5. Mixed Leaf Extract

Like dashaparni ark, mixed leaf extract also serves as an excellent bio-pesticide for managing sucking pests, borers and defoliators.

Ingredients:

This extract is prepared using five different types of plant leaves

- Plants which are bitter in taste: Neem (*Azadirachta indica*), Kalmegh (*Andrographis paniculata*), Thumbai (*Leucas aspera*)
- Plants which produce milky latex : Giant milkweed or Calotropis (*Calotropis gigantean / Calotropis procera*), Nerium (*Nerium oleander / Nerium indicum*), Cactus (*Opuntia dillenii*), Jatropha (*Jatropha curcas*)
- Plants that are generally avoided by cattles: Vasaka (*Adhatoda vasica*), Alpavardhini or bush morning glory (*Ipomoea fistulosa*)
- Plants with medicinal property : Nochi or Nirgundi (*Vitex negundo*), (*Ocimum tenuiflorum / Ocimum sanctum*), Thai basil (*Ocimum basilicum var. thyrsiflora*)
- Plants that are least preferred by pests: Drum stick (*Moringa oleifera*), Pongamia or karanja (*Pongamia pinnata*)

Preparation Procedure:

- One or all the plant leaves from each category should be taken in equal quantity (1 kg each) and pounded well to make into a fine paste.
- The pounded leaves paste should be transferred into a mud pot and twice the quantity of water is added to it.
- 1 L cow urine and 100 g asafoetida should be added to the solution and stirred well. The mouth of the pot is then tied tightly with a muslin cloth.
- The extract is allowed to ferment for one week with intermittent stirring under shade
- The extract is filtered using muslin cloth after one week and the final extract is ready to use in the field.

Dosage:

- Spraying of 2-5% mixed leaf extract is effective against insect pests like aphids, whiteflies, mealy bugs, fruit borers, stem borer, army worm, cut worm, leaf eating caterpillars, ash weevils etc.
- Mixed leaf extract can also be used as preventive pesticide against foliar insect pests.

Advantages of using the afore mentioned bio-pesticides in natural farming system:

- The bio-pesticides mentioned above are typically less hazardous than traditional synthetic insecticides.
- In contrast to broad-spectrum synthetic insecticides, which can impact organisms as diverse as birds, insects, and mammals, these bio-pesticides solely affect the target insect pest.
- These bio-pesticides often degrade quickly, resulting in lower exposures and mainly avoiding pesticide pollution problems in the environment as well as chemical residue in farm produce.
- When employed as part of Integrated Pest Management (IPM) programmes, these bio-pesticides can successfully manage insect pest problems and are as effective as conventional synthetic insecticides.

Limitations of afore mentioned bio-pesticides under natural farming system:

- Field effectiveness of the above mentioned bio-pesticides is limited due to geographical and climatic fluctuations in humidity, temperature, soil conditions and so on.
- These bio-pesticides are very target specific and narrow in action, which means they only function against specific pests, and if at any case the non-targeted insect pests infested the standing crop may still cause yield or crop loss.
- Multiple biological components are used in the preparing the afore mentioned bio-pesticides, making it challenging to arrange the raw materials for the same at times.
- Farmers invest more time and effort in preparing the afore mentioned bio-pesticides, making the process time consuming and tedious.
- Because these bio-pesticides are sensitive to changes in temperature and humidity, they have a short shelf life.

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