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MARKETS FOR GREEN AGRICULTURE : ECOLABELLING APPROACH

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Green marketing is often hailed as a remedy to environmental degradation and health concerns among consumers. It seeks to merge traditional marketing principles with ecological considerations. At its core, green marketing integrates responsibility and environmental issues into marketing management. t can be described as a holistic method for identifying, predicting, and meeting the demands of both customers and society in a manner that is both profitable and sustainable. Green marketing encompasses various initiatives, such as promoting eco-friendly products, including organic items, altering production processes, adapting packaging, and adjusting promotion and distribution strategies (Sharma and Kushwaha, 2019).

Ecolabelling

Ecolabelling has emerged as a valuable instrument for governments to promote responsible environmental practices and for businesses to pinpoint and access markets, both domestically and sometimes internationally, for their eco-friendly products. Numerous countries have implemented some form of ecolabelling scheme, with others contemplating similar initiatives (Murali et al., 2019). The success of ecolabelling programs globally hinges on a steadfast commitment to clear objectives. Though articulated differently by program authorities, three fundamental objectives are typically identified and pursued.

1. Protecting the environment

The foremost aim of ecolabelling programs is typically environmental conservation and protection. Governments, as well as other organizations, utilize these initiatives to sway consumer choices, promoting the production and marketing of environmentally friendly goods and the provision and utilization of eco-friendly services. Ecolabelling functions as a market-driven tool designed to foster environmental enhancement.

2. Promoting environmentally responsible innovation and leadership

Ecolabelling programs provide a market-driven incentive to environmentally forward-thinking businesses by endorsing and promoting an ecolabel. By offering products that alleviate environmental strain, these businesses can carve out or bolster a market niche and cultivate a favorable corporate reputation among consumers, thus gaining a competitive edge (and potentially inspiring other businesses to emulate them). Typically, ecolabelling criteria are designed to recognize only the most environmentally responsible performers within a product category. Many programs progressively elevate standards over time, encouraging producers and service providers to adapt to evolving performance enhancement opportunities and market dynamics.

3. Raising consumer consciousness regarding environmental concerns

Ecolabelling programs play a crucial role in raising consumer consciousness regarding environmental issues and the consequences of their purchasing decisions. In nations where consumer awareness is prevalent, a reputable ecolabel that offers dependable information on the

environmental effects of products in the market might suffice to encourage the adoption of ecolabelled products. Conversely, in regions where environmental concerns don't drive consumer behavior as strongly, ecolabelling can be employed to incentivize environmentally beneficial choices.

Guiding Principles for Ecolabelling

Ecolabelling initiatives adhere to a set of guiding principles aimed at ensuring their effectiveness and credibility. Voluntary participation is paramount, emphasizing the importance of businesses willingly engaging in the program. Compliance with environmental and pertinent legislation is essential, ensuring that labelled products meet legal requirements. The concept of "fitness for purpose" and overall performance level is considered, emphasizing the product's functionality alongside its environmental impact. These principles are grounded in sound scientific and engineering principles, ensuring the integrity of the labelling process. Criteria for ecolabelling must distinguish leadership and be credible, relevant, attainable, measurable, independent of commercial interests, and subject to an open and accountable process. Flexibility is key to accommodating diverse products and industries, while consistency with established standards such as ISO 14020 and ISO 14024 ensures alignment with global best practices (Testa et al., 2015).

Major Participants

The success of any ecolabelling initiative hinges on the active participation of various stakeholders. Government entities often spearhead such programs, providing funding and exerting influence through procurement policies. Program management authorities, typically independent bodies, oversee the technical, marketing, and administrative aspects of program delivery. Industry associations, retailers, and companies play a crucial role by ensuring that ecolabelling criteria are credible and practical in the marketplace, offering guidance and support throughout the process. Consumer involvement is equally vital, as their demand drives market impact, necessitating that their requirements and preferences be considered and reflected in program initiatives and outputs. Together, these stakeholders collaborate to enhance the effectiveness and credibility of ecolabelling initiatives.

India and eco-labels

In 1972, India established the National Council for Environmental Policy and Planning within the Department of Science and Technology, later rebranded as the Ministry of Environment and Forests (MoEF) in 1985. Over the years, India has become a signatory to nearly all multilateral agreements concerning environmental issues and has actively participated in international environmental laws. In recent decades, India has focused on fortifying its environmental legal framework, leading to the enactment of numerous environmental statutes. The Environment (Protection) Act of 1986 stands as a comprehensive legislation intended to establish a framework for coordinating central and state authorities as outlined in the Water (Prevention and Control) Act of 1974 and the Air (Prevention and Control) Act of 1981 (MoEF, 2006).

In 1991, the Government of India introduced its inaugural eco-label, termed 'Eco-mark', through the Central Pollution Control Board (CPCB). This initiative adopts a cradle-to-grave approach, encompassing all stages from raw material extraction to disposal, and advocates for active participation from consumers, industry, and government to address environmental protection concerns and implement strategies. Symbolized by an earthen pot, the Eco-mark scheme emphasizes the use of renewable resources like earth, minimal hazardous waste production, and

low energy consumption during manufacturing. It uniquely integrates environmental considerations with product quality standards, aiming to incentivize manufacturers and importers for producing products with reduced environmental impact, while also rewarding companies for significant initiatives toward environmental improvement. The scheme aims to enhance consumer awareness, facilitate the identification of green products, and promote sustainable resource management. To qualify for the Eco-mark, products must meet specific environmental criteria outlined in Indian laws, including compliance with acts such as the Water (Prevention and Control of Pollution) Act of 1974, the Air (Prevention and Control of Pollution) Act of 1981, the Water (Prevention & Control of Pollution) Cess Act of 1977, and the Environment (Protection) Act of 1986. The criteria consider various factors such as recyclability, sourcing of raw materials, manufacturing processes, waste treatment, packaging, and overall environmental impact. Currently, the CPCB has established Eco-mark criteria for 16 product categories, ranging from soaps and detergents to textiles and leather, with products meeting relevant standards set by the Bureau of Indian Standards and displaying environmentally friendly packaging being eligible for the eco-label.India organic.

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REVOLUTIONIZING AGRICULTURAL MARKETING OF HORTICULTURAL CROPS : THE ROLE OF ARTIFICIAL INTELLIGENCE

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ABSTRACT
The study highlights the transformative potential of artificial intelligence (AI) in revolutionizing the marketing of horticultural crops. It outlines the challenges faced in traditional marketing practices, including inefficient distribution networks and limited market access for smallholder farmers. The abstract emphasizes the role of AI in addressing these challenges through predictive analytics, supply chain optimization, market intelligence, and precision marketing. It also showcases successful case studies from around the world where AI has been implemented to connect farmers directly with buyers, optimize supply chains, and improve market access. However, it acknowledges the challenges and considerations associated with AI adoption, such as data privacy and digital literacy. The abstract concludes by underscoring the promise of AI in enhancing efficiency, transparency, and profitability in the horticultural industry, while emphasizing the importance of collaboration between stakeholders to realize its full potential.

Key Words : Artificial Intelligence (AI), Supply Chains, Market Access.

INTRODUCTION

The agricultural sector stands at the precipice of a technological revolution, poised to transform traditional practices and usher in a new era of efficiency and productivity. Among the various domains within agriculture, the marketing of horticultural crops holds immense potential for optimization through the integration of artificial intelligence (AI) technologies. With AI-driven solutions, stakeholders in the horticultural industry can overcome longstanding challenges, enhance market transparency, streamline supply chains, and maximize profitability.

CHALLENGES IN TRADITIONAL MARKETING OF HORTICULTURAL CROPS

The marketing of horticultural crops has historically been fraught with challenges, including inefficient distribution networks, price volatility, information asymmetry, and wastage due to improper handling and storage. Moreover, smallholder farmers often face barriers to accessing markets, resulting in limited bargaining power and reduced profits. These challenges underscore the urgent need for innovative solutions to revolutionize agricultural marketing practices.

THE ROLE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence, with its ability to analyse vast amounts of data, derive actionable insights, and automate decision-making processes, presents a transformative solution to the complexities of agricultural marketing. In the context of horticultural crops, AI technologies offer several key advantages:

Predictive Analytics:

AI-powered predictive analytics algorithms leverage historical data, market trends, weather patterns, and other relevant variables to forecast supply and demand dynamics accurately. By

anticipating market fluctuations, farmers and traders can make informed decisions regarding crop selection, timing of harvest, and pricing strategies, thereby minimizing risks and maximizing profitability.

Supply Chain Optimization:
AI-driven supply chain optimization tools enable real-time monitoring of inventory levels, transportation logistics, and storage conditions. By optimizing route planning, inventory management, and cold chain logistics, stakeholders can reduce post-harvest losses, improve product quality, and ensure timely delivery to markets, thus enhancing overall efficiency and competitiveness.

Market Intelligence:
AI algorithms can aggregate and analyse data from diverse sources, including satellite imagery, social media, market reports, and consumer preferences, to provide actionable market intelligence. By gaining insights into consumer trends, preferences, and purchasing behaviour, farmers and traders can tailor their production and marketing strategies to meet evolving market demands effectively.

Precision Marketing:
AI-powered precision marketing tools enable targeted advertising and personalized engagement with consumers. By leveraging data analytics and machine learning algorithms, marketers can identify and segment target audiences, customize promotional campaigns, and deliver relevant content across multiple channels, thereby maximizing the effectiveness of marketing efforts and enhancing brand visibility.


Source: *Western Australian Horticulture Update 2023: Tuesday 31 October - Wednesday 1 November 2023, Ascot Racecourse, 71 Grandstand Road, Ascot: Two-day industry expo dedicated to innovative technology in horticulture.*

CASE STUDIES AND SUCCESS STORIES
Several initiatives and pilot projects worldwide have demonstrated the transformative impact of AI on agricultural marketing of horticultural crops. For example, in India, platforms like *AgriMarke*t and *Freshokartz* leverage AI technologies to connect farmers directly with buyers, thereby eliminating intermediaries and ensuring fair prices. Similarly, companies like *TaniHub* in Indonesia and Gro Intelligence in the United States utilize AI-driven analytics to optimize supply chains, improve market access, and enhance value chain transparency.

The biennial Western Australian Horticulture Update (WAHU) event returned to Ascot Racecourse on Tuesday 31 October and Wednesday 1 November 2023, hosting a two-day industry expo

dedicated to innovative technology in horticulture. With a focus on bringing together stakeholders from all areas of horticulture, WAHU aimed to foster connections and build knowledge on the changing landscape of horticultural production. Attendees had the opportunity to explore the latest business development and research innovations, gaining insights into practical technology implementation and applications to improve horticultural practices from the grower to the consumer. The event featured a comprehensive program, including presentations on topics such as artificial intelligence in food production, future trends, cold chain management, sustainable packaging, and food traceability. Attendees also participated in panel discussions, breakout sessions, and networking opportunities, ensuring they remained abreast of global trends and equipped to enhance their business capacity and competitiveness in the evolving horticulture industry.

CHALLENGES AND CONSIDERATIONS

While the potential benefits of AI in agricultural marketing are undeniable, several challenges must be addressed to realize its full potential. These include issues related to data privacy, infrastructure limitations, digital literacy, and equitable access to technology. Moreover, there is a need for capacity building, stakeholder collaboration, and policy support to ensure that AI-driven solutions are inclusive, sustainable, and ethical.

CONCLUSION

Artificial intelligence holds immense promise for revolutionizing the agricultural marketing of horticultural crops, offering solutions to longstanding challenges and unlocking new opportunities for stakeholders across the value chain. By harnessing the power of AI-driven predictive analytics, supply chain optimization, market intelligence, and precision marketing, the horticultural industry can enhance efficiency, transparency, and profitability. As we embrace the digital transformation of agriculture, collaboration between governments, academia, industry stakeholders, and technology innovators will be essential to realize the full potential of AI in shaping the future of agricultural marketing.

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SULPHUR IN SOILS AND CROPS IN INDIA

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Abstract

Depletion of sulphur reserves of soils as a result of greater uptake and removal of sulphur by the crops under intensive agriculture coupled with the use of high analysis sulphur free fertilizers and expansion of irrigation facilities, making leaching an important route of sulphur losses from the soil are responsible for large scale deficiencies of sulphur in soils and plants. An update of the earlier assessment on the extent of S-deficiencies in India soils shows that these are increasing and more widespread than is generally thought to be the case. This paper highlights the current status of sulphur in soils and plants in plants, diagnosis and improvement of sulphur deficiency in crop plants.

Introduction

Among different secondary nutrients, sulphur deficiency is considered to be most widespread. Significant responses to sulphur fertilization to a large number of field crops especially oil bearing and pulse legumes, forages and the Brassica family have been recorded. However, information is far from adequate to actually pinpoint the deficient areas or the intensity of sulphur deficiency. Coarse textured sandy soils of Indo-Gangetic alluvial plains, are the vulnerable areas of sulphur deficiency where, crops like groundnut, rape-seed and mustard, chickpea, soyabean, berseem, potato etc. have exhibited sulphur deficiency to varying extent. Enhanced removal of sulphur under explotive agriculture is an important cause for the occurrence of progressive incidence of sulphur deficiency. In view of high priority being laid on the much needed break through in pulses and oilseeds, sulphur deserves greater attention in different regions of the country.

Sulphur in Soils

Sulphur is the thirteenth most abundant element in the earth's crust with an average concentration of 0.06%. The sulphur content of agricultural soils ranges from less than twenty parts per million (ppm) to several thousand ppm but is in most cases with in the range 50-500 ppm. Total sulphur is generally lower in cultivated tropical and subtropical soils than in temperate soils. This is due to the more intensive weathering accompanied by leaching and to the lower levels of organic matter which constitutes the major reservoir of sulphur in soil. In agricultural soils, sulphur is present in both mineral and organic forms. Most soils contain a large proportion (50-90%) in organic forms as part of the soil organic matter. Sulphur occurs throughout the soil profile but its concentration is usually highest in the surface layer, generally following the pattern of organic matter distribution. Organic matter can provide or immobilize sulphur, as it does with nitrogen. A small proportion of the total sulphur is present in the soil solution from which plants draw their sulphur requirements.

Most factors influencing the availability of soil S include :

- *Soil S content* : soils vary in their sulphur content to a large extent. Those with the lowest sulphur content usually occur in arid or semi-arid areas where the organic matter is low (often below 1%).

- *Soil texture :* fine-textured soils, with more silt and clay, usually have higher sulphur contents than coarse-textured, sandy soils, which not only have lower levels of organic matter but also high percolation rates resulting in greater losses of sulphur by leaching.
- *Organic matter and its decomposition* : organic sulphur becomes available from the decomposition of soil organic matter. However, if the sulphur in organic matter is less than 0.15% or the C:S ratio is wider than 200, the organic matter can lock up soluble sulphur instead of releasing it. Factors favouring sulphur release are :
  - High temperatures (Optimum around 40 ^{0}C),
  - Soil moisture status of about 60% of field capacity,
  - Conditions favourable for a high microbial population,
  - S contents in organic matter of at least 0.15 %.
- *Moisture status :* very dry conditions retard the movement of sulphate ions in the soil towards the roots and thus retard sulphur uptake.
- *Sulphur additions :* by adding sulphur to the soil, inputs such as fertilizers and manures increase the level of sulphur available for crop use. The same applies to S additions from precipitation and irrigation water.
- *Soil pH :* the exchangeable fraction of sulphur is generally insignificant in soils with pH > 5.5.

Sulphur deficiency can be expected more frequently under the following conditions :

- On soils which are low in sulphur, coarse-textured and low in organic matter.
- In areas away from the influence of industrial activity and other sources of sulphur emissions.
- Where intensive agriculture is practiced and the rotations include crops with high sulphur requirements.
- Where fertilizer use is dominated by sulphur free products and the application of organic material is infrequent and at low rates.

Among the reasons why sulphur deficiency is being reported with increasing frequency from various parts of the world are :

- Depletion of sulphur reserves as a result of greater uptake and removal of sulphur in crops due to the higher yields which have been made possible largely by the application of N, P and K.
- Expansion of irrigation facilities, making leaching an important route of sulphur losses from the soil.
- Large-scale changes in the fertilizer use pattern during the past decades towards materials containing virtually no sulphur (e.g. urea, TSP, DAP).

An update of the earlier assessment on the extent of S-deficiencies in India soils shows that these are increasing and more widespread than is generally thought to be the case. In recent years, the database in this respect has been particularly enriched by results from Bihar, Gujarat, Madhya Pradesh, Punjab and Uttar Pradesh. It is now clear without doubt that S-deficiencies extend well beyond coarse-textured soils and can occur in a scattered manner in several parts of India. These re likely to occur to varying degrees in about 120 out of around 400 districts. Available information in this respect has been summarized and indications are that S-deficiency is emerging as a very important problem in two large states of Bihar and Uttar Pradesh.

At present, fertilsers are contributing only 15% of the S removal b crops assuming 25% S-use efficiency, the balance coming from soil reserves, organic manures and other sources. The

consequences of –ve balance are depletion of soils S, spread of S-deficiency to newer areas, its intensification with time and threat to sustainability.

Sulphur in Plants

As an essential nutrient, sulphur has certain specific tasks to perform in plants. Among other things, it is:

- Essential for protein formation, as a constituent of the three amino-acids cystine, cysteine and methionine;
- Required for the formation of chlorophyll (the green-coloured substance in above-ground plant parts which permits photosynthesis) and for the activity of ATP - sulphurylase (the enzyme involved in sulphur metabolism);
- Involved in the formation of glucosides and glucosinolates (essential components of the oils found in rapeseed, mustard and other cruciferous plants) and in the synthesis of glutathione, coenzyme A and vitamin B1, biotin and thiamine; and it is a constituent of the sulphydril linkage (-SH) which provides pungency to onions and oils.

These essential functions permit the production of healthy and productive plants which capable of giving high yields as well as superior quality.

The effects of sulphur on crop quality include improvements in :

- Quantity and quality of plant proteins in staple foods of the tropics, such as cereals, pulses, tubers and oilseeds;
- Nutritional value of fodders and forages (by narrowing the N : S ratio);
- Milling and baking quality of cereals;
- Oil contents of oilseeds and other oil crops;
- Colour and quality of vegetables.

The role of sulphur in crop production is being displayed in **Fig. 1**.

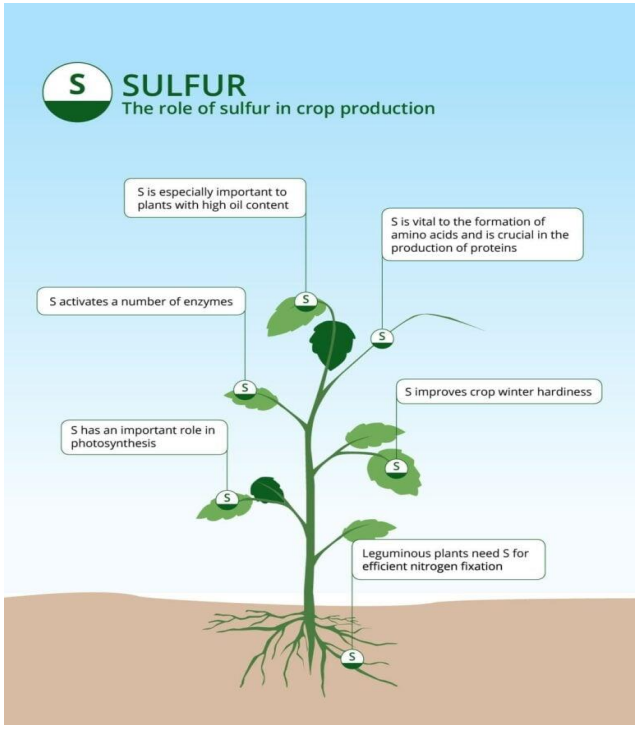

Fig. 1. The role of sulphur in crop production (Source: ICL Agriculture, Sulphur based fertilizers)

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Sulphur content of plant

The sulphur content of plant dry matter ranges from 0.05% to 0.5% S and in most cases is between 0.2% and 0.3%. The sulphur content depends on a number of factors, especially the type of crop, N and S supply levels, growth conditions and management. For example, the sulphur content of rice plants may vary from 0.034% under conditions of S deficiency to 0.16% where sufficient sulphur is available and added S has no effect on crop yields. In general, the S content is highest in cruciferae, lower in legumes and lower still in gramineae (**Table 1**). This is the reason for the frequent emphasis on sulphur in fertilizer recommendations for oilseeds and legumes.

Table 1. Sulphur content of grains and seeds

Family	Crop	% S in Dry matter
Cruciferae	Rape	1.00
	White mustard	1.40
	Oil radish	1.70
	Black mustard	1.00
Leguminosae	Broad beans	0.24
	Bush beans	0.24
	Peas	0.27
	Soybeans	0.32
Gramineae	Barley	0.18
	Oats	0.18
	Wheat	0.17
	Maize	0.17
Source : Mengel and Kirkby, 1987		

As the protein content is largely determined by the amounts of nitrogen supplied, and sulphur is a constituent of three amino-acids which are the building blocks for proteins, N and S are closely interlinked in plant nutrition. In general, the desirable N : S ratio is taken as 17 : 1 for legumes and 14 : 1 for cereals. The average crop uptake of sulphur as compared to phosphorus is given in **Table 2**.

Table 2. Average crop uptake of sulphur as compared to phosphorus

Group	Crops in group	Mean S uptake (P uptake = 100)
1	Cabbage, rapeseed, onion, turnip	174
2	Alfalfa, clovers, grasses	119
3	Rice, wheat, maize, sorghum	76
Source : Based on The Sulphur Institute, 1982		

The amount of sulphur absorbed by crops can range from a few kg to 75-80 kg/ha depending upon the crop, productivity levels and cropping intensity. Data for a number of crops are summarized in **Table 3**.

Table 3. Estimates of average total crop uptake of soil sulphur in relation to yields

Crop	Form	Yield t/ha	Total uptake Kg/ha S
Barley	Grain	5.0	20

Crop	Form	Yield t/ha	Total uptake Kg/ha S
Maize	Grain	6.0	25
Rice	Paddy	6.0	10
Sorghum	Grain	4.0	15
Wheat	Grain	6.0	30
Millets	Grain	3.0	22
Beans	Grain	2.4	25
Chickpeas	Grain	1.5	13
Lentil	Grain	2.0	6
Greengram	Grain	1.0	12
Pigeonpeas	Grain	1.2	9
Coconut	Nuts	10,000 nuts	15
Oilpalm	Fresh bunch	25.0	30
Groundnuts	Pods	2.0	15
Rapeseed	Seed	3.0	65
Sesame	Seed	1.0	5
Soybeans	Seed	3.0	20
Sunflower	Seed	3.0	15
Castorbean	Seed	2.0	9
Bananas	Fruit	40.0	15
Citrus	Fruit	30.0	30
Grapes	Fruit	20.0	30
Papaya	Fruit	50.0	10
Pineapple	Fruit	50.0	20
Cabbage	Heads	70.0	80
Eggplant	Fruits	60.0	10
Okra	Fruits	20.0	10
Onion/garlic	Bulbs	35.0	20
Tomatoes	Fruits	50.0	30
Potatoes	Tubers	40.0	20
Cassava	Tubers	40.0	20
Sugarbeet	Roots	45.0	35
Turnip	Roots	45.0	45
Tea	Made tea	2.5	25
Tobacco	Dry leaf	2.0	10
Coffee	Clean beans	2.0	27
Sugarcane	Cane	100.0	60
Alfalfa/Lucerne	Hay	9.0	25
Coastal Bermuda	Hay	20.0	40
Grass/clover	Hay	12.0	35
Maize	Silage	70.0	25
Red clover	Hay	12.0	20

Crop	Form	Yield t/ha	Total uptake Kg/ha S
Stylosanthes	Hay (7 cuts)	20.0	60
Fodder beet	Plant	45.0	45
Tropical grasses	Dry fodder	27.0	60
Source : Aulakh et al., 1985; Hobt and Kemmler, 1986; Munson, 1982			

In many areas in tropical and subtropical countries where straw etc. is removed from the field along with the main product, the same figures can be used for uptake and for removal. However, in perennials and annual crops where residues are returned to the field, the net removal of sulphur will of course be less than the uptake.

Sulphur Deficiency Symptoms

An inadequate supply of sulphur to the plant causes deficiency. The so-called "hidden hunger" refers to a condition where there is a sufficient shortage of sulphur within the plant to depress yields but without visible symptoms of a sulphur deficiency appearing. Fertilization practice should be designed always to maintain the sulphur status of the crop above the "hidden hunger" level.

A sulphur status below the "hidden hunger" level presents a serious problem, with deficiency symptoms appearing in various plant parts. The deficiency symptoms, mostly of pale yellow or light green leaves, resemble those of nitrogen deficiency but, unlike N, they usually appear first on the younger leaves and are likely to intensify rather than diminish after nitrogen application. In general, sulphur deficient plants are small and spindly, with short, slender stalks, and show retarded growth. In cereals the deficiency can cause delay in maturity; in legumes, poor nodulation and poor nitrogen fixation; in fruits incomplete maturity; and in forages inferior nutritional quality. In legumes, relying on biological nitrogen fixation, the plants may quite often become deficient in nitrogen due to the fixation process being retarded by lack of sulphur, with the result that the older leaves turn yellowish as well.

Sulphur deficient plants are frequently rigid and brittle and in many species a reddish or purplish colouration is seen, especially on the undersides of the leaves. The biochemical consequences of sulphur deficiency in plants are many and mostly result in lower yields and poor quality.

Plants suffering from sulphur deficiency may contain :

- low amounts of sulphate (SO_4) but high amounts of nitrate (NO_3) and amide (NH_2); accumulation of amide is due to shortage of sugars resulting from poor photosynthesis by chlorotic sulphur deficient plants;
- an excess of sulphur free amino-acids (e.g. asparagines, glutamine and arginine) due to the inhibition of protein synthesis under S deficient conditions;
- lower concentration of oils (of crucial importance in oilseed cultivation);
- low contents of chlorophyll, and hence low photosynthesis.

Knowledge of the sulphur status of plants can be valuable in assessing the nutritional status of the crop and also as a diagnostic tool. Total contents of sulphur and sulphates in plants can be useful indicators of their sulphur status but quite often need to be interpreted in conjunction with the N:S ratio as part of a multiple index. In most plant species, sulphur is not readily translocated from old to young tissue. The sulphur content of recently mature tissue therefore reflects the

current S status more accurately than that of old tissue or whole plants and is preferred for sampling. **Fig. 2** may help diagnosing sulphur deficiency in plants.

Crop Response to Sulphur Application

Data from FAO network of trials in India showed spectacular direct and residual responses to sulphur application in rice-wheat system. The author reported 14% increase in yield of rice-wheat system with application of 30 kg S/ha through gypsum at Kanpur. Experiments at Modipuram have shown that fertilizing each component crop of rice-wheat system with S was as good as fertilizing either rice or wheat at double the rate. A decline in productivity of rice with continuous application of S-free fertilizers in Eutrochrepts of Barrackpore and of both rice and wheat on Hapludolls of Pantnagar with the drawdown in native availability of available S to the level below the critical level of S deficiency.

Sulphur Application Rate

On sulphur deficient soils, application of 20 to 60 kg S ha^{-1} increased crop yields significantly (**Table 4**) depending on soil, crop, variety and climate. Mean yields increases due to S application are 638 to 813 kg ha^{-1} for cereals, 137 to 340 kg ha^{-1} for pulses, 144 to 566 kg ha^{-1} for oilseeds and 17.1 t ha^{-1} for sugarcane. Generally cereals and oilseeds showed greater responses to S than other crops.

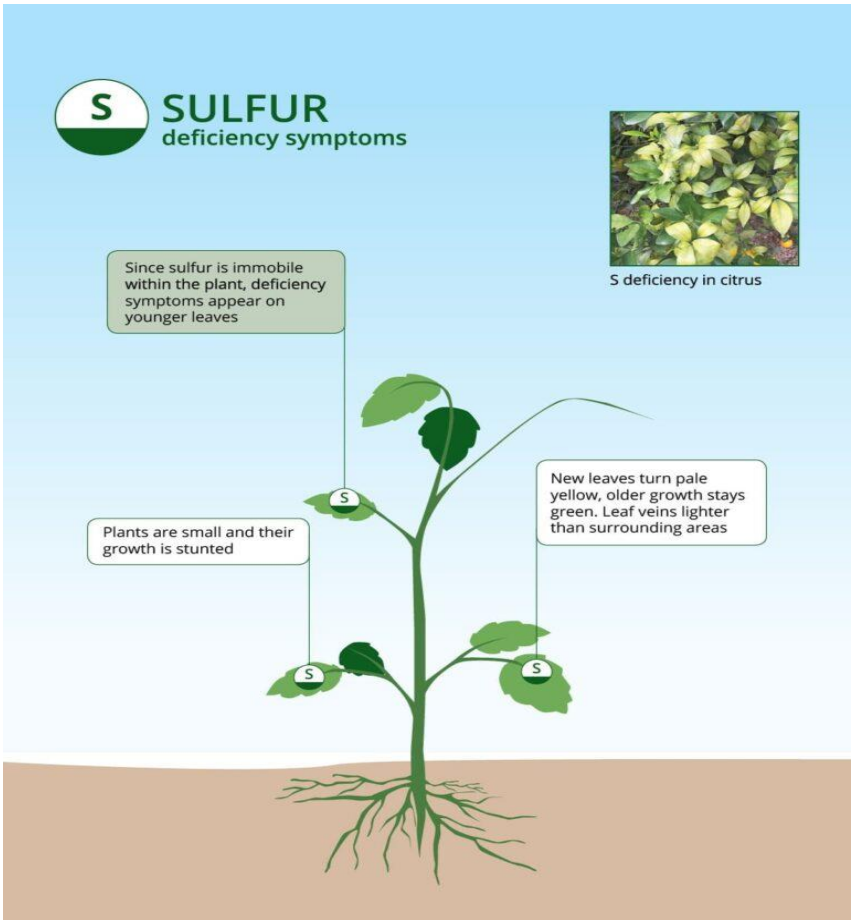

Fig.2. Diagnosing sulphur deficiency in plants (Source: ICL Agriculture, Sulphur based fertilizers)

Table 4. Ranges of average crop yield increases due to S application under field conditions

Crop	Studies Averaged	Yield without S application (Kg ha^{-1})	Mean yield increase due to S (kg ha^{-1})	(%)
Wheat	32	3209	813	25.3
Rice	27	4389	752	17.1
Sorghum	3	2571	638	24.8
Maize	3	1806	739	40.9
Blackgram	7	787	153	19.9
Greengram	7	804	137	20.2
Chickpea	4	1851	340	18.4
Pigeonpea	8	1284	282	21.7
Lentil	4	1042	289	27.7
Potato	3	14567	3080	21.1
Onion	3	2480	480	19.1
Groundnut	23	1785	566	31.7
Mustard	18	1122	335	30.0
Soybean	8	1426	361	25.3
Sunflower	6	1233	249	20.2
Sesame	3	674	144	21.4
Linseed	5	1571	246	15.7
Cotton 3		1182	387	32.7
E. Clover	3	12633	4562	36.1
Sugarcane	10	70450	17130	21.5

Sulphur management in cropping system

Field experiments, especially those carried out under the FAO sulphur network have yielded several results on the direct and residual responses to S. Depending on the system, the directly fertilized crop contributed 33-82% to the total rotational response and the crop raised on residual S contributed 18-67%. Limited data suggest that the S-management strategy should consist of preferential S application to : (i) most responsive crop (ii) crop with higher economic value and (iii) land management system which conserves S for the next crop.

Interaction of Sulphur with other Nutrients

Among the important interactions, the one between N and S is either synergistic or additive. Sulphur is best utilized when adequate N is available. Recent research shows that the P x S interaction can be synergistic or antagonistic depending on the rates of application. Both positive as well as negative interactions between S and Mg, S and B and Zn and S have been reported.

Comparative evaluation of sulphur sources

As an overall assessment, different sulphate sources are reported to be equally effective but data are quire variable. Among available sources, AS offers the only proposition for correcting S-deficiency in standing crops. Single superphosphate (SSP) and gypsum have quite often been found superior for oilseeds, particularly groundnut. Part of the credit for this goes to Ca for its role

in pod formation. When S-free fertilizers are supplemented with an S-source, they are as effective as common S-carriers in raising crop yields on S-deficient soils. Elemental S is found to be an effective source in alkaline, calcareous soils. Its superiority over sulphate sources is attributed to reduction in soil pH upon its oxidation resulting in crops and augmenting the supply of S. Similar effects are attributed to pyrites. Effectiveness of both gypsum and pyrites increases with a decrease in their particle size.

Effect of sulphur on crop quality

Findings on the improvement of amino acid and protein content as a result of sulphur application are available for several crops. Available results show that S application increased oil concentration in seeds. Oil yield per unit area is improved by S on two accounts, higher seed yields and higher oil content in seeds.

Fertilizers containing sulphur

Nutrient wise list of materials which are used as source of sulphur are given in **Table 5**.

Table 5. Some available materials and sources of Sulphur

Material	% Content
Content	
Ammonium sulphate	24
Single superphosphate	12
Potassium sulphate	18
Ammonium phosphate sulphate	15
Gypsum	18S
Iron pyrites	22.24S
Elemental sulphur	85-90
Sulphur Bentonite	90
Magnesium sulphate	13
All sulphate salts of micronutrients	13-19

Epilogue

Substantial limitations of up to 30% in yield and profit potential can occur due to sulphur deficiencies without the appearance of any visual symptoms. It is, therefore, in the interest of the farmer to provide adequate amounts of sulphur to his crops. In view of the increasing practical importance of sulphur in present day agriculture, it is advisable to select fertilizers not only on their N, P or K contents but also to take their S contents into account. It a field is suffering from sulphur deficiency, full benefits will not be obtained from the application of other plant nutrients.There is a growing volume of evidence that, in sulphur deficient fields, gains in terms of yields and quality from the use of sulphur are equal to the gains from NPK application. Balanced fertilizer use and a sound soil fertility programme include all nutrients the soil cannot provide. The conventional distinction between primary and secondary nutrients needs changing. A positive programme of correcting sulphur deficiency should replace the attitude of neglecting sulphur deficiency for the benefit of the farmers and to improve the efficiency of inputs in modern high-yielding crop production.

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UNEARTHING THE BEST EARTHWORM SPECIES FOR PERFECT VERMICOMPOST

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Abstract
Vermicomposting, which uses a variety of earthworm species, has gained popularity due to its benefits for agriculture and the environment. The five main earthworm species used in vermicomposting are summarized in this abstract: African nightcrawler (Eudrilus eugeniae), European nightcrawler (Dendrobaena veneta), Indian blue worm (Perionyx excavatus), Red earthworm (Lumbricus rubellus), and Red Wiggler (Eisenia fetida). Size, color, preferred habitats, reproductive features, eating habits, tolerance to different temperatures, and activity levels are just a few of the unique qualities that each species possesses. It is critical to comprehend these subtleties to maximize vermicompost output. By making use of these earthworms' special powers, practitioners may effectively break down organic waste and produce compost that is high in nutrients, improving soil health and promoting sustainable waste management.

Introduction
Vermicomposting, the process of using earthworms to convert organic waste into nutrient-rich compost, has gained popularity due to its environmental and agricultural benefits. Various species of earthworms are utilized in vermicomposting, each with unique characteristics and functions. Understanding these varieties and their roles is crucial for optimizing vermicompost production. (Gajalakshmi and Abbasi, 2004).

Characteristics:

Red Wiggler (*Eisenia fetida*):

- Size: 5-10 cm in length.
- Color: Reddish-brown with a pale underside.
- Reproduction: Hermaphroditic, capable of producing cocoons containing multiple eggs.
- Habitat: Thrives in organic-rich environments like compost heaps and manure piles.
- Feeding Habits: Consumes a wide range of organic matter, including kitchen scraps and garden waste.
- Temperature Range: Prefers temperatures between 15-25°C.
- Activity: Active surface dweller, often found near the top layers of compost.

Red Earthworm (*Lumbricus rubellus*):

- Size: 5-10 cm in length.
- Color: Dark red to reddish-brown.
- Reproduction: Hermaphroditic, but cross-fertilization between individuals is common.
- Habitat: Found in soil rich in organic matter, especially forest litter and rotting vegetation.

- Feeding Habits: Consumes decaying plant matter, and helps break down organic material in soil.
- Temperature Range: Tolerates a wide range of temperatures, but prefers cooler environments.
- Activity: Tends to burrow deeper into the soil compared to surface-dwelling species.

Indian Blue Worm (*Perionyx excavatus*):

- Size: 2-7 cm in length.
- Color: Bluish-grey to bluish-black.
- Reproduction: Hermaphroditic, produces small, lemon-shaped cocoons containing several eggs.
- Habitat: Often found in tropical and subtropical regions, thrives in compost heaps and organic-rich soil.
- Feeding Habits: Rapid decomposers of organic matter, including kitchen waste and animal manure.
- Temperature Range: Prefers warmer temperatures around 25-30°C.
- Activity: Active on the surface and within the top layers of soil or compost.

African Nightcrawler (*Eudrilus eugeniae*):

- Size: 10-15 cm in length.
- Color: Dark purple to reddish-brown.
- Reproduction: Hermaphroditic, produces large lemon-shaped cocoons with multiple eggs.
- Habitat: Native to tropical regions, commonly found in organic-rich soils and compost piles.
- Feeding Habits: Efficient decomposers of organic matter, including plant debris and animal waste.
- Temperature Range: Thrives in warmer temperatures between 20-30°C.
- Activity: Burrows deeply into the soil or compost, enhancing aeration and nutrient cycling.

European Nightcrawler (*Dendrobaena veneta*):

- Size: 8-12 cm in length.
- Color: Pinkish-grey to reddish-brown.
- Reproduction: Hermaphroditic, produces small lemon-shaped cocoons with multiple eggs.
- Habitat: Commonly found in cool, moist environments such as forest floors and compost heaps.
- Feeding Habits: Consumes a variety of organic materials, including leaf litter and decaying vegetation.
- Temperature Range: Tolerates cooler temperatures compared to some other species, around 15-25°C.
- Activity: Burrows into the soil or compost, aiding in decomposition and nutrient recycling.
- These species are selected for their ability to efficiently decompose organic matter and produce nutrient-rich vermicompost.

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Fig-1 : Dendrobaenaveneta

Fig-2 : Eudrilus eugeniae

Fig-3 : Eisenia fetida

Fig-4 : Perionyx excavatus

Fig-5 : Lumbricus rubellus

Conclusion

In conclusion, selecting the right species of earthworms is essential for successful vermicompost production. Each variety offers distinct advantages based on factors such as environmental conditions, scale of operations, and types of organic waste being composted. By understanding the functions and characteristics of different earthworm species, vermicomposting enthusiasts can optimize their composting systems to produce high-quality organic fertilizers for sustainable agriculture and waste management practices.

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APPLICATION OF BOTANICAL EXTRACTS AND ESSENTIAL OILS IN PEST MANAGEMENT

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Abstract
Plants inhabit diverse regions across the globe and have served as both sustenance and remedies for our ancestors. The structural components and phytochemicals present in these plants not only benefit the plants themselves but also offer advantages for humans. Given the numerous adverse effects associated with synthetic pesticides, there is a growing interest in exploring alternative options. Essential oils (EOs) and plant extracts offer an alternative solution as they are environment friendly and only target specific pests. They are concentrated volatile oils derived from various parts of plants. These valuable organic substances can be safely used for managing pests and diseases and thus promoting sustainability .

Keywords: Botanicals, Essential oils (EOs), Biopesticides, Phyto pesticides, Sustainability

Introduction

Plants are distributed across diverse regions and classified into biomes based on the dominant species. Approximately 391,000 vascular plant types have been identified, with flowering plants comprising around 94%.For generations, plants have served as medicinal remedies, utilized by ancestors and continuing to be relied upon by people in rural areas of developing countries to this day.The essential oils and plants/botanical extracts serves as abundant reservoirs of valuable chemical constituents, boasting substantial amounts of volatile, fragrant, and bioactive elements. These chemical compounds are obtained from various plant parts like flowers, buds, leaves, branches, stems, seeds, fruits, woods, and roots and they hold promise for diverse applications across industries including medicine, food, cosmetics, and agriculture. While synthetic pesticides have been utilized to boost crop yields, their widespread application poses risks to aquatic life and human health due to chemical runoff. Pest resurgence due to synthetic chemicals is a growing concern in agricultural and environmental sectors. To address these issues, researchers are turning to plant essential oils and extracts, which boast complex chemical compositions. These alternatives are biodegradable and have minimal harmful effects on non-target organisms, presenting promising solutions for sustainable pest control (Assadpour *et al*., 2023).

EOs and plant extracts comprise numerous active constituents, including alkaloids, tannins, steroids, glycosides, resins, phenols, volatile oils, and flavonoids. Despite their benefits, biopesticides, including EOs and plant extracts, make up only a small fraction (5%) of the pesticide market. However, they are experiencing significant growth, with an anticipated annual increase surpassing that of chemical pesticides. Contemporary methods frequently utilize EOs and plant extracts derived biopesticides without a thorough comprehension of their underlying mechanisms. Recent research has shed light on their insecticidal effects and how they interact with target organisms. Additionally, there's emerging evidence suggesting specific strategies to optimize their use within integrated pest management programs (Rakshi *et al*., 2021).Yet, EOs and plant extracts encounter hurdles stemming from their biological vulnerability, as they can degrade

under influences such as 0_2, light, temperature etc. Additionally, they frequently demonstrate limited water solubility and high volatility.Researchers are currently engaged in efforts to tackle these obstacles, aiming to bolster the efficacy and feasibility of employing EOs and plant extracts for pest control purposes. The article furnishes a thorough examination of the application of essential oils and botanical extracts in pest control.

Phytopesticides

Biopesticide are obtained from various sources such as plants, microbes and biological nanoparticles and present a sustainable substitute for synthetic pesticides. The biopesticides obtained from plants are called phytopesticides (Mathew,2015).The EOs and plant extracts have been effectively employed in controlling plant diseases.They possess diverse actions such as attraction, repulsion, respiration prevention, host plant detection, and destruction of pest eggs and larvae. Various plant species including Tea leaves (*Camellia sinensis*), Neem (*Azadirachta indica)*, White Weed (Ageratum conyzoides L.), Prickly ash (*Zanthoxylum sp.)* have been recorded as effective in managing, both field and storage pests. Several plant families including *Euphorbiaceae, Rutaceae, Poaceae, Zingiberaceae* has been employed for extracting phytopesticides. Their widespread availability makes them cost-effective and easily integrable into agricultural systems. These plants contain biochemical compounds such as alkaloids, steroids, terpenes, tannins, flavonoids, and phenols, which possess antifungal, antibacterial, antioxidant, and insecticidal properties.

The efficacy of these compounds against pests and their mechanisms varies depending on the specific plant species. Botanical pesticides target a wide range of pests including insects, fungi, bacteria, nematodes, and viral pathogens within plant cells. They exert various actions such as repellence, inhibition, protein denaturation, and interference with metabolic pathways. For example, pesticides derived from pyrethrum and neem disrupt insect nerve cells, induce abnormal moulting, hinder oviposition, and interfere with the endocrine system. They also affect insect metabolism, cell wall biosynthesis, membrane structure, ATPase function, quorum sensing, efflux pumps, and biofilm formation. For instance, citronella extract is known for its repellent effectiveness against mosquitoes, ticks, mites (Lahlali *et al*., 2022). Table 1 provides a compilation of plants exhibiting strong bio-pesticidal effectiveness, along with the pests they target.

Table 1: Plants with potent bio-pesticidal activity and their targeted pests.

SOURCE PLANT	TARGET PEST
Winged prickly ash*(Zanthoxylum armatum)*	Aphids, Whiteflies, Thrips
Pyrethrum *(Chrysanthemum cinerariifolium)*	Whiteflies, mites, thrips
Lantana*(Lantana camara)*	Aphids, beetles,
Ginger *(Zingiber officinale)*	*Fusarium oxysporum, Trichoplusiabinotalis*
Marigold(Tagetes)	Nematodes, aphids, and whiteflies.
Rosemary *(Rosmarinus officinalis)*	Beetles, slugs, snails, and other garden pests.
Eucalyptus *(Eucalyptus spp.)*	Mosquitoes, flies, termites

Understanding the active compounds present in essential oils (EOs) and plant extracts is pivotal for grasping their mode of action and crafting efficient biopesticide formulations. Numerous studies have delved into the biochemical and molecular mechanisms underlying the actions of

these extracts. For instance, essential oils from Pepper species comprise major compounds such as α-pinene β-asarone, β-caryophyllene, β-pinene, (E)-anethole, γ-terpinene,limonene and p-cymene (Valcárcel *et al*., 2021).Table 2 is a list of the plant's essential oils and their main composition.

Table 2: Plants along with their biochemical compositions/active compounds

ESSENTIAL OILS/PLANT EXTRACTS	ACTIVE COMPOUNDS
Thymus proximus (Thyme)	Carvacrol, p-cymene, γ-terpinene
Azadirachta indica (Neem)	Tetranortriterpenoid
Mentha suaveolens (Apple mint)	Piperitenone oxide, carvacrol, piperitenone, thymol
Lavandula angustifolia (Lavender*)*	1,8-cineole, β-caryophyllene, camphor, linalool, and linalyl acetate.
Citrus limon (Lemon)	Limonene, citral, α-pinene, β-pinene, linalool
Curcuma longa (Turmeric)	Curcumin, demethoxycurcumin, bisdemethoxycurcumin, turmerones
Rosmarinus officinalis (Rosemary)	Rosmarinic acid, carnosic acid, ursolic acid, camphor, α-pinene, β-pinene

Conclusion

While synthetic pesticides have aided in reducing crop loss due to pests, their adverse effects necessitate the promotion of biological pesticides. The absence of residual effects in biopesticides presents both advantages and disadvantages. On one hand, it reduces the risk of harm to plants, humans, and animals compared to synthetic pesticides. However, it also means that biopesticides only provide protection if they are in contact with pests, potentially requiring multiple applications and increasing costs and labor for farmers. Further research is needed to improve the stability and shelf-life of biopesticides and explore methods to prolong their presence in the environment.

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NUTRITIONAL VALUES OF MILLETS: KODO MILLET AND FOXTAIL MILLET

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Abstract

I was wondered that by seeing our grandfather and the group of his friends are very energetic and they were so healthy then their successive generations. Some of them are even free from the cardiac diseases, diabetics which are most common in the next generations to them and then I started to enquire them how they were such healthy. They answered that they have consumed sankati (it is like soup made up of millet flour) in regular food made of millets as we consume wheat and rice daily. Then I started to study about the millet's nutritional values and health benefits by the millets. The millets are having high nutrients and many health benefits. These millets are very under rated and they are not used much. As now we are getting to know about the millets more, we started consuming them also in our diet. These millets are having higher nutritional values than the wheat and rice.

Introduction

Millets are small round-shaped cereals of family *Poaceae* adopted to the tropical and arid climate and have the ability to survive in less fertile soil. The millet occurs naturally in arid areas and semi-arid areas such as central Asia and Africa. India serves as the primary producer of millet, including major varieties like Sorghum, Finger millet and Pearl millet. Millet has the strong strength to withstand the attack of pests and diseases, has a short growing season, and can grow vigorously in drought conditions, setting it apart from other major cereals. They also have the higher nutritional values comparing to the rice and wheat. Millets having gluten free nature that led to interest in the potential benefit that manage type 2 diabetes and reduces the glycemic index of foods. Some evidences point out that the millets are cultivated about 4000 years ago.

Source:-Foxtail_wholemillet.jpg (3840×2560) (ooofarms.com)thenai-korralu-kangni-thina-navane-setaria-italica--500x500.jpg (500×500) (imimg.com)

Kodomillet *(Paspalum scorbiculatum)*is one of the oldest grains in the world. Domesticated in India few thousand years ago and originated in Africa. It is drought tolerant and can survive on marginal soils where other crops may not survive, and can supply 450–900 kg of grain per hectare. It is commonly known by several names, such as Arka (Kannada), Kodra (Hindi), Arikelu (Telegu), Varagu (Tamil), Varak (Malayalam) and Bajra (Punjabi). It is grown from Kerala and Tamil Nadu in the south to Rajasthan, Uttar Pradesh and West Bengal in the north.

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Foxtail millet *(Setaria italica)* is a major millet in terms of worldwide production. This is also one of the oldest grains in the world. At present, foxtail millet ranks second in world production of millets which is cultivated in 26 countries in the world. It is easier to classify that foxtail millet derived from organic farming because it ranks fourth among all millets with normal production practices not utilizing pesticides by this, we can say that they are pest resistant and they are drought resistant also. It is commonly known by several names, such as Navane (Kannada), Kangni (Hindi), Korralu (Telugu), Tenai (Tamil), Thina (Malayalam) and Kangi (Punjabi). Other alternative names for foxtail millet include Italian millet, Italiar millet, and foxtail bristle grass. It is commonly cultivated in Indi some parts of Europe.

Source:- https://t2.gstatic.com/images?q=tbn:ANd9GcQODkqterhPna2nZIzNDyltGONkDxyg_Y7TihPz0ugM19brA_DAimages (554×554) (gstatic.com)

Nutritional value

			Kodo millet	**Foxtail millet**
Dietary Fiber (per 100 g)	Moisture (g)		14.23 ± 0.45	-
	Protein (g)		08.92 ± 1.09	12.30
	Ash (g)		1.72 ± 0.27	0.47
	Total Fat (g)		2.55 ± 0.13	4.30
	Dietary Fiber (g)	Total	06.39 ± 0.60	-
		Insoluble	4.29 ± 0.82	-
		Soluble	2.11 ± 0.34	-
	Carbo hydrates (g)		66.19 ± 1.19	60.09
	Energy (KJ)		1388 ± 10	331
Water Soluble Vitamins (per 100 g)	Thiamine – B1 (mg)		0.29 ± 0.054	0.59
	Riboflavin – B2 (mg)		0.20 ± 0.018	0.11
	Niacin-B3 (mg)		1.49 ± 0.08	3.02
	Pantothenic Acid – B5 (mg)		0.63 ± 0.07	0.82
	Total B6 (mg)		0.07 ± 0.017	-
	Biotin -B7 (µg)		1.49 ± 0.18	-
	Total Folates - B9 (µg)		39.49 ± 4.52	-
Fat Soluble Vitamins (per 100 g)	Ergocalcife (µg) Alpha		-	-
	Tocopherols (mg)	Beta	0.03 ± 0.010	-
		Gamma	-	-
		Delta	0.43 ± 0.12	-
		Alpha	-	-
	Tocotrienols (mg)	Beta	-	-
		Gamma	-	-
		Delta	0.19 ± 0.05	-
		Alpha	-	-
	α - Tocopherol (mg)		0.07 ± 0.02	-
	Phylloquinoes – K1 (µg)		03.75 ± 0.63	-
Fatty Acid	Palmitic (mg)		6.40	10.80

(per 100 g)	Stearic (mg)	6.30	-
	Palmitoleic (mg)	-	-
	Oleic (mg)	13.0	53.80
	Linoleic (mg)	66.50	34.90
	Total Saturated Fatty Acids (mg)	-	-
	Total Mono Saturated Fatty Acids (mg)	-	-
Amino Acid (per 100 g)	Histidine	2.14 ± 0.07	2.11
	Isoleucine	4.55 ± 0.22	4.59
	Luecine	11.96 ± 1.65	13.60
	Lysine	1.42 ± 0.17	1.59
	Methionine	2.69 ± 0.16	3.06
	Cystine	1.92± 0.05	0.45
	Phenylalanine	6.27 ± 0.34	6.27
	Threonine	3.89 ± 0.16	3.68
	Tyrptophan	1.32 ± 0.19	
	Valine	5.49 ± 0.23	5.81
Mineral and Trace Elements (mg/g of N)	Aluminium (mg)	1.07 ± 0.83	-
	Arsenic (mg)	-	-
	Cadmium (mg)	-	-
	Calcium (mg)	15.27 ± 1.28	-
	Chromium (mg)	0.021 ± 0.027	0.030
	Cobalt (mg)	0.005± 0.003	-
	Copper (mg)	0.26± 0.05	1.40
	Iron (mg)	2.34 ± 0.46	-
	Lead (mg)	-	-
	Lithium (mg)	0.027 ± 0.003	-

Source: Indian Food Composition Tables, NIN – 2017 and *Nutritive value of Indian foods, NIN – 2007

Foods from millets

Traditional foods from millets

As millets are in the food habits of our ancestors, we have the recipes of Muruku, kolukattai, Pakoda, Vadai, Upama, Adhirasam, kesari, Adai, Chapati, Dosa, Papad, Pulao, pongal etc. are some of the traditional foods prepared by the millets. These all the traditional foods will be rich in taste, quality and nutritional value. These foods are also healthy foods which are adopted traditionally.

Bakery products

Bakery products like as biscuits, muffins, cakes, and breads can also be prepared by incorporating flours, and many attempts and efforts have been made to standardize the recipe and quality of products. Millets are superior to other cereal grains in fibers, nutrients and micronutrients that can be used in bakery industries. Biscuits are analyzed based on dough characteristics. Results revealed that a composite flour of 60:40 millets: wheat is better for quality. The bread was also prepared from composite flours (e.g., finger millet with wheat, proso millet, and barnyard millet). muffins by replacing wheat flour with Finger millet flour (0%–100%).

Medicinal value of Millets

Millets for diabetes

Diabetes occurrences have been found to be lower in millet consumers. It partially suppresses the enzymatic digestion of complex carbs, millet's phenolic content, which includes and pancreatic amylase and alpha glucosidase, lowers postprandial hyperglycemia. Aldose reductase inhibitors, for example, stop sorbitol build up and lessen to the risk of cataract illnesses which is result of diabetes.

Millets and aging

The chemical reaction between the aldehyde reduction group of sugars, known as non-enzymatic glycosylation and the amino group of proteins and, known as non-enzymatic glycosylation, is primarily responsible for ageing and diabetes. Kodo millet is one of many millets that are high in antioxidants and phenolics such tannins, phytates, and phenols that may have a significant antioxidant effect onmetabolic syndrome, ageing, and general health.

Millets against cancer and celiac disease

Millets are high in tannins, phytes and phenolic acids, which act as "anti-nutrients." However, in animals, these antinutrients reduce the risk of breast and colon cancer, the phenolics found that they are effective at halting the development of cancer invitro andvivo in millets. However, given that millets are glutenfree, they have a considerable potential in foods and beverages that may be suitable to consume for those who have celiac disease. Therefore, millet grains have the ability of prevention of cancer and also the production of celiac food products.

Millets for cardiovascular disease

The risk of heart attack and stroke are increasing by bad eating obesity, smoking, and inactivity. The majority of the countries in the world are dealing with high and rising rates of cardiovascular disease, millets are having a higher level of free radical scavenging activity, which lowers the risk of cardiovascular diseases.

Conclusion

Millets are having high nutrients and many health benefits. Thise millets are very under rated and they are not used much**.** They have the health benefits like to control diabetes, cancer celiac disease and cardiovascular disease. Millets are also having the traditional foods and bakery products. That attracts the youngers by the taste. By adding millets in our diet, we can get health. Kodo millet and foxtail millet are the minor millets even having the greater nutrition value. Millets also are free from gluten which are mostly suggested to the ones who have the problem to digest gluten instead of wheat. Millets are having more health benefits then the rice and wheat.

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AGNIASTRA: A SUSTAINABLE APPROACH TO PEST MANAGEMENT

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Introduction

A complete natural pesticide to be prepared using the Indian traditional insect pest management approach. Agniastra is an extremely effective pesticide against pests such as stem borer, fruit borer, leaf roller, and pod borer. Farmers can prepare this liquid solution at our home. It also provides nutrients for the soil and plants, as well as killing pests and insects and improving soil richness. Agniastra provides plant greenery and can be sprayed on vegetable plants, fruit trees, flower plants, and other agricultural products.

Agniastra is a plant based natural pesticide killing to pest and sustain to ecofriendly with environment such as soil health, water, human health. Agniastra is chemical free substances. It provides chemically free food for better heath.

Ingredients Required for Agniastra

- Cow urine 10 Litres
- Tobacco leaves 1 Kg
- Green chili pulp 500 Grams
- garlic paste 500 g
- Crushed neem leaves 5 Kg

Neem leaves

Garlic Paste

Tobacco leaves

Green Chili paste

Cow urine

Preparation method of Agniastra

- Take 10 liters of cow urine in to the pots
- Add 5 kg of crushed green leaves neem

- Add 500 g crushed green chilli
- Add 500-gram garlic paste
- Add 500-gram tobacco leaves
- Now mix all content with cow urine and boil it
- After 3 to 4 boils, take it down from the fire
- Cool down for 24 hours and filter the solution with a cloth
- Now solution is prepared for spray on crop

Doses

- For 1 acre mix 2 to 3 liters of Agniastra with 100 liters of water and it can be sprayed on the crops.

Useful

- 2 to 3 times of spray for effective management
- The pest control Agniastra is effective in controlling Fruit Borer, Stem Borer, Leaf Roller & Pod Borer.
- The pesticide can be used as a foliar spray.

Precaution

- Do not add any other chemicals with Agniastra.
- Local Cow's Urine should be used Cows and don't use cross-bred or foreign breeds
- The liquid pest control should be kept in the shade and covered with a plastic mosquito net or wire mesh to prevent houseflies from laying eggs and the formation of maggots in the pesticide.

Conclusion

Agniastra is an effective natural pesticide for control to insect pests and ecofriendly with environment and human health and provide better quality of food and nutritional security for future prospects and healthy soil.

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http://www.agricindia.com
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EVAPORATION REDUCTION STRATEGIES: AN OVERVIEW

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INTRODUCTION

Water is one of the nature's precious gifts, which sustains life on earth. Civilizations over the world have prospered or perished depending upon the availability of this vital resource. Water has been worshiped for life nourishing properties in all the scriptures. Vedas have unequivocally eulogized water in all its virtuous properties.

In the earlier days availability of water was taken for granted. It is now being realized that water, though replenish able, is not an unlimited resource and cannot be produced or added as and when required, by any known technological means. The other important limitation is that the availability of water over the years depends upon the spatial and temporal variation of precipitation. Thus water may be abundant during monsoon season and scarce in non-monsoon season, when most needed. The ingenuity of man, therefore, lies in his ability to modify the pattern of availability of water to suit needs. One of the commonest forms of such modification is storage of water during monsoon season for eventual use in lean season. Due to high temperatures and arid conditions in about one third of the country, the evaporation losses have been found to be substantial. Therefore, it is imperative to minimise evaporation losses in the storages/water bodies.

The need for prevention of enormous evaporation losses assumes greater significance, in view of the predictable scarcity of water; the country will be facing in future. It has been assessed that against the utilizable water resources of the order of 1123 BCM, the requirement by 2025 AD to be met from surface water resources will be around 1093 BCM, thereby surplus by just 30 BCM.

METHODS TO REDUCE EVAPORATION

Wind Breakers

Wind is one of the most important factors which affect rate of evaporation loss from water surface. The greater the movement of air over the water surface, greater is the evaporation loss. Planting of trees normal to windward direction is found to be an effective measure for checking of evaporation loss. Plants (trees, shrubs or grass) should be grown around the rim of tanks in a row or rows to act as wind breaker. These wind breakers are found to influence the temperature, atmospheric humidity, soil moisture, evaporation and transpiration of the area protected.

Wind breakers are found to be useful under limited conditions for small reservoirs. In large reservoirs, wind breakers are not effective, as their effect is limited to a short distance from the rim of the reservoir, thereby exposing the inner water spread area to the hazards of wind. Another disadvantage of this method is that large quantity of water can be lost due to

transpiration by the trees planted. Considering these effects, the wind breakers are commonly employed for specific high wind speed (10-16 km. per hour.) locations.

Covering the Water Surface

By Covering the surface of water bodies with fixed or floating covers considerably retards evaporation loss. These covers reflect energy inputs from atmosphere, as a result of which evaporation loss is reduced. The covers literally trap the air and prevent transfer of water vapour to outer atmosphere. Fixed covers are suitable only for relatively small storages. For large storages, floating covers or mat or spheres may be useful and effective. However, for large water surfaces the cost of covering the surface with floats is prohibitive. Further in case of reservoirs with flood outlets, there is also the danger of floats being lost over spillway or through outlets. The floating covers are thus of limited utility to larger water bodies.

Genet and Rohner had reported that floating spheres of a polystyrol reduced evaporation to 80% in small experimental tanks. The white spheres have the added advantage of reflecting solar energy and thus influencing evaporation. Department of Soil and Water Conservation Engineering, College of Technology and Agriculture Engineering, Rajasthan Agriculture University has done experiments with other floating bodies as vegetable oils, wax, wheat husk, paddy husk, wooden blocks, saw dust and thermocol boards. According to these studies, conducted for a limited period of 15 days, the most effective evaporetardant is mustard oil, which resulted in 46% saving in water. The next in the order of effectiveness was found to be thermocol, followed by wax, Paddy straw, wheat straw, saw dust and wooden blocks were found to have less effect on reducing the evaporation. However, mass scale and economic use of these materials were not recommended, till conclusive results providing their economics and utility are available, based on some more experiments under varying conditions and on varying sizes of water bodies.

Reduction of Exposed Water Surface

In this method shallow portions of the reservoirs are isolated or curtailed by construction of dykes or bunds at suitable locations. Water accumulated during the monsoon season in such shallow portions is diverted or pumped to appropriate deeper pocket in summer months, so that the shallow water surface area exposed to evaporation is effectively reduced. This method is one of the recognized methods of conservation in drought areas and has been successfully tried for lake Worth in Texas, USA. In India, this method has been tried for Nayka reservoir, supplying water to Surendranagar in Gujarat, which yielded good results. The compartmentalisation work in the lakes supplying water to Chennai city has indicated that this method is more economical and effective than chemical WER method.

Underground Storage

This is a radically different approach for control of evaporation losses, which comprises storage of water in underground cavities or aquifers. This can certainly be done with great advantage in specific cases, where aquifers for such storages are available and do not entail higher lateral dispersion losses. Sub-surface dams can also be constructed in such schemes to prepare limited aquifers and thereby raise the level of storage, reducing subsequent pumping. Sub-surface dams or underground check dams have been constructed in Maharashtra, Andhra Pradesh, Gujarat and some other States across streams or rivulets in water deficient areas to hold groundwater and recharge the adjoining limited aquifers. They can be of masonry on rolled imperious fill depending on the rocky or alluvial strata. Problems of water supply by rising of groundwater thus

have been mitigated for many settlements. One outstanding application of this method was recharge of the aquifer adjoining Talaji rivulet near the town of Talaja in Bhavnagar District of Gujarat where significant water level rise was registered, after the limited monsoon. The main advantage of this method is that loss of valuable lands and forest areas due to surface submergence can be altogether avoided. The method has a great future all over India in view of the environmental advantage.

Integrated Operation of Reservoirs

This method is suitable for a system of reservoirs which can be operated in an integrated way. The method consists of operating the reservoirs in such a way that total exposed water surface area is kept minimum for the system as a whole. Consequently evaporation loss gets minimized. For achieving this objective water use should be planned in such a way that shallow reservoirs with large water spread area are depleted first. This method has been successfully practiced by Mumbai Municipal Corporation in their water supply scheme. Such techniques were also tried in the Hiran dam 1 & 2 in Junagarh district of Saurashtra region of Gujarat. The Chennai Metropolitan Water Supply and Sewerage Board has also been practicing integrated operation of Red Hills, Cholavaram and Poondi reservoirs, which supply water to Chennai City, so that the exposed water surface is kept minimum.

Treatment with Chemical Water Evapo-Retarders (WER)

Chemicals capable of forming a thin mono-molecular film have been found to be effective for reducing evaporation loss from water surface. The film so formed reflects energy inputs from atmosphere, as a result of which evaporation loss is reduced. The film allows enough passage of air through it and hence, aquatic life is not affected. The film developed by using fatty alcohols of different grades has been found most useful for control of evaporation. These materials form a film of mono-molecular layer when applied on water surface which works as a barrier between water body and the atmospheric conditions. These fatty alcohols used for evaporation control are generally termed as chemical water evapo-retardants (WERs) and these are available in the form of powder, solution or emulsion. These chemical water evapo-retardants have the disadvantage of high cost of application. However, when adopted in scarcity period, drought, etc. the quantity of water saved by this method would work out cheaper than alternate means of bringing water from far off places by manual or mechanical transport. The economics of WERs application may however vary from site to site depending on local factors. The chemical water evapo-retardants have another limitation of the mono-layer breaking at high wind velocities. Following chemicals are generally used for water evaporation retardation:

- Cetyl Alcohol (Hexadecanol) $C_{16}H_{33}OH$
- Stearyl Alcohol (Octadecanol) $C_{18}H_{37}OH$
- Ethoxylated Alcohols and Linear Alcohols
- Linoxyd CS-40
- Acilol TA 1618 (Cetyl Stearyl Alcohol)

CONCLUTION

Evaporation control methods for large water bodies primarily consist of physical and chemical methods. Physical evaporation reduction methods are able to “save” a greater percentage of water, between 70%-100% and entail a large capital cost and lower operations and maintenance costs. Chemical evaporation control methods “save” a lower percentage of water, between 20%-

40% and have little capital cost but higher operations and maintenance costs(Benzaghta, M. A., & Mohamad, T. A. 2009). All of the potential measures will impact upon the aquatic ecosystems on water storages to some extent; physical control methods are likely to have a greater impact than chemical controls. Size of the storage and local conditions may dictate the evaporation control techniques that are applicable to water storage. If high levels of evaporation reduction are required then a physical reduction method be employed. When designing new water storages that evaporation control techniques such as deeper storages, cellular construction and windbreaks be included in the design if feasible.

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FROM LIGHT TO LIFE: UNVEILING THE ROLE OF UV LIGHT IN SEED GERMINATION AND PLANT GROWTH

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Introduction

Plants being sessile lack the convenience of moving in search of favorable environmental conditions for their optimal growth and survival. Their rooted nature forces them to complete their life cycle in the environment in which they are growing. However, plants have the ability to alter their development in response to dynamic environmental conditions. Light is one of the indispensable environmental cues regulating plant growth and development. It not only provides plants with the source of energy during photosynthesis, but also plays a crucial role in plants' overall growth and development throughout their life cycle (Shinomura *et al*. 1994). Light influences multiple responses in plants including germination, seedling de-etiolation, stem elongation, phototropism, stomata and chloroplast movement, shade avoidance, circadian rhythms, and flowering time (Deng and Quail 1999). One of the most striking effect of light on plants is seen when a seed first receives light, germinates, comes out of the soil and establishes as a seedling. Light-mediated seedling development is called photomorphogenesis or de-etiolation.

A seedling response to light is significantly dependent on the quality of light signal, which is determined by its wavelength. Plants can perceive a broad range of wavelengths in the solar spectrum, spanning from far-red to UV. Different wavelengths perceived by the seedlings can have independent effects on the light-regulated developmental responses (Kami *et al*. 2010). Among these, UV-B radiation can act as a developmental cue as well as a stress-inducing agent, depending on its intensity and duration of exposure (Yin and Ulm 2017). The impact of UV light on plants depends on factors such as the intensity of the light, the duration of exposure, and the plant species.

➢ Types of UV Light

UV light is categorized into three main types: UV-A, UV-B, and UV-C. UV-A (315–400 nm) and UV-B (280–315 nm) are the most relevant to plant development, as they are able to penetrate the Earth's atmosphere and reach the Earth's surface.

➢ The Impact of UV Light on Seed Germination

Seed germination is a critical stage in the life cycle of plants, marking the beginning of their growth and development. While factors such as water, temperature, and soil quality are well-known to influence germination, the role of ultraviolet (UV) light in this process is less understood. This article explores the effects of UV light on seed germination and the mechanisms by which it influences this crucial stage of plant growth.

a. UV Light and Seed Coat Permeability

One of the primary ways in which UV light affects seed germination is by influencing the permeability of the seed coat. UV radiation can cause structural changes in the seed coat, making it more permeable to water and gases essential for germination. This enhanced permeability can accelerate the germination process and improve seedling establishment.

b. Regulation of Phytohormones

UV light exposure can also influence the levels and activity of phytohormones, such as abscisic acid (ABA) and gibberellins, which play crucial roles in seed germination. UV-B radiation, in particular, has been shown to induce the degradation of ABA and stimulate the production of gibberellins, promoting seed germination. These hormonal changes help regulate various physiological processes during germination, including seed dormancy release and embryo growth.

c. Enhancement of Enzymatic Activity

UV light exposure can stimulate the activity of enzymes involved in the breakdown of stored reserves in seeds, such as starches and proteins. Increased enzymatic activity facilitates the mobilization of nutrients from the seed to support embryo growth and development during germination. This enhanced metabolic activity promotes quicker and more vigorous germination under UV light conditions.

d. Induction of Protective Mechanisms

While UV light can promote seed germination, it can also induce the production of protective compounds in seeds to mitigate potential UV-induced damage. These compounds, such as antioxidants and flavonoids, help protect the seedling from oxidative stress and UV-induced DNA damage during early growth stages. Additionally, UV exposure can trigger the synthesis of defense-related proteins, enhancing the seedling's resilience to environmental stressors.

- **Positive Effects of UV Light on Plants**:

  a. Increased Photosynthesis:

  UV light can stimulate photosynthesis in plants, leading to increased growth and productivity. Plants exposed to moderate levels of UV radiation often exhibit higher rates of photosynthesis compared to those grown under UV-free conditions. UV-C light may damage DNA molecules, proteins and membranes, and exert inhibiting effects on the functioning of mitochondria and chloroplasts (Hsu *et al*., 2021).

  b. Defense Mechanisms:

  UV light can trigger the production of protective compounds such as flavonoids and antioxidants in plants. These compounds help plants defend against UV-induced damage and other environmental stresses.

  c. Morphological Changes:

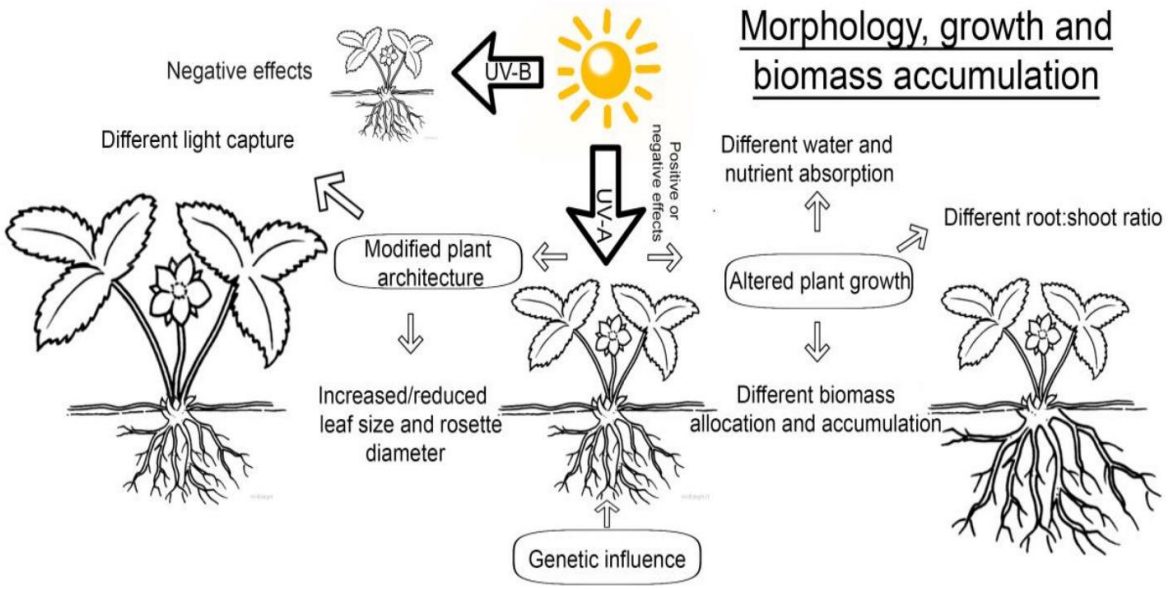
  UV light can induce changes in plant morphology, such as altered leaf thickness, shape, and color. These changes can enhance the plant's ability to absorb light and protect itself from excessive UV exposure.

  d. Environmental Benefits

  UV light is a natural and environmentally friendly method for enhancing fruit ripening, reducing the need for synthetic ripening agents. It can also help reduce post-harvest losses and improve overall fruit quality.

e. Implications for Agriculture and Food Industry

The use of UV light as a tool for fruit ripening has significant implications for agriculture and the food industry. By harnessing the positive effects of UV radiation, growers can produce fruits with superior quality, taste, and nutritional content. This can lead to increased consumer satisfaction and market demand for UV-ripened fruits.



Loconsole *et al.* 2021

Pic 1 - Effect of UV rays on morphology, growth and biomass accumulation of plant

➢ **Negative Effects of UV Light on Plants:**

a. DNA Damage:

Excessive UV radiation can cause DNA damage in plants, leading to mutations and cell death. DNA damage can impair plant growth and development, ultimately affecting crop yield.

b. Reduced Growth and Yield:

UV radiation may induce leaf differentiation and senescence processes via modification of leaf structure (Kakani *et al*., 2003). Prolonged exposure to high levels of UV radiation can inhibit plant growth and reduce crop yields. This effect is particularly significant in crops grown in areas with high UV intensity, such as at high altitudes or near the equator.

c. Photosynthetic Inhibition:

While moderate UV exposure can enhance photosynthesis, excessive UV radiation can inhibit this process. Inhibition of photosynthesis can disrupt plant metabolism and reduce overall plant health.

➢ **Protective Mechanisms Induced by UV Light in plants**

1. Accumulation of UV-Absorbing Compounds:

Plants exposed to UV light can synthesize UV-absorbing compounds such as flavonoids and phenolic compounds in plant epidermal layers to provide UV absorbing sunscreen (Nassour and Ayash, 2021). These compounds act as antioxidants and UV screens, protecting plant tissues from UV-induced damage. UV treatment increases the amount of UV-absorbing pigments in some rice

cultivars (Ziska and Teramura, 1992; Dai *et al*., 1992). Under water stress conditions, the accumulation of UV-absorbing compounds may provide additional protection against oxidative stress and photo damage.

2. Enhanced Antioxidant Defense:
UV light exposure can induce the production of antioxidant enzymes, including superoxide dismutase (SOD), catalase (CAT), and peroxidases. These enzymes scavenge ROS,(Foyer and Noctor 2005) and detoxify reactive molecules, helping alleviate oxidative stress and maintain cellular homeostasis under water stress conditions.

3. Enhanced Secondary Metabolite Production:
UV light exposure can induce the production of secondary metabolites in plants, such as flavonoids and phenolics. These compounds act as chelators, binding to heavy metal ions and reducing their bioavailability in plant tissues. This helps protect plants from heavy metal-induced toxicity and oxidative damage.

- **Strategies to Mitigate the Negative Effects of UV Light:**

a. UV Filtering:
Using materials that filter out or absorb UV radiation, such as shade cloths or UV-blocking films, can protect plants from excessive UV exposure.

b. Genetic Modification:
Developing UV-resistant plant varieties through genetic modification can help mitigate the negative effects of UV radiation. These varieties are engineered to produce higher levels of protective compounds and enzymes that repair UV-induced damage.

c. Cultural Practices:
Implementing cultural practices, such as providing adequate water and nutrients, can help plants cope with UV stress. Proper management of planting density and irrigation can also reduce the impact of UV radiation on plant growth.

Conclusion
Light is one of the indispensable environmental cues regulating plant growth and development. It not only provides plants with the source of energy during photosynthesis, but also plays a crucial role in plants overall growth and development throughout their life cycle. UV light plays a complex role in plant growth, with both positive and negative effects depending on the intensity and duration of exposure. While moderate levels of UV radiation can stimulate photosynthesis and enhance plant defenses, excessive UV exposure can cause DNA damage and inhibit growth. One of the most striking effect of light on plants is seen when a seed first receives light, germinates, comes out of the soil and establishes as a seedling. Light-mediated seedling development is called photomorphogenesis or de-etiolation. Among these, UV-B radiation can act as a developmental cue as well as a stress-inducing agent, depending on its intensity and duration of exposure.

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FIVE KEY SUCCESS MODELFOR FISH FARMING

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INTRODUCTION

The fisheries and aquaculture production contributes around 1% to India's Gross Domestic product (GDP) and over 5% to the agriculture GDP. Day by day northern part (Bihar, Uttar Pradesh, Madhya Pradesh, Uttarakhand, Haryana,etc.) of India is coming front line for Inland fish culture. Generally, there dominant species is Pangasius and some percentage of IMC & Tilapia in Uttar Pradesh. The growth of fish farming followed by some major rules, that we can define through A "**Five key success model**." We can describe **"Five Key Success model"** through five points that are Nursery programme, Feeding Programme, Probiotics Programme, Aeration Programme, Bio-security programme.

NURSERY PROGRAMME

Nursery pond management mainly designed for enhances the growth and survival rate of juvenile fish.

- Maintain intensive control over the young seed during their early, and most vulnerable, weeks of life.
- Nursery pond management to be used for multiple harvests each year.
- Secured with craft & bird sensing to avoid all predator animals. Water inlet & outlet setup.
- introduced optimal water parameter with probiotics programmed.
- Nursery programmed consists 3C concept where includes clean seed, clean pond, clean water.

FEEDING PROGRAMME

A good quality feed and appropriate feeding management maximum feed efficiency, lower cost of production, and reduce environmental degradation.

- Proper feeding methods can help control excess nutrient intake.Feed type must be given according to habit of fish. Used right size pellet& timings.
- Feed will formed with all required nutrients. (like Protein, amino acids, lipids & fatty acids, Carbohydrates, Vitamins, Minerals)& also formed with good water stability.Reduce over feeding.

Feeding Percentage (for pangasius fish)

ABW(GM)	FEED %	TIMINGS
20	10	4
30	7	4
50	5.5	4
100	4	3

ABW(GM)	FEED %	TIMINGS
200	3	2
300	2.8	2
400	2.2	2
500	1.7	2
600	1.5	2
700	1.3	2
800	1.2	2
900	1.1	2
1000	1	2

PROBIOTICS PROGRAMME

Probiotics are formed of beneficial bacteria that helps to increase nutrient sources, modulate immune system & immune response against pathogenic, also providing enzymes for better digestion.

- Increase disease resistance.
- Growth aquatic organisms.
- Improves the digestibility of nutrients.
- Increase tolerance to stress.
- Maintain water parameter.

AERATION PROGRAMME

Aeration increases capacity of fish production and improves fish health and growth rate.

- Summer seasons, with a bottom mounted aeration system operating, the cool waters are brought to the surface where heat transfer from the warm atmosphere increases water temperature. As the circulation continues warmer waters replace cooler waters at the bottom of the pond.
- Aerator removes ammonia, Carbon dioxide, Hydrogen Sulfide which affects the pond in farming.
- It also ensuring optimal oxygen supply, better survival, higher production and disease-free environment.
- Aeration can protect algae bloom and die off in pond.

Requirements: 1-1/2 HP aerator per acre.

BIO-SECURITY PROGRAMME

Bio-security in aquaculture reduce the risk of transmitting an infectious disease.Also minimize the risk of spread an infected animal or infectious agent to other sites susceptible species. Bio-security reduces exposure to pathogens : Some precaution measures

- In bio-security Craft & bird net sensing to prevent all type of predators of fish.
- All incoming sources for farming must be introduced with dis-infection (like-water source, vichles, feed etc.)
- Before entire farming area introduced himself/herself with asepsis.
- In farming activities, everything will include into sterilization.

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MARINE PENAEID SHRIMP RESOURCES OF ANDHRA PRADESH

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Introduction

Penaeid shrimps, or Penaeid prawns, are a highly diverse group of fisheries in the family of marine crustaceans in the suborder Dendrobranchiata. Their well-developed appendages and laterally compressed body set them apart from crabs and lobsters. These organisms' range in size from microscopic to 35 cm in total length. Numerous species within this category hold cultural significance. *These species include Penaeus vannamei (white-legged shrimp), Penaeus indicus (Indian white shrimp), and Penaeus monodon (tiger shrimp).* One species is native to the Pacific coast of Mexico, Central America, and South America, while the other two are native to the Indian subcontinent. These species are extensively cultivated in Andhra Pradesh and other coastal regions of India.

A total of 364 species are classified under 128 genera belonging to the order Decapoda. The genus Penaeus, which has 14 species, Metapenaeus, which has 13 species, and Parapenaeopsis, which has 9 species, are the most common shrimp in the Penaeidea family (Biswas, 2013). Geographically speaking, this area of India is home to 33 different species of penaeid shrimp. While South and Southeast Asia have the greatest recorded species diversity, Global penaeid shrimp species, belonging to the genus Penaeus, command the highest prices in both local and worldwide markets due to their high value.

Penaeid Shrimp Fisheries

Both culture and capture methods exploit the penaeid group of shrimps. Shrimp trawlers, filter nets, seine nets, push nets, barrier nets, beam trawls, cast nets, and pocketed scoop nets are the primary fishing tools and boats used to catch these shrimps. Different species have different habitats, and their range extends from deep ocean waters to coastal and estuarine regions.

The amount of shrimp and prawns that were captured globally in 2020 was recorded at 3.2 million metric tonnes, while in 2022, the contribution of penaeid shrimp to the overall number of marine fish landings was 1.63 lakh metric tonnes. Andhra Pradesh ranks second in terms of the state-by-state contribution of its east coast crustacean resources to India's total crustacean resources, with a percentage of 11.6% of the state's total marine landings (2.16 lakh tonnes) coming from these resources.

In 2022, the state of Andhra Pradesh had 2.16 lakh tonnes of marine landings, with 11.6% of that amount coming from crustaceans. The state's crustacean landings were primarily composed of penaeid shrimps (75.9%), with crabs (17.7%) and non-penaeid shrimps (5.4%). The total amount of penaeid shrimp landed in the state was 18.99 tonnes, which was an increase of 3.7 tonnes over the previous year (CMFRI, 2023). The specific contribution of penaeid shrimp to Andhra Pradesh's marine landings for the past three years, from 2020 to 2022, is 18.99, 15.29, and 12.56 tons,

respectively. 90% of the penaeid shrimp caught in Andhra Pradesh are exploited using trawl nets installed in mechanized trawlers (Rao et al., 2013).

The two main fishing harbours, Visakhapatnam and Kakinada, are where the majority of fishing takes place and are important for the arrival of marine fish in Andhra Pradesh. To catch these shrimps, small motorised trawlers about 9 to 11 metres in overall length were used throughout the Andhra Pradesh coast, operating up to 70 to 90 metres below the surface.

Penaeid shrimp species are found along the coast of Andhra Pradesh
Family–Penaeidae
Penaeus indicus, P. monodon, F. merguiensis, P. japonicus, P. semisulctus, Metapenaeus monoceros, M. ensis, M. dobsoni, M. affinis, Metapeaeopsisstridulans, M. barbata, Solenoceracrassicornis, Parapenaeopsisstylifera, P. hardwickii, P. uncta, P. maxillipedo, P. coromondalica, Trachypenaeuscurvirostris, T. granulosus, T. sedili, and Parapenaeuslongipes.

Family–Solenoceridae
Solenoceracrassicornis, S. melantho
The species found in the Andhra Pradesh Coast that are most abundant in terms of commerce are *Metapenaeus monoceros*, *M. dobsoni, M. brevicornis*, *Penaeus indicus, and P. monodon*. Overall, the genus Metapenaeus of penaeid shrimp displays a capture percentage of 25–30%, followed by Solenocera (15–25%) and Metapeaeopsis (10–20%). Penaeid shrimp catch peaks in April and June, then steadily rises to a peak in October and December, before progressively declining to March. This tendency is more or less noticeable in AP. "Tigers" (*Penaeus monodon, P. semisulcatus,* and *P. japonicus*), "Whites" (*Penaeus indicus, P. merguiensis,* and *P. penicillatus*), and "Browns" (*Metapenaeus monoceros*, *M. ensis*, and *M. affinis*) were the species categories of prawn catch.

Some of the interesting features of penaeid shrimps
Genus–Penaeus
Penaeus indicus: often referred to as an Indian prawn or Indian white shrimp, this shrimp has pink sides and is blue and white in color. It is found in the Indo-West Pacific, extending from eastern and southeastern Africa to northern Australia. It is indigenous to India and Southeast Asia. accessible at a depth of up to 90 meters across muddy or sandy sea bottoms in all coastal waters, estuaries, and backwaters. In shallow estuarine waters, larvae and post-larvae are found. Reach a maximum length of 20–23 cm for females and 18.4 cm for males. The range of fecundity is 68000–125420 eggs. The body seems semi-transparent, with a lot of dark brown spots covering it and a yellowish white to greyish green hue (Holthuis et al.,1980).

Penaeus monodon: also known as Asian tiger shrimp, black tiger shrimp, and giant tiger prawn. On the east coast, particularly in Orissa, Andhra Pradesh, and West Bengal, catch is more common. The largest Indian marine prawn in the world, reaching a maximum length of 35 cm for females and 26.8 cm for males. physique that is grey, green, or dark greenish blue; in larger adults, it turns reddish brown. It is the framed crustacea that is most noticeable. The species never reaches maturity when raised in culture. It matures in a marine environment and breeds in the ocean's deeper waters. Fertilised eggs hatch in marine environments.

Peneus merguiensis: also known as banana prawn. Often occur in the central areas of the east and west coasts. The maximum length measured was 35 cm in females and 26.8 cm in males. This species is among the penaeid prawns found in Indian waters that are significant for commerce. It

lives in coastal waters that are between 55 and 150 metres deep. It is comparatively more common in shallow waters with a sandy and muddy sea floor. The body of the shrimp is dotted with dark brown, giving it a yellow to green tint.

Penaeus semisulcatus: also referred to as the green tiger prawn. The species is dispersed at a depth of 130 meters throughout the east and west coasts of India. It dominates commercial catches along the southeast coast and contributes to a significant fishery. It can reach a maximum length of 23–25 cm for women and 25 cm for men. *Penaeus semisulcatus has a pale brown body with two transverse stripes across the rear of the carapace, which are either cream or yellow in color.* The carapace also occasionally has a greenish tint. Reach adulthood and start a family in the water. The larvae travel to lakes, backwaters, and estuaries. Due to its large growth, this species is in high demand in the export market and is being targeted more and more by motorized boats.

Genus–Metapenaeus

Metapenaeus monoceros: referred to as pink, brown, or speckled shrimp. This species can be found throughout the entire coast, particularly in backwaters, estuaries, and shallow water, reaching depths of up to 60 meters, with a primary range of 10 to 30 meters. This species favors bottoms that are sandy or sandy-mud. Adults inhabit areas farther offshore, while juveniles inhabit estuaries, lagoons, or coastal habitats. Body colour: pink, green, greyish, or pale with brown specks; the largest size measured was 22 cm; the maximum size for females was 22 cm; the maximum size for males was 19.5 cm. The species matures and reproduces in the sea. Males reach adulthood in ponds, while wandering females reach later stages of maturity in cultural settings.

Metapenaeusdobsoni: a native species of shrimp found in the eastern Indian Ocean, commonly referred to as the kadal shrimp. This is a major species in the prawn fishery around India's southwest and southeast shores. India was home to the largest single species. Shrimp can grow up to 13 cm in length; males are 12 cm long and females are 13 cm long. Metapenaeusdobsoni'scolor ranges from pale yellow to brownish with reddish, brownish, or greenish flecks. After reaching adulthood, the species reproduces in the sea. Four-to-five-millimetre post-larvae move to the estuaries.

Metapenaeusaffinis is often referred to as jinga shrimp or brown shrimp. At depths of 5 to 92 meters, this species thrives in benthic and brackish environments. Both the southern portion of India's east coast and its west coast have significant commercial value for them. Reach a maximum length of 18 cm, a maximum size of 19.5 cm for men, and 22 cm for women. Body colour varies from pale green to pale pink, with flecks of reddish-brown or green-blue, or pink-brown. The inshore regions of the sea are where the species matures and breeds.

Genus–Parapenaeopsis

Parapenaeopsisstylifera, also known as karikkadi shrimp, Coromandel shrimp, and Kiddi shrimp. The coast is home to medium-sized prawns, Parapenaeopsisstylifera, particularly on the west and south-east shores. The Indian coast hosts this commercially significant fisheries resource at depths of 20 to 90 meters. Reach a maximum length of 14 cm, a maximum size of 11.7 cm for females, and 11.5 cm for males. The shrimp's colour is either pinkish-white, brownish, or even grey.

Parapenaeopsishardwickii: is one of the penaeid prawn species that inhabits fresh, brackish, and marine settings. Also called spear shrimp, it makes up a respectable fishery in the waters around the Godavari Estuary, the northwest coast, and Bombay. The species ranges from the coast to

approximately 90 meters below the surface. Juveniles often inhabit the intertidal and subtidal margins of mud flats, as well as backwaters and estuaries. The maximum measured length is 12 cm; the maximum measured size for females is 13.5 cm, and for men it is 11.1 cm. The body color is grey, rarely pink, and occasionally slightly pink.

Kishinouyepenaeopsismaxillipedo: is a kind of Penaeidae family decapod shrimp. It's also known as the torpedo shrimp. accessible along the coastlines of Tamil Nadu, Kerala, and Bombay. Not important. reach a maximum size of 10 cm for males and 12.5 cm for females at their maximum length. body colour: grey, occasionally light brown.

Genus–Trachypenaeus

Trachypenaeuscurvirostris: is a species of prawn that lives in the shallow waters of the Indo-West Pacific. Available both on the east and west coasts of India at a depth of 10-150 m, commonly called Southern Rough Shrimp. Body pink to reddish brown, sometimes whitish on the sides. It is a cocktail shrimp that is ecologically and economically important. Attain 10.5 cm in length in females; 10.5 cm, male 8.5 cm in females.

Genus–Metapenaeopsis

Metapenaeopsisstridulans: is a species of shrimp known as the fiddler shrimp. It is a member of the Penaeidae family of prawns, commonly referred to as velvet shrimp. It is accessible in Bombay and the northern east coast, primarily caught by trawling at depths of 10 to 90 meters. The body of the shrimp exhibits mottling, ranging from dark brown to crimson. The shrimp can reach a maximum length of 12 cm for females and 11.5 cm for males.

Genus–Parapenaeus

Parapenaeuslongipes: is a species of shrimp known as the Flamingo shrimp. It belongs to the Dendrobranchiata suborder and the Penaeidae family. Found in the sea off the coasts of the Hoogly River, Mangalore, Cochin, Ganjam, Visakhapatnam, and Veraval. Males of this species develop to a maximum size of 8 cm, while females grow to a maximum length of 6.1–7.9 cm. Trawl nets near Veraval's shore captured the majority of the specimen.

Status of Penaeid Shrimp Production from Aquaculture

Along the nine maritime states of India, Andhra Pradesh has the most area under cultivation and production (8,15,745 MT), with 1,08,526.27 hectares under vannamei culture. The state produced about 782,000 MT of vannamei shrimp in 2022, followed by Gujarat, Tamil Nadu, and Pondicherry. This culture has produced 27,616 MT of tiger shrimp in nine farming states in India, with West Bengal leading the way and Kerala and Andhra Pradesh following.

Conclusion

India, particularly Andhra Pradesh, hosts 33 different species of penaeid shrimp.South and Southeast Asia exhibit the highest recorded species diversity.Penaeid shrimp species, especially those belonging to the genus Penaeus, command high prices in local and global markets.Both culture and capture methods exploit penaeid shrimps.Penaeid shrimp contributed significantly to marine fish landings of the Visakhapatnam coast. Further developing proper management practices in the shrimp culture, bringing new species for aquaculture practices, increase the number of fishing harbours and sustainable catching methods will increase the penaeid shrimp production in Andhra Pradesh coast.

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Marine Shrimp Landing from Visakhapatnam Fishing Harbour

Penaeus monodon

Metapenaeus monoceros

Penaeus indicus

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ANTIOXIDANTS IN FOOD: A WAY TO HEALTHY LIFE

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ABSTRACT

Oxidative stress is a major factor in ageing and the development of age-related diseases such cardiovascular disorders. Cardiovascular disease is partly caused by oxidative changes in proteins, lipids, and nucleic acids in artery walls. Thus, ingesting antioxidants or applying them medicinally may prevent the onset of certain degenerative conditions. Antioxidants are critical for avoiding cardiovascular disease and cancer, as well as maintaining the health of the kidney, liver, and digestive system. Regular metabolism produces oxidant biproducts, which have the ability to cause major damage to DNA, lipids, and proteins. The ageing process and degenerative diseases associated with ageing, such as cancer, heart disease, reduced immune systems, cognitive decline, and cataracts, are significantly impacted by this injury. Antioxidant as micronutrients such as and include vitamins, minerals, carotenoidsand polyphenolsprotect the body from harmful free radicals Antioxidants work by scavenging free radicals from biological cells, therefore, preventing or reducing oxidative damage. Fruits, vegetables, herbs and many other food items are rich source of antioxidants. Reduced fruit and vegetable consumption raises the risk of most malignancies, heart disorders, cancer, ageing and cataracts; nevertheless, excessive use of few of antioxidant supplements may have unfavourable side effects.

Key Words: Antioxidant, Micronutrients, ageing process, Diseases, Fruit, Vegetable

INTRODUCTION

Antioxidants (Anti + Oxidants) are basically those substances that retards process of oxidation. Free radical chemistry has received a lot of attention lately. There is indisputable evidence that free radicals cause oxidative damage to biomolecules in molecular membranes and cell nuclei, including proteins, lipids, and nucleic acids. Retaining the equilibrium between antioxidants and free radicals is essential for good health. Thus, the prevention and treatment of numerous diseases, including diabetes, atherosclerosis, coronary artery disease, cancer, inflammation, liver diseases, cardiovascular diseases, cataracts, nephrotoxicity, and aging-related neurodegenerative processes, may depend critically on the management of oxidative stress processes (Sindhi et al., 2013).

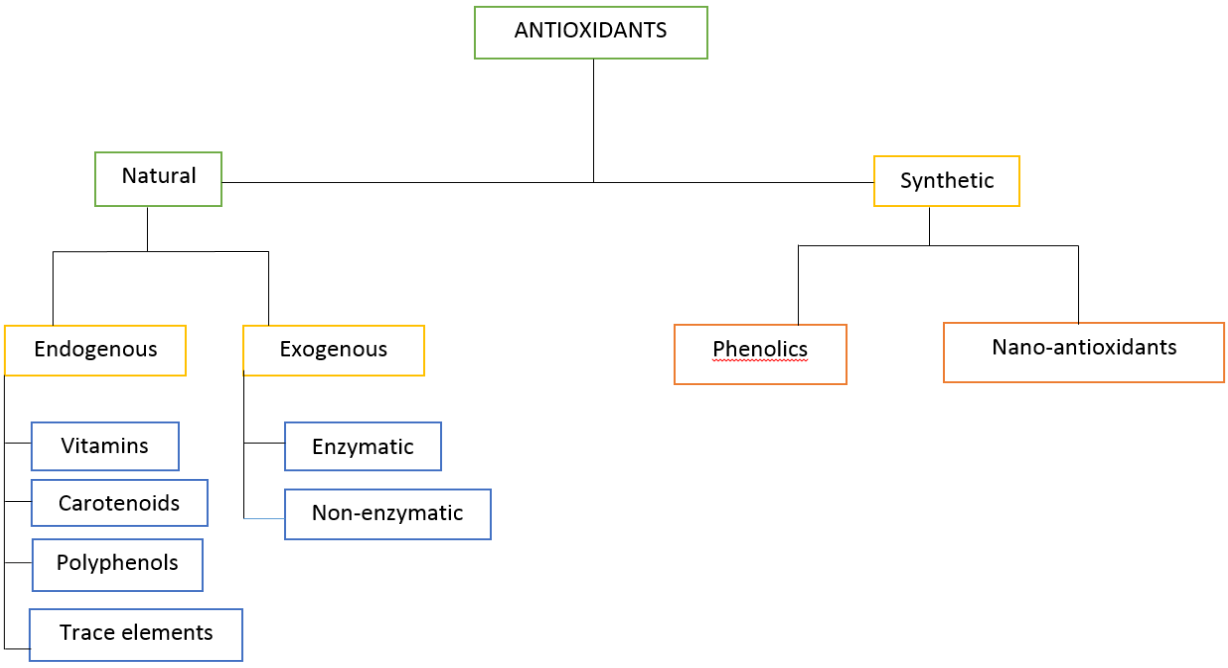
Enzymatic and non-enzymatic antioxidants, which are mostly obtained from the food (such as glutathione, uric acid), neutralize excess free radicals and help to maintain redox equilibrium. Also, synthetic antioxidants like n-propyl gallate (PG), butylated hydroanisole (BHA), and butylated hydrotoluene (BHT) are used but they may be contaminated with hazardous solvents. Plants comprises of consumable fruits, vegetables, spices, and herbsare the primary source of natural

antioxidants because they are high in microelements, phenolic compounds, carotenoids, and vitamins. It should be noted, nonetheless, that the antioxidant activity varies throughout natural resource kinds and morphological components. Natural product activity is also affected by a wide range of other variables, including harvest season and soil and climate conditions. To a great extent, they obstruct the standardization of natural goods. Natural antioxidants are increasingly being employed as food product preservatives or as a means of preventing the development and oxidation of bacteria, including many dangerous ones like *Salmonella spp.* and *Escherichia coli* (Salganik, 2001).

Antioxidants are increasingly being utilized as food packaging additives or as preservatives in food items nowadays. A substantial amount of research has been published in recent years showing that natural antioxidants improve the stability of dyes, the aroma of fruit juices, and the stability of edible oils. They also function well as additives in meat products, effectively displacing artificial preservatives and stabilizers. It should be noted that the evident taste criteria and the necessity for clearance by the FDA (American Food and Drug Administration) or EFSA (European Food Safety Authority) severely restrict the choice of bioactive chemicals for the food business. There is an intriguing pattern that we can now see. In recent years, natural extracts have become attractive, also due to the rapid development of nanotechnology. As a source of substances with reducing potential, they have replaced the toxic reagents used in chemical synthesis and ushered in the era of the so-called biogenic synthesis (Flieger et al., 2021). This article aims to discuss about classification, sources and applications of antioxidants. The health benefits associated with them and working mechanism of antioxidants with examples.

CLASSIFICATION

Antioxidants are basically divided into two categories natural and synthetic. They are further subcategorized to endogenous, exogenous and phenolics, nano-antioxidants. Endogenous is further categorized to vitamins, carotenoids, polyphenols and trace elements. Exogenous is further categorized to enzymatic and non-enzymatic. These are mostly found from plant sources.



-Enzymatic

Superoxide dismutase (SOD) get rid of Oxygen ion by speeding up its dismutation by about four orders of magnitude at 7.4 pH. The mitochondria of mammalian cells contain the active site manganese (Mn SOD) of the SOD enzyme. Additionally, the majority of a SOD with an active site copper and zinc (CuZn SOD) is found in the cytosol. Mutations affecting CuZn SOD are possibly linked to the family dominant type of amyotrophic lateral sclerosis, often known as Lou Gehrig's disease, a degenerative condition of motor neurons in the brain and spinal cord. These mutations usually decrease activity somewhat, yet they could potentially inadvertently turn this ordinarily protective protein harmful. H_2O_2 removing enzymes need to work in tandem with SOD enzymes. In most mammalian cells, peroxisomes include catalases, which are enzymes that break down H_2O_2 produced by oxidases. Catalases convert H_2O_2 to water and oxygen. However, it is likely that the major H_2O_2 removing enzymes in mammalian cells are the glutathione peroxidase (GPX) enzymes, which contain active site selenium and are involved not only in H_2O_2 removal, but also in the metabolism of lipid peroxide (Halliwell et al., 1995).

a. Non-enzymatic:

The preterm new-born may be more susceptible to increased ROS production due to diminished function or decreased bioavailability proteins. Since non-enzymatic antioxidants (NAC) are depleted in response to ROS-mediated stress, resistance to oxidative stress also depends on non-enzymatic mechanisms. Retinol-binding protein and the retinoic acid receptor are thought to be mediated by vitamin A's actions. As a precursor to the antioxidant glutathione, NAC has been shown to have no effect on mortality. Iron may be a strong oxidising agent; ferroxidase, transferrin, and ceruloplasmin all help in iron metabolism. (Sindhi et al., 2013).

b. Metal ion sequestrants:

According to Halliwell et al. (1995), An additional important antioxidant defence is the presence of metal ion storage and transport proteins including metallothioneins. For example, iron in the two iron-binding sites of transferrin or lactoferrin will not catalyse free radical reactions. Sequestration is occasionally jeopardised. Transferrin is iron-saturated in a large proportion of preterm infants and in a smaller percentage of seemingly normal full-term neonates. Iron in plasma can catalyse harmful free radical processes such lipid peroxidation and OH ion formation. Such babies could be at high risk of free radical damage if exposed to elevated O_2 to toxins generating O_2 and H_2O_2 or to infection (raising endogenous production of O_2 and H_2O_2 as per the studies reported by Halliwell et al. (1995).

a. Vitamins:

Vitamin C: According to Halliwell et al. (1995), ascorbate may have several antioxidant actions in vivo in addition to its putative ability to regenerate α-tocopherol. In the respiratory tract, it may react rapidly with such air pollutants as O_3**,** cigarette smoke, and NO_2.Unlike vitamin E, vitamin C has several well-established other metabolic roles e.g. as a cofactor for such enzymes as proline, lysine, and dopamine-P-hydroxylases.

Vitamin E: The resulting α-tocopherol radical is far less effective than peroxyl in destroying the side chains of fatty acids. So, the overall effect of α-tocopherol under physiologic conditions is usually to slow the chain reaction of lipid peroxidation. Many different mechanisms may convert this α-tocopherol radical to α-tocopherol none yet rigorously proved to operate in vivo. Most probable is the reaction of vitamin C with this radical at the surface of membranes and lipoproteins (Halliwell et al., 1995).

b. Carotenoids:

They are often simplistically grouped with vitamins E and C as antioxidant nutrients. They help in preventing many diseases as epidemiologic evidence can be found particularly in smokers that high body levels of ROS species or free radicals are associated with increasing risk of cancer and cardiovascular diseases. Although many carotenoids have been claimed to exert antioxidant events in vivo under certain conditions although sometimes questionable assays have been used such as plasma Thiobarbit uric acid reactive substances (TBARS) and pentane exhalation, it is not yet proved that any protective effects they exert against human disease are due to antioxidant action of conversion to carotenoids and effects on cell communication may be equally or more important.

c. Phenols:

Numerous plant phenols, such as flavonoids and lipid peroxidation prevent lipoxygenase enzyme activity in vitro and may be important dietary antioxidants. It has been speculated that flavonoids in red wine could explain the “French paradox”. In vitro, some pigments can be pro-oxidants when combined with iron or copper ions. Plant phenols might scavenge RNS, e.g. preventing tyrosine nitration by $ONOO^-$, nonetheless, one must take into account the biological characteristics of any resultant nitroso/nitro phenolics. Flavonoids are phenolic substances isolated from a wide range of vascular plants, with over more than 8000 individual compounds known. They act in plants as antioxidants, antimicrobials, photoreceptors, visual attractors, feeding repellents, and for light screening. Many studies have suggested that flavonoids exhibit biological activities, including antiallergenic, antiviral, anti-inflammatory, and vasodilating actions. However, most interest has been devoted to the antioxidant activity of flavonoids, which is due to their ability to reduce free radical formation and to scavenge free radicals.

Health benefits of antioxidants:

Anti-cancerous:

Antioxidants, such as lanthanides, glutathione, lycopene, selenium, and flavonoids, have been shown in several studies to play an anti-cancer effect in bio-coordination chemistry. It is now essential to understand the mechanism of action of the molecule, minimise harmful side effects, and improve its design thanks to recent advancements in movie chemistry. Cancer is treated with a wide range of medications based on metals. Because they include therapeutic radioisotopes, lanthanides—also referred to as pharmacological agents in radio immune and photodynamic therapy—are particularly interesting. It has been reported that these Lanthanides are coordination compounds with improved pharmacological properties and a broader range of antitumour activity. Apoptosis is a cell suicide altruistic mechanism that aims to selectively kill malignant and other cells that endanger human health and life. It is frequently referred to as "a guardian angel" or "cell policeman." The integrity and survival of the entire organism are preserved by the killing of the "harmful" cells. ROS function as crucial mediators and triggers in a multistage chain of events that carry out apoptosis. From a schematic perspective, apoptotic signals originate in cancer cells and stimulate the p53 protein to accumulate, which in turn releases ROS, cytochrome C, and a few other regulators from mitochondria. The latter cause a caspase-activated deoxyribonuclease to be promoted and a cascade of proteolytic enzymes known as caspases to break down a variety of crucial cell proteins. Cell death by apoptosis is caused by cleavage of essential proteins and DNA. Crucially, the majority of radiation and anticancer medications destroy cancer cells by triggering apoptosis. Cancer cells with p53 gene

mutations are resistant to apoptosis and, consequently to anticancer medications (Yoshihara et al., 2010).

Hepatoprotective agents :

Hepatoprotective effect has been found to be associated with plants that have high antioxidant activity. Previous reports confirm that antioxidants have been religiously used in the treatment of various types of liver diseases. Several clinical trials have confirmed the effectiveness of antioxidants like Vitamin C, E, *etc*. in the treatment of hepatocellular carcinoma patients.

Anti-Diabetic :

Diabetes is a serious global health issue. This long-term metabolic condition is defined by absolute or relative deficiencies in insulin secretion, or by non-secretion of insulin, which leads to persistent hyperglycaemia and disruptions in the metabolism of proteins, lipids, and carbohydrates. Diabetes causes metabolic disruptions that lead to a number of consequences, including macro and microvascular dysfunctions. Numerous studies have demonstrated that diabetes mellitus is linked to elevated free radical production and reduced antioxidant capacity. These findings cause imbalances in the process of radical formation and defence, which in turn causes oxidative damage to cellular constituents like proteins, lipids, and nucleic acids. Both insulin-dependent (type 1) and non-insulin-dependent (type 2) diabetes are associated with elevated oxidative stress. Among various factors that are responsible for increased oxidative stress, glucose autoxidation is most responsible for the production of free radicals. Other factors include cellular oxidation/ reduction imbalances and reduction in antioxidant defences (including decreased cellular antioxidant levels and a reduction in the activity of enzymes that dispose of free radicals). In addition, increased levels of some prooxidants such as ferritin and homocysteine are also observed. Another important factor is the interaction of advanced glycation end products (AGEs) with specific cellular receptors called AGE receptors. Higher blood antioxidant levels, especially tocopherol, have been linked to a decreased incidence of type 2 diabetes mellitus in humans. Glutathione peroxidase (GPX) and reduced glutathione (GTH) are the cell's main defences against oxidative stress. Reduced levels of ascorbate, glutathione, and superoxide dismutase are the most often observed antioxidant deficits associated with diabetes. Lower levels of reduced glutathione have been documented in diabetic neutrophils and monocytes. Plants, especially those possessing robust antioxidant chemicals in high concentrations, have a significant role in ameliorating oxidative stress-related illnesses like diabetes mellitus. Numerous studies can be found on web that have examined how these plants and the antioxidants they contain help in fighting against diabetes and its complications. These findings are encouraging and demonstrate the potential benefits of high-antioxidant plants for the treatment of diabetes mellitus (Sindhi et al., 2013).

Healthy heart:

Bio-active dietary fibre exhibits a similar action to that of antioxidants. Increased fecal bulk, brought on by dietary fibre, aids in the removal of cholesterol and bile acids from the digestive system. Dietary fibres assist in lowering plasma levels of LDL cholesterol and triglycerides, which lowers the risk of atherosclerosis and related cardiovascular symptoms including hypertension and stroke by slowing the rate of reabsorption of cholesterol (Halliwell et al., 1995).

Aiding brain function and improving mental health:

As we know that the brain is more vulnerable to free radical damage than most other bodily systems because of the quantity of oxygen it consumes for normal everyday functioning due to its

naturally high metabolic activity. Consuming antioxidants is one of the main ways you may defend your brain from this assault. In particular, antioxidants may be able to postpone memory loss and other types of cognitive decline. All of this is connected to oxidative stress, which has been linked to memory loss, cognitive decline, and Alzheimer's disease. Antioxidants can benefit both mental and brain health, despite the differences between the two. Studies published in Current Neuropharmacology demonstrate the frequent link between anxiety and depression and oxidative stress. While there is no substitute for appropriate mental health medicine or care, eating a well-balanced diet high in antioxidants is one of the lifestyle modifications that many people find helpful (Jovanovic & Simic, 2000).

Anti-inflammation:

According to Yoshihara et al.(2010)inflammation is sometimes misunderstood, it's not necessarily nasty or alarming. Within reason, inflammation really plays a vital role in the body. Your white blood cells use inflammation as a defence mechanism against external illnesses like germs. That does not imply, however, that it is always convenient or required. Headaches and soreness in the joints and muscles are just a few of the symptoms that might indicate inflammation. Food antioxidants have a very straightforward mechanism of action: by shielding cells from harm, they can stop undesired inflammatory reactions before they start.

Healthy gut

Entire body of an individual may be impacted by the state of stomach. The condition of gut microbiome can impact all aspects of your life, including your skin and mental health. It is true that microbiome, consisting of beneficial bacteria that maintain a healthy balancing of all important biological function in the body. Antioxidants can lower intestinal oxidative stress levels by altering the makeup of helpful microbial species in the gut, according to research published in the journal "*Antioxidants*". Gut health may benefit from having a solid and well-balanced foundation by consumption of antioxidants in daily life (MATTILL, 1947).

Support eye health:

As we know carotenoids as a precursor of Vitamin A is one of the most dominant micronutrient to enhance one's eye health. Increasing the amount of foods high in antioxidants in your diet can significantly reduce your chance of developing cataracts and age-related macular degeneration, two serious eye conditions. Indeed, it may also decrease the course of age-related macular degeneration, according to a 2013 research published in Clinical Interventions in Ageing. These qualities are also widely recognised for beta-carotene and vitamin E (Yoshihara *et al*, 2010).

Conclusion

This article covered majorly the health potential of food antioxidants with their basic information. It is of great need to utilize all the knowledge pertaining to use of antioxidants in daily life for the overall well-being of human beings. The plant based antioxidants are giving boon to nutraceutical food industry.

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AN OVERVIEW OF DISRUPTIVE TECHNOLOGIES FOR AQUACULTURE

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Introduction

- ✓ Aquaculture – Long history and contributes high quality proteins to human being.
- ✓ Past few decades, aquaculture is the fastest growing sector.
- ✓ Since 2013, Production of Aquaculture > production of wild fisheries
- ✓ In the past 50years, application of science and introduction of new technologies result in rapid development of aquaculture.
    1. Improved reproductive technologies: Enabled people to close the life cycle of aquaculture species which provides for species diversification.
    2. Use of live feeds: Microalgae, rotifers, brine shrimp and other copepods in hatcheries has solved the big bottleneck in culturing of some marine species
    3. Selective breeding : With the help of quantitative genetics have substantially improved triats of commercial importance in over 60 aquaculture species
    4. Sex reversal technology and DNA markers: Sex determination have enabled the production of Mono- sex tilapia, Yellow catfish, River shrimps
    5. Improved feed formulation: Based on the nutritional requirements of each fish species have improved FCR and reduced feed cost.
    6. Disease management: Technologies have reduced the occurrence of diseases in aquaculture.

Early innovations in the aquaculture results in the contributed to a tremendous growth and meet the ever-increasing seafood demands but reduced the supply of fish meal and oils, worsening environmental conditions and climate change and seriously affect our capacity in producing enough aquaculture products to meet the demand. So, further sustainable and profitable development of aquaculture is possible with emerging and disruptive technologies will increasingly offer novel ways to enhance the global seafood production and profitability.

Keywords: Aquaculture, Digital technologies, Nutrition, Vaccines.

A. NOVEL MOLECULAR TECHNOLOGIES FOR GENETIC IMPROVEMENT

- ✓ Genetic improvement through breeding – Boom of the world aquaculture.
- ✓ **Conventional breeding programmes-** played a critical role and will continue to drive the global aquaculture industry forward.
- ✓ Molecular technologies and existing breeding technologies resulted in the accelerated the genetic improvement of some aquatic species.

Marker assisted selection (MAS)

- ✓ The process of using DNA markers as indirect selection criteria for selecting triats in breeding.

- ✓ Applied to improve disease resistance.

Ex. Resistance to infectious pancreatic necrosis in Salmon
Lymphocystis in Japanese flounder

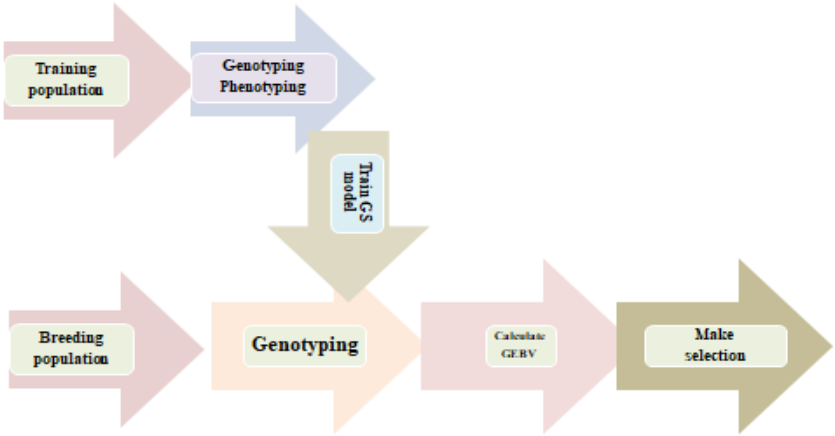
Other technologies:

1. Sex control:
   - ✓ To produce monosex stocks in some species
   - ✓ To prevent uncontrolled reproduction
   - ✓ To aid in broodstock management.
2. Gynogenesis:
   - ✓ Gene manipulation technology to produce all female fishes
   - ✓ Monosex population in aquaculture
   - ✓ Asexual reproduction
3. Androgenesis:
   - ✓ A form of quasi-sexual reproduction in which a male is the sole source of the nuclear genetic material in the embryo.

Genomic selection:

- ✓ Novel approach of molecular breeding.
- ✓ GS uses markers as predictors of performance and consequently delivers more accurate predictions of breeding performance.

How can we do that?



Genomic editing/ Gene editing (GE):

- ✓ Type of genetic engineering in which DNA is inserted, deleted, modified or replaced in the genome.
- ✓ GE targets the insertions to site specific locations.
- ✓ 4 families of engineered nucleases.
  - ✓ Mega nucleases
  - ✓ Zinc finger nucleases (ZFNs)
  - ✓ Transcription activator – like effector based nucleases (TALEN)
  - ✓ Clustered regularly interspaced short palindromic repeats (CRISPR)

GE allows for rapid introduction of favorable alleles to the genome, to increase the frequency of desired alleles at the loci determining important traits, to generate new alleles. Aquaculture species is especially suitable for GE due to their high fecundity and external fertilization.

Drawback : GE in aquaculture species is to find the right genes, which can be edited rapidly change traits.

Advances : Advances in GE and GS are composed to dramatically reshape the aquaculture industry by helping improve the economical important traits of many aquaculture species.
In the future, gene selection, gene editing, conventional breeding strategies and matured biotechnologies will accelerate genetic improvement in aquaculture.

B. Information/ Digital technologies:

- ✓ In the past 50 years, development of aquaculture is very fast but there is still much to be done to improve its profitability and sustainability (FAO, 2020).
- ✓ Digital technologies – possess the power to revolutionize the aquaculture industry.

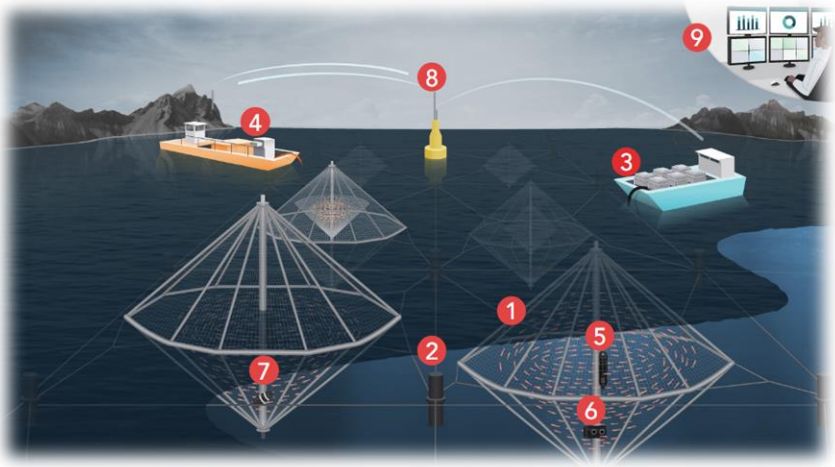
Robotics to carryout laborious work:

- ✓ Aquaculture production is a complicated process.
- ✓ Many steps, including Feeding, Cleaning ponds and nets, Monitoring behaviour, removing sick fish are labour intensive and costly which is difficult without machines.
- ✓ In aquaculture industry – few customized systems, which can work universally for all the aquaculture species and culture systems due to high diversity of aquaculture species and systems.
- ✓ Robotics has potential to conduct some laborious work in aquaculture.

Ex. In USA, automated underwater robots were used for inspection and cleaning of nets in Salmon industry, Many research institutes and companies have developed and developing various types of robots in aquaculture:

1. Robot fish
2. Innova sea
3. SINTEF
4. SEAVAX

INNOVASEA: SEASTATION NET PEN



1. Submersible pen system: Stays below the surface to avoid pounding waves and keep fish at healthier depths.
2. Mooring system: Heavy duty grid-based mooring system tethers pens to the ocean floor and keeps them secure through typhoons and hurricanes.

3. Submerged pen feeding: Unique underwater feeding system feeds fish in each pen from a single surface point with minimal feed loss.
4. Harvesting: Raising the pen gathers the fish into a smaller area to make harvesting easier than ever.
5. Environmental sensors: Strategically positioned throughout the site, these monitor everything from water temperature and tilt to dissolved oxygen and turbidity to keep fish safe and healthy.
6. Biomass estimation: Ground-breaking technology and advanced algorithms provide accurate assessments of each pen's volume of fish.
7. Feed optimization: Monitor environmental conditions, satiation levels and pellet consumption to make data-driven decisions on the spot.
8. Cloud communication: Data is delivered to operators in real time and offloaded securely to the cloud so it can be accessed anywhere using smartphone, tablet or laptop.
9. Cloud based software: Combines real-time data with powerful analytics tools to give you instant insights into farm operations.

SINTEF ACE – ROBOTIC LAB

- ✓ **ResiFarm**: Resilient Robotic Autonomy for Underwater Operations in Fish Farms
- ✓ **Aquagraph:** Graph databases for visualization and optimization of aquaculture production processes
- ✓ **CHANGE :**An underwater robotics concept for dynamically changing environments
- ✓ **Fish-Machine Interaction:** Development of new knowledge and methods for optimized operations in fish farms
- ✓ **NETCLEAN 24/7:** Tetherless robot for biofouling prevention and inspection in salmon farming
- ✓ **AUTOSMOLT2025:** Autonomous containment and production systems for smolt and post-smolt production
- ✓ **RACE Digital Cage:** Generalized interface for collection, storage, interpretation and visualization of different monitoring sensor data
- ✓ **RACE Mucus sensor:** Developing and validating new tools and methods for quantifying the thickness of the mucosal layer of Atlantic salmon
- ✓ **INDISAL:** Enabling technology for identification of individual salmon in commercial fish cages
- ✓ **Crowdguard:** Aims to increase salmon farmers' control during crowding operations through development and validation of new and unique technology for data collection during crowding of salmon.
- ✓ **Cage reporter:** Development of technology for autonomous, bio-interactive and high-quality data acquisition from aquaculture net cages
- ✓ **Artifex:** Remotely controlled operations without personnel on site
- ✓ **Bioracer:** About biomass and feeding in commercial salmon farming by developing methods for monitoring feeding and biomass-related condition
- ✓ **SENSODRONE:** Operational and robust airborne sensors platforms for surveillance and inspection in maritime environments
- ✓ Despite all these existing robotic products, it is important to note that fully automated aquaculture is still currently impossible.

- ✓ However, it is certain that the next 5-10 years will be sustainable changes.
- ✓ It should also be noted that any automation using robotics must consider the specificity of each species, culture systems and various environments.

C. Offshore farming/ Open ocean aquaculture

- ✓ Emerging approach to culture marine food fish.
- ✓ Offshore aquaculture is increasingly regarded as one of the important means to ensure a sufficient and stable supply of seafood, where it is believed to minimize the negative effects on conventional marine aquaculture on the environment of oceans.

Advantages:

- ✓ Offshore sites provide sufficient sea space for culturing of fish.
- ✓ Water quality is usually good enough for aquaculture.

Ex:

1. In Norway, World's largest offshore fish pen with 110m wide and having a capacity of 1.5 million fish and equipped with 22,000 sensors to monitor environment and behaviour of fish.
2. In China- Qingdao, Started to build the world first intelligent fish farming ship with length of 250m and width of 45m and designed speed of 10 knots and the expected production of 4000 tons of high value marine products every year

- ✓ Offshore aquaculture might face economic, biophysical, and technological challenges that prevent its growth and hinder it from contributing significantly to global seafood and nutrition security.
- ✓ The aquaculture industry needs to consider many factors, including cost, environment, affordability and sustainability, before entering offshore aquaculture.
- ✓ Rapid development of novel technologies, offshore finfish aquaculture is promising and worth trying.

D. Alternative proteins and fish oils

- ✓ Aquaculture is the fastest growing food producing sector in the world.
- ✓ In aquaculture production system, feed represents major cost.
- ✓ Fish meal and fish oil – major protein and lipid source in aquaculture feed.
- ✓ Rapid growth of the aquaculture industry and the increasing demand of fish – result in a rise in the amount and price of fish meal and fish oil, over the last few years.
- ✓ Fish meal and fish oil- relay heavily on wild caught (Over fishing has already put serious pressure on wild caught).
- ✓ Fish meal and fish oil – primary protein sources in aquafeed
    - ✓ There is a need to look for an alternative protein and lipid sources, which is not cheaper but nutritionally enrich as well.

Basic criteria for alternative protein sources:

- ✓ Nutrient profile
- ✓ Palatability
- ✓ Digestibility
- ✓ Anti-nutritional factors
- ✓ Availability and price.

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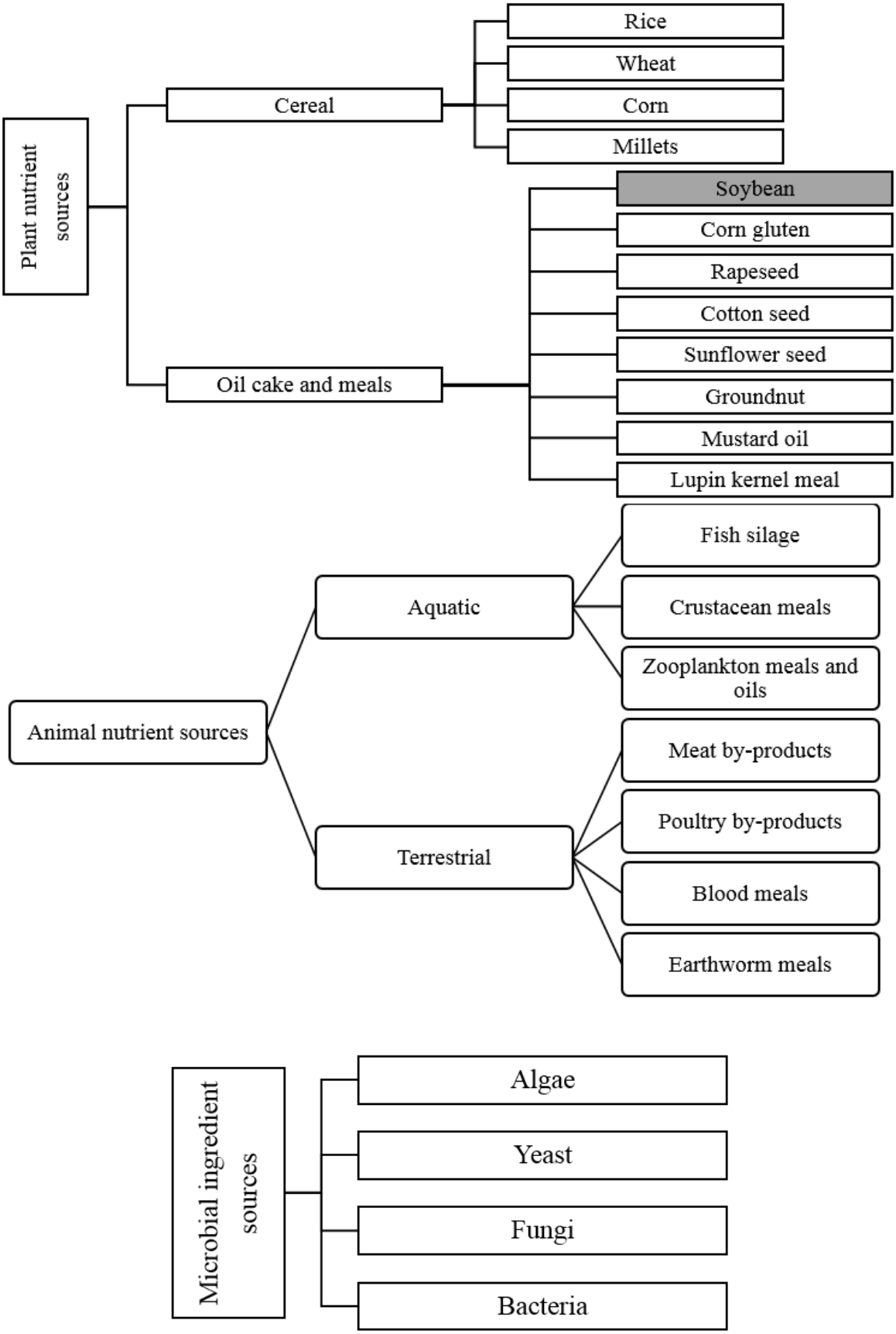

- ✓ 60% substitutions are preferable by many researchers in order not to compromise growth performance of fish.
- ✓ Using of alternative protein and lipid sources, lower pressure on capture fisheries and can maintain sustainability of fisheries and aquaculture.

E. Vaccines against diseases

- ✓ Disease – major challenge in aquaculture industry.
- ✓ Economic loss by disease- 6 billion USD
- ✓ Production decline could be caused by some factors such as disease outbreak, environmental pollution and climate change result in massive death of fish.

Development history of aquatic vaccines

Steps	Year	Development
Step - 1	1942	Research beginning Successfully prepared vaccine against *Aeromonas salmonicida*
Step - 2	1976	Production beginning First licensed vaccine against Enteric Red Mouth (ERM), USA
Step - 3	1984	Fish vaccine industry forming The first seminar on fish vaccination held in Paris
Step - 4	Present	Industry scale More than 210 licensed vaccines

- ✓ Vaccines are available for more than 17 species of fish and protect against more than 22 different bacterial diseases and 6 viral diseases. Vaccines are available in more than 40 countries.
- ✓ Currently 19 major companies market fish vaccines globally and many small companies also exist.
- ✓ Route of administration
  - ✓ Oral vaccination
  - ✓ Injection vaccination (Intramuscular vaccination, intraperitoneal vaccination)
  - ✓ Immersion vaccination (dip vaccination, bath vaccination)

Conclusion

- ✓ The emerging and disruptive technologies in the aquaculture industry have the potential to revolutionize the sector and bring about **positive outcomes**.
- ✓ These technologies, such as robotics, information/digital technologies, offshore farming, replacement of fish meal and oils with alternative proteins and fish oil, and oral vaccines, can make the industry **more sustainable and profitable.**
- ✓ By integrating these technologies into different parts of the aquaculture industry, it is possible to **improve resource and energy efficiency**.
- ✓ Overall, the outcome of these technologies can lead to a more sustainable and profitable aquaculture industry.

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NONCODING BUT CODING: UNRAVELLING THE REGULATORY ROLES OF MICRORNA-ENCODED PEPTIDES (miPEPs) IN PLANTS

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Summary
Peptides derived from short chains of amino acids play crucial roles in plant growth, development, and stress responses. Recent studies have shown that certain non-coding RNAs, such as pri-miRNAs, can encode regulatory peptides known as miPEPs. These miPEPs positively regulate the production of corresponding miRNAs, enhancing their ability to down regulate target genes. MiPEPs may enter cells through various mechanisms. Agronomically, miPEPs have significant implications because they indirectly mediate important plant developmental roles. They can enhance root growth, promote early flowering, increase stem height, and increase nodule numbers, among other benefits. The external application of synthetic miPEPs has shown promising results in enhancing miRNA expression and promoting desirable traits in crops. This approach could serve as an alternative to traditional transgenic methods, offering a more targeted and environmentally friendly approach to crop improvement. However, a limitation in plant miPEP discovery is the lack of precise annotations for pri-miRNAs in certain plant species, hindering comprehensive research in this area. Nevertheless, miPEP technology represents a promising avenue for sustainable agriculture, offering specific and effective solutions to enhance crop growth, yield, and stress resistance in the face of global environmental changes.

Introduction

Peptides composed of a short chain of amino acids can play significant roles in plant growth, development, and stress responses. Generally, canonical peptides serve as local signalling molecules mediating short- or long-distance intercellular communication. Additionally, they are commonly used as ligands perceived by an associated receptor, triggering cellular signal transduction. Most of these functional peptides are derived by either processing precursor proteins or direct translation of small open reading frames present in the genome and are sometimes located in the untranslated region sequence of a messenger RNA. In recent years, increasing pieces of evidence from studies in both plants and animals have revealed that peptides are also encoded by RNAs currently defined as non-coding RNAs (ncRNAs), including long ncRNAs, circular RNAs, and primary microRNAs (Ren *et al*., 2021). Primary microRNAs (pri-miRNAs) are transcribed from MIR genes and then processed to produce mature miRNAs. Interestingly, pri-miRNAs have been found to encode microRNA encoded peptides (miPEPs) via short open reading frames (ORFs) located at the 5′ end of the primary miRNA transcripts (pri-miRs). These miPEPs are known to boost the activity of their associated miRNAs by increasing their accumulation levels, thus leading to the down regulation of target genes. Notably, they have no significant similarity, indicating that each miPEP is unique and specific to its corresponding miRNA (Yadav *et al*., 2021).

Biogenesis

MicroRNAs (miRNAs) are approximately 22-nucleotide-long regulatory elements that suppress the expression of endogenous genes both transcriptionally and post-transcriptionally. The biogenesis

of miRNAs begins with the Pol II-dependent transcription of intergenic MIR genes. These genes produce much larger primary miRNAs (pri-miRNAs), from which mature miRNAs are derived through processing by the Dicer-like RNase III endonucleases (DCLs) complex. The processed miRNAs are then incorporated into the active RNA-induced silencing complex (RISC), where they bind to ARGONAUTE1 (AGO1) protein. The guide strand of the miRNA directs the RISC to bind to the target gene via base pairing, leading to gene silencing either by target cleavage or by inhibiting translation. Interestingly, besides generating miRNAs, pri-miRNAs can also contain short open reading frames (ORFs) located in the 5' upstream region of the pre-miRNA. These short ORFs encode regulatory peptides known as microRNA encoded peptides (miPEPs),(Ren *et al*., 2021).The first line of evidence for pri-miRNA encoded regulatory peptide (miPEP) was presented by Lauressergues et al. (2015).

Recent studies have revealed that microRNA encoded peptides (miPEPs) are indeed encoded by specific micro ORFs (miORFs) located at the transcription start site, typically positioned at the 50th position of the primary microRNA (pri-miRNA). These miPEPs play a significant role in enhancing the transcription and production of the pri-miRNA from which they originate. Unlike miRNAs, which primarily negatively regulate gene expression, miPEPs function as positive regulators of their corresponding miRNA production. Importantly, miPEPs do not interfere with the expression of other miRNAs. After translation in the cytoplasm, miPEPs shuttle back to the nucleus, where they contribute to a self-catalysis mechanism by enhancing the transcription of the nascent pri-miRNAs that encode them. This process promotes miRNA biosynthesis and ensures a specific and targeted enhancement of miRNA production without affecting the expression of unrelated miRNAs (Figure 1), (Kaur *et al*., 2022).

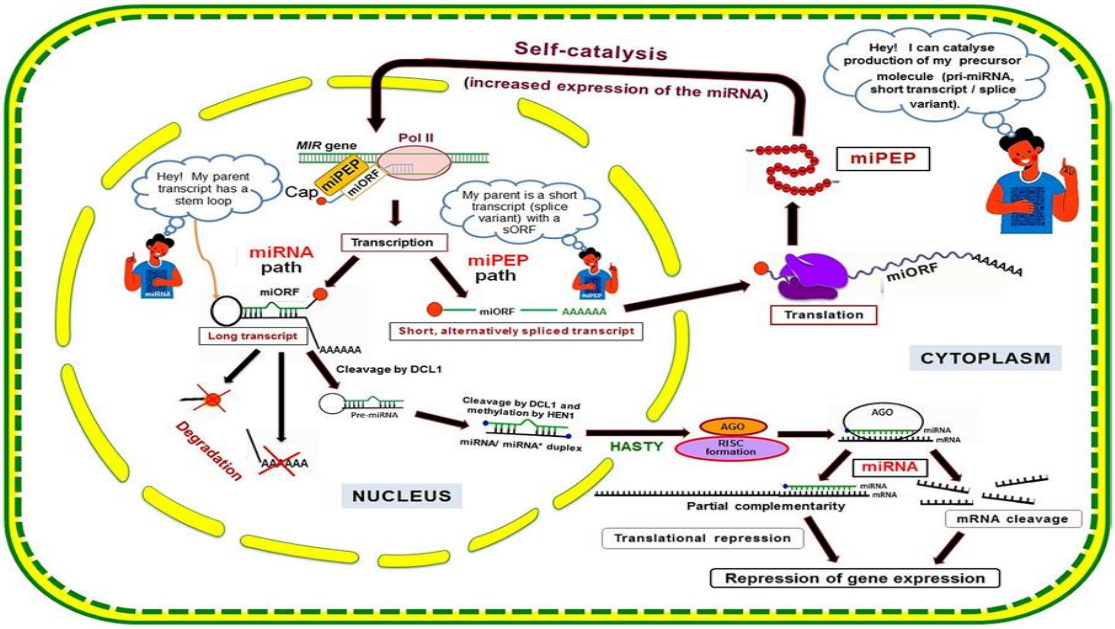

Figure 1. Biogenesis of miRNA and miPEP

Putative regulatory mechanisms of mipeps in plants

The upstream region of the pre-miRNA, which contains the short ORF, is likely polyadenylated to prevent degradation (I) and facilitate its export to the cytoplasm, where it guides the synthesis of miPEPs. External miPEPs can enter the cytoplasm through endocytosis-associated processes (II)

and passive diffusion (III) (Ormancey*et al*., 2020).MiPEPs might interact with transcription factors (TFs) that control the transcription of MIR genes (IV and V), leading to increased expression of the associated miRNA. Alternatively, miPEPs could function as part of the "Pol II transcriptional complex," enhancing the transcription of MIR genes (VI). These mechanisms highlight the putative multifaceted roles of miPEPs in regulating miRNA expression and gene regulation (Figure 2), (Ren *et al*., 2021).

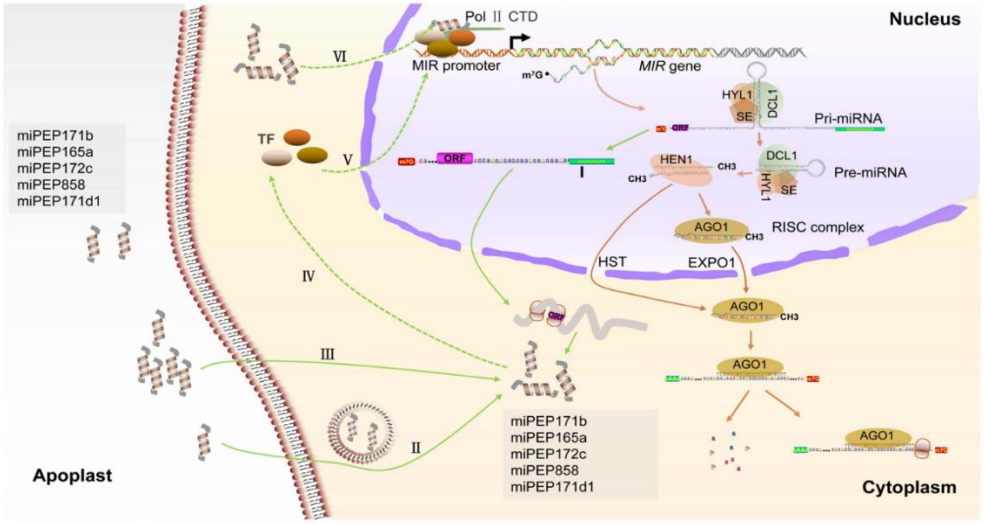

Figure 2. Putative regulatory mechanisms of miPEPs in plants

Mipep entry into cells

A recent study demonstrated that fluorescein-labeled AtmiPEP165a can be internalized in *Arabidopsis thaliana* roots through both endocytosis and passive diffusion mechanisms. However, the internalized miPEP did not penetrate the central cylinder of the roots, nor did it undergo systemic transport. Instead, its penetration was restricted to the peripheral zone of the roots, suggesting that miPEPs may exert their effects in a localized manner. As a result, when miPEPs were applied to the leaves, no observable phenotypic changes were induced in the roots. Similarly, when miPEPs were applied to the roots, no changes were observed in the leaves. These findings indicate that miPEPs likely function locally, influencing biological processes specifically within the regions where they are applied, rather than exerting systemic effects throughout the plant (Ormancy*et al*., 2020).

Functional role of mipeps in plants

MiPEPs play crucial and specific roles in various biological functions and are not merely by-products or non-functional entities. They contribute significantly to promoting early flowering, increasing inflorescence stem length, enhancing root length, increasing nodule numbers, and facilitating adventitious root formation. These roles highlight the functional importance and regulatory capacity of miPEPs in plant development and physiological processes.

Agronomical implications of mipeps

MiPEPs play a crucial role in enhancing the transcription of pri-miRs and increasing the expression and activity of corresponding mature miRNAs, primarily due to the same tissue distribution. This phenomenon underscores the potential for miPEPs to facilitate novel and environmentally friendly strategies for manipulating plant development, which is essential for sustainable

agriculture. In this context, miPEPs hold substantial agronomic significance as they indirectly influence key aspects of plant development. These include promoting enhanced root growth, triggering early flowering with a greater number of flowers, and increasing stem height.

The effects of miPEPs have been observed through external application, such as miPEP165a and miPEP171b in Arabidopsis and Medicago, respectively. When synthetic miPEPs were externally applied through spraying or watering, they enhanced miRNA expression. For instance, miPEP172c and miPEP167c have been found to stimulate nodulation, increasing the number of nodules in legumes like soybean. Moreover, vvi-miPEP171d1 has been identified as a regulator of adventitious root formation in grapevines, offering potential solutions to the challenges of clonal propagation in this economically significant crop. These discoveries highlight the potential of miPEPs in crop improvement programs, particularly in enhancing yield without resorting to tedious transgenic methods. By focusing on miPEPs-based research, we can tap into previously unknown roles encoded within pri-miR sequences, shedding light on new avenues of gene regulation. This underscores miPEPs as a promising tool for genetic modulation, offering diverse applications that could revolutionize crop enhancement efforts. Ultimately, miPEPs represent a novel frontier in functional proteomics, with significant implications for advancing agricultural productivity and sustainability (Yadav *et al*., 2021).

Limitation

A significant challenge in plant miPEP discovery is the limited availability of precise annotations for pri-miRNAs in plants. While recent advancements in sequencing technologies have improved the annotation accuracy for most pri-miRNAs in *A. thaliana*, the identification of miPEPs remains particularly challenging for many plant species, especially crops and weeds. This challenge stems from the scarcity of comprehensive genomic and transcriptomic data necessary for robust miPEP identification.

Conclusion

MiPEP identification uncovers the dual functions of pri-miRNAs combined with their coding and non-coding abilites. One of the major challenges for the coming years is to reduce the use of herbicides and fertilizers through the use of natural molecules that are safer for people and to the environment. MiPEP technology could be an alternative for addressing these ecological problems. Strict regulatory measures linked to transgenic development can be avoided and synthetic miPEPs can be directly applied. Since miPEPs are highly specific, we can imagine using a cocktail of several peptides to improve crop growth, yield as well as resistance to stress in the context of the environment becoming more and more unpredictable due to global environmental changes.

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DOLICHOS BEAN (*Lablab purpureus*) : A VERSATILE LEGUMINOUS CROP WITH MULTIFACETED BENEFITS

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Introduction

Large amounts of legumes, especially vegetable beans, are part of the diet of India's vegetarian populations. The Sustainable Development Goal Target 2.2 sets the ambitious objective of eliminating all forms of malnutrition by 2030 (FAO, 2019 & Devari *et al*., 2018) hence ,it is crucial to recognize that mere efforts to enhance access to staple food grains will not suffice. Addressing this challenge necessitates the incorporation of lesser-known, nutrient-rich plant species into diets. Dolichos bean seed, another food and traditional oriental medicine from pulse, also referred to as Indian bean, hyacinth bean, lablab bean. Perhaps because of its ornamental effect when in full bloom, it is also known as the Bonavist bean in western countries (Ayyangar and Nambiar, 1935). This drought tolerant, multi-purpose and cool-season legume crop constitutes an important source of therapeutic agents used in the modern as well as traditional systems of medicine (Morris 2009). Owing many advantages and reputation as aclimate-smart crop, this leguminous vegetable crop has become more and more popular in recent years. Although it is perennial but cultivated as annual or biennial. Dolichos beans are characterized by the presence of oil glands on leaves. Dolichos bean is a good source of protein, minerals and vitamins. However, methionine is the limiting amino acid in dolichos bean. Seed contains trypsin inhibitor phytic acid and polyphenol and also contain lectin, the toxicity of lectin can be eliminated by heating. It is used as both green pod as a vegetable and dry seed as a pulse. Tender pods are cooked as vegetable alone or with potato. It is also grown for fodder and green manure crop. It is soil improver crop. This article explores the diverse attributes of Dolichos bean, its cultivation, and its significance in the agricultural landscape of India.

Taxonomy and Distribution:

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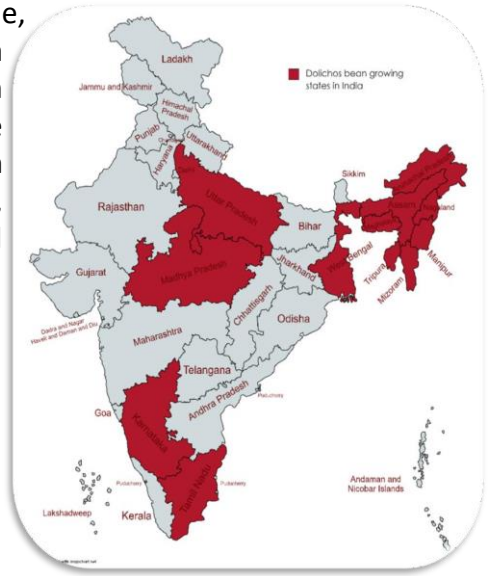
Dolichos bean (*Lablab purpureus*) belongs to the family leguminoseae and has a chromosome number of 2n=2x=22, 24. It is one of the most ancient among the cultivated legume species-possibly more than 3000 years old (Ayyangar and Nambiar, 1935).The dolichos bean is thought to have originated in India (Ayyangar and Nambiar, 1935; Nene, 2006), as evidenced by archaeo botanical finds in India ranging from1200to300 BC at the Veerapuram excavation site in Andhra Pradesh to 2000 to 1700 BC at Hallur, the earliest Iron-Agesite in Karnataka (Fuller, 2003). It is grown throughout the country and distributed in North East India, Tamil Nadu, Karnataka, Madhya Pradesh, Uttar Pradesh and West Bengal.



***Taxonomic Status*:**
Order :Fabales
Family:Fabaceae
Subfamily:Faboideae
Genus : Lablab
Species:purpureus
Tribe: Phaseoleae
Sub-tribe:Faboideae

Cultivated types:

Two botanical varieties of dolichos beans are identified based on the morphology and texture of the pods as well as the angle at which the seeds cling to the pod suture (Ayyangar and Nambiar, 1935; Magoon et al., 1974). These two *Lablab purpureus* var. *typicus* and *Lablab pupureus* var. *lignosus* are under cultivation in which former is vegetable type, cultivated for its soft and edible pods while the latter is cultivated as field bean for its dry seed as pulse crop. *Lablab purpureus var. typicus* yields flat, longer, and more tapering pods with a long seed axis running parallel to the podsuture.

Diversity of Dolichos bean

As the country of origin, India offers a wide variety of plant and pod characteristics for the pole type dolichos bean (*Lablab purpureus*var. *typicus*), which can be used to evolve a high yielding variety. The progress in research and the improvement of nutrient-dense but underutilized species play a pivotal role insecuring nutrition within indigenous communities in their specific habitats. Although the lablab bean shows promise as a climate-smart crop and holds particular benefitsfor protein-dependent rural communities in Asia and Africa (Groteluschen, 2014), its productivity has yet to experience a substantial increase. It is consequently important to increase crop yield in order to meet rising needs from an expanding human population. In India, the total area under beans is 0.228mha with an annual production of 2.51mT (National Horticulture Board, 2022).

Varieties

Plants are two types viz. bush type and pole type.

Bushtype : Arka Jay, Arka Vijay, Pusa Sem-2, Pusa Sem-3, Konkon Bhusan.

Pole type : Pusa Early Prolific, Dasarawal, Deepaliwal, Rajani, Kashi Haritima, Arka Soumya, Arka Sambhram

Variation in Flower colour

Multifaceted Benefits:

1. *Nutritional Superiority*

It is a rich source of vegetable proteins, with its seeds and pods containing 20– 28% protein, making it an excellent source of nutrition (Devaraj, 2016 & Habib *et al.,* 2017). In addition to its protein content, it is also rich in carbohydrates (60.74g), fats (1.69g), fibers (25.6g), and minerals such as iron (5.1mg), phosphorus (0.372mg) and zinc (9.3mg) making it a well-rounded and nutritious food (Naeem *et al.,* 2020). Pulses contain approximately 21–25% protein. However, have limiting amount of essential amino acids such as methionine, tryptophan and cystine (Tiwari and Singh 2012). The total dietary fiber measurements in dried peas range from 14 to 26% while beans were found to have 23–32% total dietary fiber (Brummer *et. al*., 2015).Hence, dolichos bean

could meet the requirement of both pulses and vegetables and could be the prominent substitute, having more protein and dietary fibers.

2. *Pharmaceutical superiority*

The seeds are used as a laxative, diuretic, anthelmintic, anti-spasmodic, aphrodisiac, anaphrodisiac, digestive and carminative (Chopra et al. 1986; Kirtikar & Basu 1995). The medicinal properties like antidiabetic, anti-inflammatory, analgesic, antioxidant, cytotoxic, hypolipidemic, antimicrobial, insecticidal were observed in *Dolichoslablab* (Singh and Kudesia, 2020). The bean contains the potential breast cancer fighting a flavonoid known as kievitone (Hoffman 1995). The flavonoid, genistein found in this bean may play a role in the prevention of cancer (Kobayashi *et al*. 2002) and as a chemotherapeutic or chemo-preventive agent for head and neck cancer (Alhasan *et al.* 2001). Recent research has shown that lablab bean extracts have the ability to hinder viral infections, including influenza and SARSCoV-2, which was responsible for global pandemic (Liu *et al.,* 2020). Plant tissue contains tyrosinase, also known as polyphenol oxidase, which is crucial for the processing of fruits and vegetables as well as the preservation of processed foods. Food scientists have long been interested in preventing browning of foods, whether it be enzymatic or not (Sanchez-Ferrer *et al.* 1995; Paul & Gowda 2000). Tyrosinase, which is present in the bean, may be used to treat hypertension in people (Naeem *et al*. 2009).

3. *Income generation:*

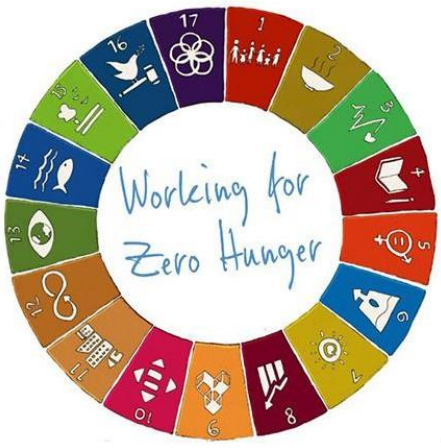
The cultivation of Dolichos bean provides an important source of income for resource-poor individuals, especially in rural areas. It is a versatile crop that can be consumed in various forms - the leaves, pods, and seeds are all edible. This nutritional profile makes it an excellent food source for local communities.

4. *Soil conservation*:

Agronomically, Dolichos bean is a resilient crop. It can grow in poor soil conditions and is relatively drought- tolerant. Moreover, as a leguminous plant, Dolichos bean has the ability to fix atmospheric nitrogen, which enhances soil fertility and reduces the reliance on synthetic fertilizers and even can be used as a biocontrol agent for pests (Naeem *et al.,* 2020). Its cultivation can contribute to sustainable agricultural practices and soil conservation efforts. Its adaptability to diverse agro-climatic conditions makes it a viable option for small holder farmers, contributing to their economic sustainability.

Conclusion:

Dolichos bean, with its nutritional richness, income generation potential, soil conservation properties and adaptability to climate change, holds significant position as a versatile leguminous crop. Its cultivation and utilization contribute to sustainable agriculture, food security and livelihood improvement, making it an important asset in India's agriculturally and scape.



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UNLOCKING NATURE'S ALLIES: HARNESSING ENTOMOVECTORING FOR SUSTAINABLE CROP PROTECTION

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Abstract
Entomovectoring is a novel approach in precision agriculture and organic farming, leveraging the innate behaviors of insects to deliver microbial control agents directly to crops by the efficient utilization of pollinators. Entomovectoring highlights its potential as a sustainable alternative to traditional pesticide application methods. This approach capitalizes on the natural behavior of pollinators to visit flowers and plants and effectively spreading the microbial control agents to control specific insect pests and diseases in most of the commercial crops ecofriendly.

Keywords : precision agriculture, pollinators, microbial control agents, insect pests

Introduction

Agriculture is the key development in the rise of sedentary human civilization by cultivating domesticated species of plants and livestock, which creates food surpluses that helps to people to live in cities. Organic farming is a production system which completely avoids the use of synthetically manufactured fertilizers, pesticides, growth regulators, genetically modified organisms and livestock food additives. organic farming holds lot of benefits, instantly possess lack of technical ideas in application of microbial control agents in management of pests and diseases of the crops. Entomovectoring is highly innovative approach, utilizing the pollinators to deciphate the microbial control agents to control pest and diseases precisely.

Steps involved in entomovectoring:

1. Selection of target insects: We have to Identify and select suitable insect species which naturally visit the target crops or plants. These insects should have a propensity to visit the flowers, to facilitate the delivery of microbial control agents.

2. Identification of biological agents: We have to choose target specific biological control agents namely fungi, bacteria or virus to be delivered to the crops to control pest and diseases.

3. Development of delivery systems: Design and develop delivery systems which can effectively transfer the biological agents onto the target crops. This involves preparation of formulations which are attractive to the target insects.

4. Field application: we have to implement entomovectoring in the field by releasing the selected insects carrying the biological agents through dispensers. This involves releasing the insects in specific areas of the field or at certain times to maximize effectiveness. Careful monitoring and management must be necessary to ensure proper distribution of the agents and optimal pest or disease control.

5. Monitoring and evaluation : Monitor the effectiveness of entomovectoring by regularly assessing pest or disease levels in the crops. Evaluate the factors such as insect populations, crop health, and yield to determine the success of the approach.

Some practical application of entomovectoring technique

In enhancing the pollination and suppression of graymold disease in strawberry Soboksa (2014) used honeybees (*Apis mellifera* L.) and Bumblebees (*Bombus terrestris* L.) as entomovector to deliver biofungicide, *Gliocladium catenulatum* to suppress graymold disease in strawberry. The vectoring of biofungicide with Honeybees and Bumblebees resulted in significant disease suppression both at harvest and pre-harvest than the control treatments. Higher marketable yield was also recorded when honeybees vector biofungicide than hand-spray of biofungicide. Shelf lives of fruits also improved by entomovectoring. Meanwhile by delivering the *G. catenulatum* by using entomovectoring helps in better yields and successful management of disease, core rot of apple in apple cultivation (Hokkanen *et al.,* 2015).

Vakaliya and Borad (2017) evaluated the efficiency of Honeybees as entomovectors of HaNPV (*Helicoverpa armigera* nucleopolyhedro virus) in Pigeonpea ecosystem. They recorded maximum activity of entomovectoring at 10 m distance, carried average of 4.00×10^5 POB load to the pigeonpea field and found maximum mortality rate with presence of only 2.22 larvae/ 10 twigs. Thus this technique helps in management of noxious pest of pigeonpea i.e., pod borer without intervention of any chemical pesticides.

Advantages of Entomovectoring

- ✓ It reduces the utilization of chemical pesticides, which have detrimental effects on the environment, non-target organisms, and human health.
- ✓ Entomovectoring is highly target specific
- ✓ It is cost-effective since it utilizes natural pollinators which are visiting crops regularly.

Conclusion

Entomovectoring technique helps organic farming in spread of biocontrol agents and to kill the pests efficiently without harming bees, without contaminating bee products, without deteriorating environment and human interaction. This technique helps in obtaining residue free, high quality and yields of fruits and vegetables in open and green house conditions also.

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IMPORTANCE OF MICRO IRRIGATION IN HILLY AREAS FOR ENHANCING WATER PRODUCTIVITY

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Abstract
Effective irrigation management is crucial for optimal yield and quality of agricultural produce. Micro-irrigation is a highly efficient method that reduces water usage and maintains soil moisture content. It is ideal for water-scarce areas and uneven hilly terrains. Using micro-irrigation saves water and enhances plant yield and quality by providing precise water application to the crop's root zone.

Keywords : Micro irrigation, Drip, Sprinkler, Hilly areas

Introduction

Irrigation is a process of providing controlled amounts of water to the land to grow crops and plants. It plays a crucial role in helping crops flourish, maintaining landscapes, and restoring vegetation to disturbed soils in dry areas and during periods of below-average rainfall. Additionally, irrigation is used to safeguard crops from frost, hinder weed growth in grain fields, and prevent soil consolidation. Different irrigation methods vary in how they supply water to plants. One of these methods is micro-irrigation, which involves distributing water through a piped network at low pressure and applying it as a small discharge to each plant. With this system, it is possible to irrigate a larger area using less water. Water is transported in pre-determined quantities from the source to the field through pipelines in this system. This helps in preventing the wastage of water and increasing water use efficiency. By adopting the micro-irrigation system, around 30-40 per cent of water can be saved. Using this irrigation system not only improves the quality of crops but also increases productivity. The government is actively promoting sprinkler and drip irrigation systems under the mission of 'Per Drop More Crop'. In our country, water is primarily brought to fields for irrigation through raw drains, which results in approximately 30-40% of the water being wasted due to leakage. Therefore, there is a significant benefit to using micro-irrigation systems.

Mainly two methods are more popular in micro irrigation systems-sprinkler irrigation and drip irrigation.

Sprinkler method

Sprinkler irrigation is a method of providing water to plants by spraying it into the air. This technique mimics the effect of rainfall. The process involves using a small pressurized nozzle that converts water into fine droplets. The sprinklers are placed at appropriate distances depending on the crops and are powered by a pump. The nozzle then sprays the water out in a fine mist that falls on the plants like rain. This method is particularly useful in areas where water is scarce, or where the soil is sandy or hilly. Sprinkler irrigation has proved to be highly efficient, with plants absorbing around 80-90 per cent of the water. This is a significant improvement compared to traditional irrigation methods, which only utilize around 30-40 per cent of the water. Micro sprinkler irrigation is a pressurized and low-volume system that provides efficient crop yield per

drop. It can be used to irrigate the flowers, nursery, greenhouse etc. It can also be used in leafy vegetables such as spinach, cauliflower etc.

Drip method

Drip irrigation, also known as micro irrigation or trickle irrigation, is a method of supplying water to plants as per their requirement through drippers on the surface or sub-surface around the roots of the plants via pipelines. If managed properly, this method can be the most water-efficient way of irrigation, where evaporation and runoff are minimized. Irrigation with this method can save up to 50% of water while increasing crop production, reducing weeds and improving the quality of crop products. Additionally, fertilizers can also be applied through this method along with irrigation.

Farming in Hills and its features

In India, hill agriculture is predominantly practised in the north-western hill regions including Himachal Pradesh, Jammu and Kashmir, and Uttaranchal. It is also prevalent in the north-eastern hill region, comprising of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. These hilly areas hold a vast number of wild relatives of crop plants, which can serve as an excellent source of beneficial genes for crop improvement and can also provide underutilized nutritious crops and their gene pool. Therefore, a specialized and focused approach todeveloping agriculture in these regions is the need of the hour.

Features

1. Default organic agriculture. 2. Integration of livestock in agriculture. 3. Large variability in Climate. 4. Marginal land holding. 5. Predominance of women farmers. 6. Proneness to soil erosion and loss of soil fertility. 7. Socio-economic aspect. 8. Suitability for horticulture crops. 9. Rainfed agriculture. 10. Traditional crops.

Freshwater resources for human use are becoming increasingly scarce day by day. Currently, 90 percent of the water is allocated to agriculture, but this is expected to reduce to 75 percent in the coming decade. The demand for water from other uses such as domestic, power generation, and industries is also increasing due to the rise in the standard of living. This tremendous pressure necessitates scientific management of all available water resources.

To achieve sustainable water management, we need to develop new water resources, and conserve and properly manage existing water resources. One of the ways to achieve this is by increasing water use efficiency. The adoption of advanced irrigation methods such as drip and sprinkler irrigation can help economize the use of irrigation water and double the irrigated area. Another approach is fertigation, where fertilizers are applied chiefly through micro-irrigation. This method applies all three major nutrients in one solution directly to the plant root zone, thus increasing water and fertilizer use efficiencies. Fertigation is a sophisticated and convenient means of applying nutrients to crop plants that save time, labour, and energy. Micro-irrigation is effective in saving water and increasing water use efficiency as compared to the conventional surface irrigation method. Additionally, it helps reduce water consumption, weed growth, soil erosion, and the cost of cultivation. Micro-irrigation can be adopted in all kinds of land, especially where it is impossible to effectively use the flooding method for irrigation.

Importance of micro irrigation in hilly area

Micro irrigation systems, specifically drip irrigation systems, involve precise and slow water application in the form of fine droplets. This method is highly efficient in providing irrigation water directly into the soil at the root zone of plants. The distribution of water into the soil follows a three-dimensional infiltration pattern, which is different from the one-dimensional (vertical) infiltration pattern of conventional irrigation systems, where the entire soil surface is wetted. Drip irrigation is a great option in places where water availability limits conventional irrigation, as it reduces the risk of yield reduction due to terminal dry spells. The regulated supplies through drippers not only affect the plant root/shoot growth parameters but also the fertilizer use efficiency (FUE) and nutrient uptake. Additionally, it reduces the wastage of water and fertilizers and optimizes nutrient use by applying it at the proper place and time, which eventually increases water use efficiency (WUE) and nutrient use efficiency (NUE).

Tüzel (1993) classified the water distribution level following the uniformity+ coefficient

- UC> 90% Excellent
- 80 %< UC<90% Good
- 70 %< UC<80% Moderate
- 60 %< UC<70% Poor
- UC< 60% Unacceptable

Below is the average uniformity coefficient of the drip system. The drip system has a higher uniformity coefficient at 2.5 mhydraulic heads with different numbers of strips operating in polyhouse (Table 1).

Table 1: Uniformity coefficient (Cu).

Uniformity coefficient (Cu) % of Drip system		
No. of strips	**Hydraulic head (m)**	
	1	**2.5**
6	92.34	97.43
12	91.04	97.52
18	91.32	97.53
24	90.58	97.53
30	88.66	97.55

Sourec: Department of Soil Science, CSKHPKV, Palampur

Drip irrigation in cucumber and strawberry indicates that using drip irrigation at 0.4 PE and 0.6 PE can help increase the marketable yield and save water as compared to 1.0 PE. The total water saving through drip irrigation in cucumber and strawberry is 129.13 % and 56.88 %, respectively (Table 2).

Table 2: Drip irrigation in cucumber and strawberry.

Crop	Marketable yield (t/ha)			Total water use (mm)			Water saving through drip irrigation (%)
	0.4 PE	**0.6 PE**	**1.0 PE**	**0.4 PE**	**0.6 PE**	**1.0 PE**	
Cucumber	56.6	-	49.0	232.4	-	532.5	129.13
Strawberry		3.29	3.24		375.2	588.6	56.88

Sourec: Department of Soil Science, CSKHPKV, Palampur

Drip fertigation

Fertigation is a technique of applying fertilizer which involves mixing the fertilizer with irrigation water and delivering it to plants through a drip system. This method uses both liquid fertilizers and water-soluble fertilizers. Fertilizer use efficiency can be improved by 80-90% using this method. The drip system employs three main types of equipment for its operation:-Ventury, a fertilizer tank and a fertilizer pump. Applying chemicals through this precisely reduces overall usage. This leads to increased nutrient absorption by plants and reduced leaching to water tables. Fertigation with drip irrigation can help in improving the yield by improving the nutrient use efficiency.

Table 3: Fertilizer schedule for cucumber and strawberry at different fertigation levels.

Crop	Basal doses (g/m^2)			Fertigation Doses per spilt (g/ m^2)			No. of splits	Interval (days)	Increase in yield (%)
	Urea	SSP	MOP	19:19:19	0:0:50	Urea			
Cucumber									
F_{100}	8.0	12.0	4.0	2.8	2.2	1.1	7	10	8.78
F_{200}	16.0	20.0	8.0	2.0	0.3	0.8	20	3	
Strawberry									
	Urea	**SSP**	**MOP**		**0:0:50**	**Urea**			
NK_{50}	2.2	25.0	0.8	-	2.25	4.86	18	7	55.28
NK_{100}	4.4	25.0	1.6	-	4.50	9.72	18	7	

Sourec: Department of Soil Science, CSKHPKV, Palampur

In cucumber, the fertigation at 200% of the recommended dose of fertilizer (RDF) results in 8.78% increase in yield while in strawberry, fertigation at 100 % of RDF results in 55.28% increase in yield (Table 3).

Conclusion

Micro-irrigation (MI) has received focus in India to enhance water-use efficiency in the context of continuous extraction of groundwater for irrigation, conveyance efficiency low in canal command areas, high variability in rainfall due to climate change and quantitative assessment of water used not considered. By the year 2030, the demand for food in India is projected to be 355 mt for food grains, 180 mt for vegetables, 182 mt for milk, 15 mt for meat, and 16 mt for fish, warranting an improvement of 50–100% over the current production. As water resources are being depleted and to achieve the above target, there is a need to focus on water-saving strategies keeping in view regional water availability and water budgeting.

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GREENHOUSE CROP DISEASES: A COMPREHENSIVE GUIDE FOR THE IDENTIFICATION AND MANAGEMENT

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Introduction

Greenhouse crop production offers numerous advantages, including extended growing seasons, controlled environmental conditions, and higher yields (Heuvelink, 2005). However, the unique environment of greenhouses also presents challenges, particularly concerning plant diseases. Pathogens such as fungi, bacteria, viruses, and nematodes can thrive in the warm, humid conditions typical of greenhouses, posing significant threats to crop health and productivity (Koch et al., 2018).Effective management of greenhouse crop diseases is essential for sustainable and profitable production. This topic explores the diverse array of diseases that afflict greenhouse crops, ranging from foliar diseases like powdery mildew and leaf spot to soilborne pathogens causing root rot and damping-off (Dixon, 2009). Understanding the biology, epidemiology, and environmental factors influencing disease development is crucial for implementing targeted management strategies (Agrios, 2005).This discussion will delve into various approaches to disease management in greenhouse crops, encompassing cultural, biological, chemical, and integrated pest management (IPM) tactics (Gladders et al., 2019). Emphasis will be placed on proactive measures such as sanitation, quarantine protocols, and cultural practices aimed at minimizing disease pressure (Bélanger et al., 2002). Additionally, the utilization of biological control agents, resistant varieties, and judicious application of chemical treatments will be explored as integral components of a comprehensive disease management program (Parrella et al., 2003).Through this exploration, greenhouse growers and agricultural stakeholders will gain insights into the complexities of greenhouse crop diseases and acquire practical strategies to mitigate their impact. By adopting a holistic and proactive approach to disease management, growers can safeguard crop health, optimize yield potential, and ensure the sustainability of greenhouse crop production systems.

Common Diseases in Greenhouse Crops:

Greenhouse environments, characterized by high humidity, temperature fluctuations, and dense planting, create favorable conditions for the proliferation of various plant pathogens. Common diseases affecting greenhouse crops include fungal, bacterial, and viral infections. These diseases can manifest in symptoms such as wilting, leaf spots, necrosis, stunting, and reduced fruit quality, ultimately leading to significant economic losses if left unchecked.

Integrated Pest Management (IPM):

Sanitation: Regular removal of plant debris and weeds from greenhouse beds and aisles helps prevent the buildup of pathogens. For example, removing fallen leaves infected with powdery mildew from cucumber plants reduces the spread of the disease.

Crop Rotation: Rotating crops within greenhouse beds can break disease cycles. For instance, alternating between solanaceous crops like tomatoes and non-solanaceous crops like lettuce can help reduce the buildup of soilborne diseases such as fusarium wilt.

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Proper Spacing: Adequate spacing between plants promotes air circulation and reduces humidity, minimizing the spread of diseases like Botrytis blight in greenhouse-grown roses.

Optimized Irrigation: Avoiding over-watering and ensuring proper drainage can prevent waterlogged conditions that promote root diseases such as Pythium root rot in hydroponically grown lettuce.

Temperature and Humidity Management: Maintaining optimal temperature and humidity levels can prevent the development of diseases like downy mildew in greenhouse-grown cucumbers, which thrive in cool, humid conditions.

Biological Management : Application of *Trichoderma* spp. or *Bacillus subtilis* to suppress soilborne pathogens like *Rhizoctonia solani* in greenhouse-grown peppers.

Monitoring and Early Detection: Regularly inspecting greenhouse crops for signs of diseases, such as aphids or aphid-transmitted viruses in greenhouse-grown peppers, allows for early intervention.

Threshold-Based Decision Making: Implementing action thresholds for pests like thrips in greenhouse-grown roses helps determine when control measures are necessary based on population levels.

Chemical Controls

S. No.	Crop	Disease	Symptoms	Management practices
1	Fenugreek (*Trigonella foenum-graecum*)	1.Cercospora leaf spot	Small, circular, water-soaked spots on leaves, turning brown/grey	Chlorothalonil @2 g/L of water **or** Copper oxychloride @2 g/L of water
		2. Powdery mildew	White, powderygrowthorleaves, stems, and pods	Sulfur- Dust formulation as per label instructions **or** Neem oil @2 ml/L of water
		3. Root rot (*Rhizoctonia solani*)	Wilting, stunting, yellowing of leaves, rotted and discoloured roots	*Trichoderma viride* (biofungicide)As per label instructions
		4. Root rot (*Fusarium oxysporum*)	Wilting, stunting, yellowing of leaves, rotted and discoloured roots	Carbendazim (restricted use) @1g/L of water
		5. Downy mildew	Yellowing and distortion of leaves, white, fluffy growth on undersides	Copper oxychloride @2 g/L of water
2	Coriander (*Coriandrum sativum*)	1.Alternaria leaf spot	Small, brown or black spots on leaves, starting at the edges and progressing inward, causing leaf defoliation.	Chlorothalonil @2 g/L of water
		2.Anthracnose	Sunken, circular lesions on leaves and stems, turning dark brown or black with pink spore masses.	Copper oxychloride @2 g/L of water
		3. Cercospora leaf spot	Small, round, brown spots on leaves with chlorotic halos, merging to form large, irregular lesions.	Mancozeb @2 g/L of water
		4. Downy mildew	Yellowing and distortion of leaves with white, fluffy growth on the undersides.	Copper oxychloride @2 g/L of water
		5. Root rot (Rhizoctonia solani)	Wilting, stunting, yellowing of leaves, rotted and discoloured roots.	*Trichoderma viride* (biofungicide)As per label instructions
		6.Stemphylium blight	Small, brown spots on leaves and stems, enlarging and merging to form blighted patches.	Chlorothalonil @2 g/L of water

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3	Palak (*Spinacia oleracea*)	**1.Downy mildew**	Yellowing and distortion of leaves with a white, fluffy growth on the undersides.	Copper oxychloride @2 g/L of water
		2. Cercospora leaf spot	Small, round, brown spots on leaves with chlorotic halos, merging to form large, irregular lesions.	Mancozeb @2 g/L of water
		3. Fusarium wilt	Wilting, yellowing, and stunting of plants, starting from the lower leaves and progressing upwards.	Carbendazim (restricted use) @1g/L of water
		4.Anthracnose	Sunken, circular lesions on leaves and stems, turning dark brown or black with pink spore masses.	Copper oxychloride @2 g/L of water
		5.Spinach blight (*Stemphylium botryosum*)	Small, brown spots on leaves and stems, enlarging and merging to form blighted patches	Chlorothalonil @2 g/L of water
4	Amaranthus (*Amaranthus cruentus*)	**1.Downy mildew**	Yellowing and distortion of leaves with a white, fluffy growth on the undersides.	Copper oxychloride @2 g/L of water
		2.Sclerotinia wilt	Wilting, browning, and rotting of stems, often starting near the base. Sclerotia (black resting structures) may be visible on affected tissues.	Propiconazole (restricteduse) @ 0.5 g/L of water
		3. Cercospora leaf spot	Small, round, brown spots on leaves with chlorotic halos, merging to form large, irregular lesions.	Mancozeb @2 g/L of water
		4.Alternaria leaf spot	Small, brown or black spots on leaves, starting at the edges and progressing inward, causing leaf defoliation	Chlorothalonil @2 g/L of water
		5. Fusarium wilt	Wilting, yellowing, and stunting of plants, starting from the lower leaves and progressing upwards.	Carbendazim (restricted use) @1g/L of water
		6. Ramularia leaf spot	Small, brown to reddish-brown spots on leaves, surrounded by yellow halos.	Copper oxychloride @2 g/L of water
5	French Beans (*Phaseolus vulgaris*)	**1.Anthracnose**	Sunken, circular lesions on leaves, stems, and pods, turning dark brown or black with pink spore masses.	Copper oxychloride @2 g/L of water
		2. Bacterial blight	Water-soaked spots on that enlarge and become greasy, oozing bacterial ooze	Copper oxychloride (limited effectiveness) @2 g/L of water
		3. Bean rust	Small, orange to brown pustules on the undersides of leaves, spreading as powdery spores.	Sulfur- Dust formulation as per label instructions
		4. Cercospora leaf spot	Small, round, brown spots on leaves with chlorotic halos, merging to form large, irregular lesions.	Mancozeb @2 g/L of water
		5. Downy mildew	Yellowing and distortion of leaves with a white, fluffy growth on the undersides.	Copper oxychloride @2 g/L of water
		6. Fusarium wilt	Wilting, yellowing, and stunting of plants, starting from the lower leaves and progressing upwards.	Carbendazim (restricted use) @1g/L of water
6	Peas (*Pisum sativum*)	**1.Powdery mildew**	White, powdery growth on leaves, stems, and pods, stunting plant growth and reducing yield.	Sulfur- Dust formulation as per label instructions
		2. Downy mildew	Yellowing and distortion of leaves with a white, fluffy growth on the undersides.	Copper oxychloride @2 g/L of water
		3.Ascochyta blight	Small, brown or reddish-brown spots on leaves, stems, and pods, progressing to larger lesions with dark centers.	Chlorothalonil @2 g/L of water

		4. Fusarium wilt	Wilting, yellowing, and stunting of plants, starting from the lower leaves and progressing upwards.	Carbendazim (restricted use) @1g/L of water
		5. Pea root rot	Wilting, stunting, and yellowing of plants, with brown or black rot on the roots.	*Trichoderma viride* (biofungicide)-As per label instructions
		6. Bacterial blight	Water-soaked spots on leaves stems, progressing to larger, greasy lesions with bacterial ooze	Copper oxychloride (limited effectiveness) @2 g/L of water
7	Brinjal (*Solanum melongena*)	**1.Early blight (*Alternaria solani*)**	Small, brown or black spots on leaves, starting at the edges and progressing inward, causing leaf defoliation.	Chlorothalonil @2 g/L of water
		2.Late blight (*Phytophthora infestans*)	Water-soaked lesions on leaves, stems, and fruit, turning brown black with a white fungal growth around the edges.	Copper oxychloride @2 g/L of water
		3. Phomopsis fruit rot	Small, brown or black sunken lesions on fruit, developing into large, watery rots.	Propiconazole (restricteduse) @ 0.5 g/L of water
		4.Anthracnose (*Colletotrichum gloeosporioides*)	Sunken, circular lesions on leaves, stems, and fruit, turning dark brown or black with pink spore masses.	Copper oxychloride @2 g/L of water
		5. Fusarium wilt	Wilting, yellowing, and stunting of plants, starting from the lower leaves and progressing upwards.	Carbendazim (restricted use) @1g/L of water
		6. Cercospora leaf spot	Small, round, brown spots on leaves with chlorotic halos, merging to form large, irregular lesions.	Mancozeb @2 g/L of water
8	Carrot (*Daucus carota* subsp. *sativus*)	**1.Alternaria leaf blight**	Small, brown or black spots on leaves, starting at the edges and progressing inward, causing defoliation.	Chlorothalonil @2 g/L of water

		2. Cercospora leaf spot	Small, round, brown spots on leaves with chlorotic halos, merging to form large, irregular lesions.	Mancozeb @2 g/L of water
		3. Downy mildew	Yellowing and distortion of leaves with a white, fluffy growth on the undersides.	Copper oxychloride @2 g/L of water
		4.Sclerotinia wilt	Wilting, browning, and rotting of stems, often starting near the base. Sclerotia (black resting structures) may be visible on affected tissues.	Propiconazole (restricteduse) @ 0.5 g/L of water
		5. Fusarium wilt	Wilting, yellowing, and stunting of plants, starting from the lower leaves and progressing upwards.	Carbendazim (restricted use) @1g/L of water
		6. Black rot (*Alternaria dauci*)	Dry, sunken, black lesions on roots, progressing to soft rot	Chlorothalonil @2 g/L of water
9	Beetroot (*Beta vulgaris* subsp. *vulgaris*)	**1.Cercospora leaf spot**	Small, round, brown spots on leaves with chlorotic halos, merging to form large, irregular lesions.	Mancozeb @2 g/L of water
		2. Downy mildew	Yellowing and distortion of leaves with a white, fluffy growth on the undersides.	Copper oxychloride @2 g/L of water
		3. Rhizomania	Hairy roots, stunted growth, and poor root development.	effective fungicide treatment available; Preventative crucial; use certified disease-free seeds and avoid planting in infested soil.
		4.Scab (Streptomyces scabies)	Rough, scabby lesions on the beetroot surface, affecting marketability.	Copper oxychloride (limited effectiveness) @2 g/L of water
		5. Fusarium wilt	Wilting, yellowing, and stunting of plants, starting from the lower leaves and progressing upwards.	Carbendazim (restricted use) @1g/L of water

		6. Ramularia leaf spot	Small, brown to reddish-brown spots on leaves, surrounded by yellow halos.	Copper oxychloride (limited effectiveness) @2 g/L of water
10	Knol Khol (*Brassica oleracea*)	**1.Alternaria leaf spot**	Small, brown or black spots on leaves, starting at the edges and progressing inward, causing defoliation.	Chlorothalonil @2 g/L of water
		2. Cercospora leaf spot	Small, round, brown spots on leaves with chlorotic halos, merging to form large, irregular lesions.	Mancozeb @2 g/L of water
		3. Downy mildew	Yellowing and distortion of leaves with a white, fluffy growth on the undersides.	Copper oxychloride @2 g/L of water
		4. Black rot (*Alternaria brassicae*)	Dry, sunken, black lesions on the bulb and stems, progressing to soft rot.	Chlorothalonil @2 g/L of water
		5.Sclerotinia wilt	Wilting, browning, and rotting of stems, often starting near the base. Sclerotia (black resting structures) may be visible on affected tissues.	Propiconazole (restricteduse) @ 0.5 g/L of water
		6. Fusarium wilt	Wilting, yellowing, and stunting of plants, starting from the lower leaves and progressing upwards.	Carbendazim (restricted use) @1g/L of water
11	Radish (*Raphanus sativus*)	**1.Alternaria leaf blight**	Small, brown or black spots on leaves, starting at the edges and progressing inward, causing defoliation.	Chlorothalonil @2 g/L of water
		2. Cercospora leaf spot	Small, round, brown spots on leaves with chlorotic halos, merging to form large, irregular lesions.	Mancozeb @2 g/L of water
		3. Downy mildew	Yellowing and distortion of leaves with a white, fluffy growth on the undersides.	Copper oxychloride @2 g/L of water
		4. Black leg (*Phoma lingam*)	Darkenedandsunkenlesionson stems at the soil line, causing wilting and stunting.	Propiconazole (restricteduse) @ 0.5 g/L of water

		5. Fusarium wilt	Wilting, yellowing, and stunting of plants, starting from the lower leaves and progressing upwards.	Carbendazim (restricted use) @1g/L of water
		6. Bacterial soft rot	Water-soakedareasonrootsand leaves, progressingtoslimy,foul-smelling rot.	Copper oxychloride (limited effectiveness) @2 g/L of water
12	Lettuce (*Lactuca sativa*)	**1.Downy mildew**	Yellowing and distortion of leaves with a white, fluffy growth on the undersides.	Copper oxychloride @2 g/L of water
		2. Gray mold (*Botrytis cinerea*)	Soft,grayrotonleaves,stems,and flowers.	Chlorothalonil @2 g/L of water
		3.Sclerotinia rot (White mold)	Wilting, browning, and rotting of stems, often starting near the base. Sclerotia (black resting structures) may be visible on affected tissues.	Propiconazole (restricteduse) @ 0.5 g/L of water
		4.Alternaria leaf spot	Small, brown or black spots on leaves, starting at the edges and progressing inward, causing defoliation.	Chlorothalonil @2 g/L of water
		5. Cercospora leaf spot	Small, round, brown spots on leaves with chlorotic halos, merging to form large, irregular lesions.	Mancozeb @2 g/L of water
		6. Fusarium wilt	Wilting, yellowing, and stunting of plants, starting from the lower leaves and progressing upwards.	Carbendazim (restricted use) @1g/L of water
13	Pak Choi (*Brassica rapa* subsp *chinensis*)	**1.Downy mildew**	Yellowing and distortion of leaves with a white, fluffy growth on the undersides.	Copper oxychloride @2 g/L of water
		2.Alternaria leaf spot	Small, brown or black spots on leaves, starting at the edges and progressing inward, causing defoliation.	Chlorothalonil @2 g/L of water
		3. Cercospora leaf spot	Small, round, brown spots on leaves with chlorotic halos, merging to form large, irregular lesions.	Mancozeb @2 g/L of water

		4.Sclerotinia rot (White mold)	Wilting, browning, and rotting of stems, often starting near the base. Sclerotia (black resting structures) may be visible on affected tissues.	Propiconazole (restricteduse) @ 0.5 g/L of water
		5. Bacterial soft rot	Water-soakedareasonleavesand stems, progressingtoslimy,foul-smelling rot.	Copper oxychloride (limited effectiveness) @2 g/L of water
		6. Fusarium wilt	Wilting, yellowing, and stunting of plants, starting from the lower leaves and progressing upwards.	Carbendazim (restricted use) @1g/L of water
14	Basil (*Ocimum basilicum*)	**1.Downy mildew**	Yellowing & distortion of leaves with white, fluffy growth on undersides.	Copper oxychloride @2 g/L of water
		2.Alternaria leaf spot	Small, brown or black spots on leaves, starting at edges and progressing inward.	Chlorothalonil @2 g/L of water
		3. Cercospora leaf spot	Small, round, brown spotswith chlorotic halos, lesions.	Mancozeb @2 g/L of water
		4. Fusarium wilt	Wilting, yellowing, & stunting starting from lower leaves and progressing upwards.	Carbendazim (restricted use) @1g/L of water
		5.Sclerotinia wilt	Wilting, browning, & rotting of stems, often near the base with black resting structures (sclerotia).	Propiconazole (restricteduse) @ 0.5 g/L of water
		6. Gray mold (*Botrytis cinerea*)	Soft, grayrotonleaves,stems,& flowers	Chlorothalonil @2 g/L of water

Conclusion

As greenhouse cultivation continues to expand globally to meet the demands for fresh produce, understanding and managing diseases in these environments becomes increasingly crucial. By implementing a holistic approach that integrates preventive measures, cultural practices, and innovative pest management strategies, growers can minimize the impact of diseases on greenhouse crops while ensuring sustainable and profitable production.

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LAC FARMING

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Abstract
Lac is the product obtained from the productive insect lac insect called *Kerria lacca* or *Laccifer lacca*. This overview explores introduction to lac, the biology and behaviour of lac insect, cultivation of lac, its types, their enemies, uses of lac, the national and global status of lac production and their Institutes and Journals. Lac is the subsidiary source of income for many mass group of tribals in our country and conserves vast areas of forests and biodiversity.

Introduction
Lac is the resinous substance secreted by the lac insect as its outer covering. It is a Scale insect. It belongs to the family Lacciferidae of order Hemiptera. There are 86 species of lac insects recorded till now which produce lac out of which 19 species are found in India under two genera Kerria and Paratachardina. Lac culture is the method of rearing lac insects on the host tree in order to obtain resinous substance lac which has high economic value. In India *Kerrialacca* is used mostly in lac culture which is also called Indian lac insect. The female lac insect is the chief producer of lac. The composition of lac is lac resin -75 %, lac wax - 5 to 6% , lac dye- 5to 6% and others - 12 to 13 %.

Biology and Behaviour
The female lays nearly 200-1000 eggs and these eggs hatch after 6 weeks. The newly emerged nymphs are very minute soft bodied red coloured with black eyes. Soon after the emergence the nymphs moved to the tender branches and settle and start sucking the sap .They start secreting the resinous substance so called lac on their body once they get settled. Lac secreting glands are present throughout their body and secretes lac except on mouthparts, respiratory pores and anus. Out of total nymphs one - third would be male and rest are female. These nymphs moult 3 times and become adults. The adult male may be winged or wingless and lives only for 3- 4 days after emergence. This male copulates the female under the cell and this copulated female starts producing more lac and increases the size of the cell several times and thus the female becomes the chief producer of lac.

Cultivation of Lac
Process starts by placing brood lac on suitable host plants, the brood lac consists of gravid females which are ready to lay eggs, after emerging out from mother cells the young ones settle on fresh twigs of host plants and suck the plant sap and grow and from encrustations.

a) Local practice
This method consists of continuously exploitation of host plants without giving rest for recoupment and mainly natural inoculation occurs. Some branches are left untouched for auto inoculation for next crop season and no pruning is carried out and only partial pruning is carried out. Vigour of the host trees is lost and cannot produce the new succulent shoots and later trees become weak and may die in some cases.

b) Improved practice

The principle followed in improved practices is providing of rest to host trees after harvest. In this procedure coupe system is followed for lac cultivation and these trees are divided into coupe i.e, groups has certain number of trees only few trees in the coupe gets inoculated, after harvest trees are provided rest to recoup it's lost vigour and get ready for the production of succulent twigs for the inoculation. In kusum strain, 18 months rest provided by dividing trees into 4 coupes and each coupe inoculated once in two years. In rangeeni strain, trees are divided into 3 coupes i.e, two large and one small in ratio of 3:1:3. Baisakhi crop is raised in 2 large coupe in alternate years in that each coupe will get rest of 15 months in between. Katki crop is raised every year in a small coupe and will get rest period of 7 months between two successive crops.

Inoculation methods

Propagation of lac insects can be carried out by inoculation of newly hatched (nymphs) on same (or) different host trees.

Natural/self/Auto inoculation

Common and simple process, in this process the swarmed nymphs infest the same plant again the process repeated on same host so that host tree gets weak and proper nutrition is not provided to the nymphs, no uniform sequence of inoculation is followed.

Artificial inoculation

In January pruning of old weak and diseased twigs of this host plants and by this practice host plants produces new succulent twigs. Brood twig of 20X30 cm length is tied to fresh twig in a position that each stick touches the tender branches at several places. Swarm of Nymphs from brood will migrate to the tender and infest them. After swarming, brood twigs should be removed from host plant to prevent pest infestation.

The time of inoculation and harvesting of different lac crops are:

Strain	Crop	Time of inoculation	With brood lac from	Time of harvesting
Rangeeni	Baisakhi	Oct-nov	Katki	June-july
	Katki	June-july	Baisakhi	Oct-nov
Kusumi	Jethwi	Jan-feb	Aghani	June-july
	aghani	June-july	jethwi	Jan-feb

Harvesting of Lac (cropping)

The encrusted lac twigs can be cut when the crop is mature it is of 2 types.

1) Immature harvesting:

In this before the swarming takes place lac is collected thus the obtained lac is known as ARI LAC. Lac insects gets harmed during harvest and this ARI LAC harvesting is recommended mostly on palas only.

2) Mature harvesting:

In this after swarming, lac is collected and the lac obtained from this is called as mature lac.

Types of lac

Lac is of different types. We get different type of lac during various stages of its processing firstly we get stick lac, then on further processing we obtain seed lac and further shell lac and upon

further processing button lac is obtained. Here is the process of obtaining different types of lac. After the harvesting of the twigs with lac encrustations they are scrapped and this obtained lac is called stick lac. This stick lac also called as crude lac or scrapped lac. This crude lac contains resin, debris, sand and other impurities. This stick lac is tied into a bundle and placed in running stream of water and washed and then shade dried. The shelf life of stick lac is so less, it cannot be stored for many days because higher moisture content in the stick lac leads to formation of lumps in the lac. This stick lac is further crushed and washed in larger vessels to remove impurities like twigs and insect body parts from the lac and as a result of this washing the entire water turns red this is further processed to obtain a red dye which is a byproduct and the main product resin is obtained and dried, winnowed and sieved to get another type of laci.e, Grain lac, this is also called as seed lac. Seed lac is yellowish to reddish brown in colour. In further process the seed lac is melted through various process like handmade process, heat process, solvent process where the seed lac is melted and spread into sheets to get shell lac or if it is the molted seed lac is poured into Zinc sheets, we get button lac whose diameter is 7cm and thickness is 0.6 cm.

Enemies of Lac Insects

Humans, insect pests and Non-insect pests are considered as enemies of lac. Humans are considered as enemies of lac because of occurrence of theft of lac from standing crop. Management includes cooperative ward and watch and strict actions should be taken against those who stole the lac from the standing trees. As lac insect is sedentary in nature lots of damage is created by the predators and they will predate in both field and storage conditions. The major insect predators which cause damage to lac are *Eublemmaanabilis*, *Holocercapulviria*, *Ephestiasps*, Chrysopasps. Out of which larva of *Eublemmaanabilis* and *Holocercapulviria* are considered as pests at both field and storage and complete loss of lac crop is noticed in the kusmi crop when it is attacked by Chrysopa species. Management includes using of nets for trapping lepidopteran predators and the cultivation of rangeenilac and kusumi lac at the same place should be avoided, use of biopesticides like *Bacillus thurengenesis* and biocontrol agents like Trichogamma species for controlling the predators. Next comes the non-insect pests which include monkeys, squirrels, rats and birds which cause lots of damage to lac. Rats and squirrels damage the most. Management includes using of poison baits for rats, warding off monkeys, squirrels and birds by producing scary sounds.

Lac uses

These are exploited for their various commercial products. Lac resinis natural, Bio degradable, Non-toxic and also used in food and textile and pharmaceutical industries and also in surface coating and electrical and other fields. Paratachardina species produce hard, horny substances that is insoluble in alchol. These are uniovoltine and generally treated as parasitic insects for commercial crops like tea, coffee, and sandal wood and also as bio-control agents on weeds. Used to paint wooden toys, paint sides of ships to prevent leakages, lac dye has nitrogen can also used as manure. Eri-silk gives red colour when dyed with lac dye. Chronic fever and rheumatism can be cured by lac, also has germicidal and astringent properties and gramphone records includes lac in its manufacturing. Paints, varnishes and electric insulators uses lac in it. In Madagascar lac is obtained from Gascardia (a coccinellid).

Status of raw lac production at International and National level

India holds first position in the world in lac production with around 20,000 tonnes and 80% of total world's production is from India, 75% of it's exported to different countries in processed and

semi processed forms. Thailand holds second rank after India in lac production Philippines, Vietnam, Cambodia, China, Myanmar also holds some share in lac production. Chota Nagpur region of Jharkhand state holds good position in lac production followed by Chhattisgarh state, Madhya Pradesh, West Bengal, Uttar Pradesh, Maharashtra, among these states Jharkhand state holds first place in production with (53%) followed by Chhattisgarh (17%), Madhya Pradesh (12%), Maharashtra (8%) and Odisha (3%) contribution of these 5 states plays keys role in the view of national production. Among different cropping season crops jethwi crop ranks first with (32%) followed by Aghani (27%) and baisakhi (24%) and katki (17%) in total lac production. About 8 million tribals dependent on lac. Agricultural income of Jharkhand tribals is about 20-38% is from lac cultivation and about one million man days/annum can be generated by industries engaged in post harvesting of lac and lac byproducts.

Institutes

The Indian lac research institute established on 20 September 1924 at Numkum in Ranchi, Jharkhand .It is an autonomous institute established under ICAR, by ministry of Agriculture Govt of India, for advanced research on lac and by products of lac.

And after it is renamed as Indian Institute of Natural Resins and Gums from 20 September 2007 presently it is called as National institute of Secondary Agriculture. And present director of NISA is Dr. Abhijit Kar. And it is the lead coordinating center among 7 centers for national network project for harvesting, processing and value addition of natural resins and gums. It also includes agro forestry models on resins and gums.

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LIFE CYCLE AND NATURAL BREEDING EVENTS OF MUDCRAB

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Introduction

The *Scylla* genus's mudcrab, also known as mangrove crab. The mudcrabis a valuable species that is used as a food supply and source of revenue for many tropical Indo-Pacific nations, including India, Bangladesh, Malaysia, China, Taiwan, Philippines, Indonesia, and Vietnam (Huq et al., 2015). This euryhaline species is present in coastal waters with salinities ranging from 15 to 30 ppt (Kamal et al., 2004), and it is most prevalent in mangrove areas. Due to its biochemical enrichment of 15-20% protein, 1% fat, and 2-3% minerals (Huq et al., 2015), mud crab is a highly sought food item worldwide, commanding high market prices (Soundarapandian et al., 2013). The Indo-Pacific area is home to roughly fifteen different species of crabs.

From a historical perspective, crab farming is not that old. Since the 1970s, tropical Asia (China) has paid attention to the aquaculture of *Scylla* species (FAO Fish Start, 2010). During that period, low-density shrimp and fish in polyculture ponds marked the beginning of the development of crab farming. Due to frequent disease outbreaks in shrimp ponds, there was a sharp decline in shrimp output in 1994–1995 (FAO Fish Start, 2010). Because of this, crab farming has grown in popularity in several Asian countries. There is currently an increasing mudcrab demand in Asia, Europeand America. The mudcrab output is trending upward and China leads the Indo-Pacific region in the production of farmed mudcrabs followed by Vietnam, the Philippines, Indonesia, India, and Myanmar. The *Scylla* genus of mudcrabs is a very valuable commercial species of crustaceans found all over the Indo-West Pacific (Keenan et al. 1999). There has been debate concerning its classification. It was Estampador (1949) who initially described three distinct species (*Scylla serrata, S. oceanica* and *S. tranquebarica*) based on their variation in size, colour and shape.

Keywords : Breeding, Broodstock, Distribution, Mudcrab

Habitat and Distribution

To facilitate easy burrowing, they favor mangrove areas, intertidal flats, mangrove swamps in estuaries, and soft, muddy bottoms. They can withstand extremes in temperature and salinity (15–30 ppt) in water (Huq et al., 2015). Mudcrabs are found in a variety of habitats including estuaries, mangrove swamps, tidal flats, and salt marshes. They prefer shallow waters with muddy or sandy bottoms and plenty of vegetation. Mudcrabs are burrowing crustaceans and construct burrows that are typically 30-50 cm deep. They use their burrows to hide from predators and to escape from the heat and cold. Mudcrabs are originating in tropical and subtropical areas worldwide. In India, they are found along the coastlines of the Bay of Bengal and the Arabian Sea (FAO 2010). Some of the states where mudcrabs are found in India includes

Tamil Nadu, Gujarat, Karnataka, Maharashtra, Kerala, West Bengal, Odisha, and Andhra Pradesh.

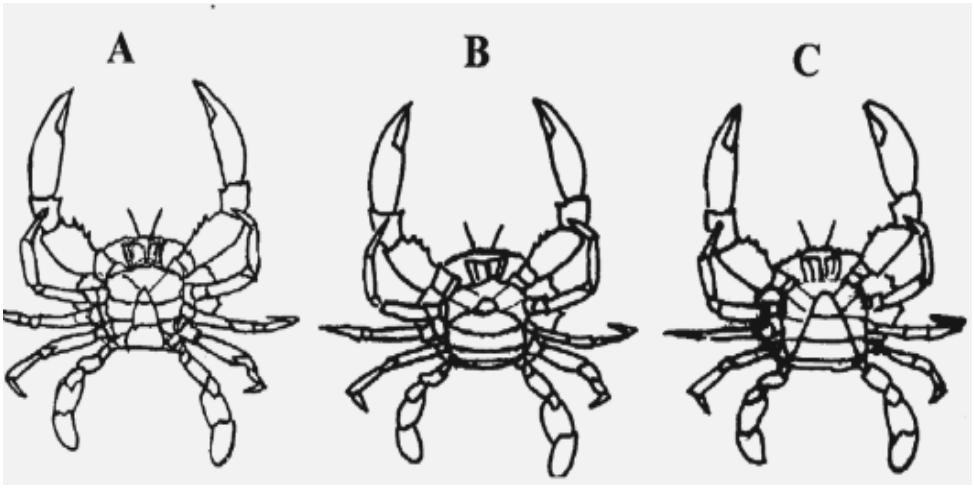
Food and Feeding

The feeding habits of mudcrabs are nocturnal and omnivorous and voraciously feed on variety of debris, including sand and plant waste, small fish, crustaceans, mollusks, and dead crabs. They consume algae, crabs, and other naturally occurring animal matter as food in the pond. They also consume eel fish and garbage fish. Chelate legs catch feeds. Variations in the maturation diets of mudcrabs are primarily responsible for their reproductive success and larval production (Fortes, 1999).

Under the PMMSY scheme entitled "Empowerment of Artisanal Fisherfolk of Pazhaverkadu Area through Mudcrab Culture Technology", mud crab adults weighing above 200g were collected, acclimatized and stocked in 300 litre FRP tanks. FRP tank bottom was provided with sand and stones for stimulating burrowing behaviour. Additionally, continuous water filtration provision was provided in the tank for getting higher survival and stimulating maturation. These crabs were daily fed with trash fish and squid meal including flesh of sardine, mackerel and sea bream. Feeding rate was maintained at 10% of the body weight and based on the weight recorded fortnightly feeding rate was adjusted. Surprisingly, moulting was observed twice in this FRP tank and resulted in an increase in the total weight of the crab.

Reproduction

Identification of adult males and females



Sexual dimorphism in mudcrabs (Source: DOI: 10.13140/RG.2.2.29718.70723)

The sexes of crabs are distinct. The form of the abdominal flap is a morphological indicator of sex. While the juvenile and mature male flaps have a comparable shape (A), the female flap differs significantly in both stages (CIBA Bulletin 12, 2000). The shape of the abdominal flap in a mature female is half-rounded (B), whereas in an immature female, it is triangular(C). Chelipeds can occasionally be used to detect sex externally. In comparison to females, male chelipeds are larger and stronger.

Male Reproductive System

An internal pair of testes, a vas differentia, and ejaculatory ducts makes up the male reproductive system. An external pair of pleopods and supplementary reproductive organs are located in the

inner side of the abdomen. The tiny genital papilla is the opening of the ejaculatory ducts. Seminal plasma and non-motile sperm make up the ejaculate. The pleopods assist in sperm passage from the ejaculatory ducts, where they are stored in the vas eferentia. When the breadth of the carapace exceeds 90 mm, both the male and female reach sexual maturity (CIBA Bulletin 12, 2000).Sexual maturity can be classified into three stages like Immature creamy/transparent colour and absence of prominent vas deferens, Maturing-Creamy white occupy 1/4th of body cavity and Mature-milky white vas deferens occupying full body cavity.

Female Reproductive System

The female reproductive system is made up of four pairs of external pleopods, seminal receptacles, a pair of oviducts, two pairs of ovaries, and a few ancillary structures. The female genital aperture, which is located at the sixth thoracic segment, is where the seminal receptacles, which make up the majority of oviducts, open to the outside world. There are three phases of ovarian development, which include Immature-yellowish/transparent colour and absence of prominent seminal receptacle, Maturing-Pink in colour occupy 1/3th of body cavity and Mature-Orange red colour with prominent seminal receptacle occupying full body cavity (Ciba bulletin 12, 2000).

Breeding season of Mudcrab

S. No	Region	PEAK BREEDING SEASON	PEAK JUVENILE IN ABUNDANCE
1	Tamil Nadu Coast	September-April	December to May in Pulicatlake
2	Kerala Coast	September-February	May to October in Vembanad back water
3	Andhra Pradesh Coast	October-February& May – June	December to April & July to Aug in Kakinada
4	Odisha Coast	November- January	March to June in Chilika lake
5	West Bengal Coast	May- August	November to February in Hooghly Matlah estuaries system.

Mating behavior

The actual process of copulation begins a few hours after the precopulatory moulting, during which the male deposits the spermatophore in the female's seminal receptacle. Following this, the male and female separates and a premating embrace between the hard shell male and female initiates the courtship, which lasts for two to three days. The male accomplishes this by climbing over the female crab and holding her by his cheliped and front two pairs of walking legs. As the female is about to moult, the male leaves the riding position and assists the female in casting off the old exoskeleton.

Spawning

The female extrudes the ova, which are then fertilized by sperm kept in spermatophores. The appendages in the abdomen that are ovigeroushold the fertilized egg in place.

Under the PMMSY spawning trial, fertilized eggs stopped development after 36 hour and successful spawning was not observed due to salinity changes between the broodstock collected

from the wild and hatchery water salinity. Further trials will be undertaken to improve the egg development and successful hatching.

Incubation & hatching

The egg is carried by the berried female for two weeks during which period the embryo develops in the egg. The egg change the color from orange to brown. Just before releasing the larva, the egg become black and at the end of incubation zoealarva hatches out.

Life cycle of Mudcrab

The larval development of mudcrabstakes place in estuaries after they spawn in the sea. The copulatory partners, the males, wait until the female crabmoults because of their rigid exoskeletons. By use of pheromones that the female releases, the male detects the impending molt of her. Next, the male crab envelops her in a tight embrace called as amplexus until she moults, guaranteeing that he will be the copulatory partner. After copulation, in which the male places spermatophores, or packets of sperm, into the female's vagina. According to DoF, Australia (2013), the mudcrab life cycle can be divided into many stages.

1. Zoea : A mudcrab is born as a larva known as a "zoea," which emerges from an egg. It has underdeveloped limbs and resembles a tadpole. It is around one millimeter long. Together with plankton, which are tiny organisms that float in groups, the zoea floats in sea.

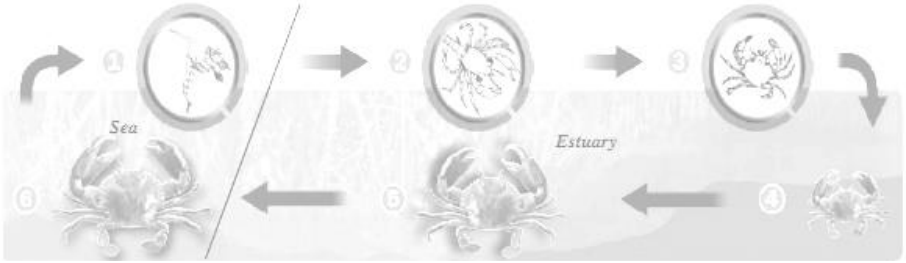
2.Megalopa : A zoea undergoes four moults over the course of 12 to 15 days in order to grow. It changes into a megalopa, which are working claws, during its fifth molt. It creeps inshore and settles on the seafloor after about a week. Megalopamoults into a juvenile crab after a few days.

3. Juvenile crab : The juvenile crab, which is only four millimeters broad, is a tiny replica of the adult. It moves to an estuary and settle in a protected place around a month after hatching, when it is between 10 and 20 millimeters wide.

4. Young adult : The crab takes 18 to 24 months to attain sexual maturity. Around 110 millimeters is when a green mudcrab reaches adulthood (carapace width).

5. Mating : The warmer months are when mudcrabs mate. To entice males, mature females release a chemical attractant known as a "pheromone" into the water. After mating, the victorious male ascends onto the female, hugs her with his rear legs, and lifts her, carrying her for a maximum of four days. When the growing "ova" (eggs) are ready to be fertilized, the male places a capsule containing sperm within the female's reproductive opening, where it is kept for months.

6. Spawning and hatching : To spawn, the female migrates offshore. The diameter of an egg is roughly 0.3 millimeters. Two to five million fertilized eggs are released at a time. Within two to four weeks, the eggs hatch. In order to help release the zoea during hatching, the female stands on the tips of her legs and moves her abdominal flap. After then, the lifecycle restarts.



Life cycle of mudcrab (Source: DOI: 10.13140/RG.2.2.29718.70723)

Artificial breeding technique

Mudcrabs are highly valued crustaceans with a significant demand in both domestic and international markets. Establishing mudcrab hatcheries can contribute to increased production and sustainable utilization of these resources. Here are some of the notable mudcrab hatcheries operating in India:

Sl. No	Center	Location	Focus
1.	Central Institute of Brackishwater Aquaculture (CIBA)	Chennai, Tamil Nadu	Research and development of mudcrab hatchery techniques, produces seeds for commercial farming
2.	Rajiv Gandhi Centre for Aquaculture (RGCA)	Chennai, Tamil Nadu	Mudcrab hatchery and seed production, Provides technical support to farmers
3.	Mangalore Fisheries College and Research Institute	Mangalore, Karnataka	Research on mudcrab hatchery management, Provides training programs for hatchery operators
4.	National Centre for Marine Fisheries Technology Extension (NCMFTE)	Ernakulam, Kerala	Mudcrab seed production and hatchery management, Provides technical assistance to hatchery operators
5.	Fisheries and Technology Development Corporation of India (FTDCI)	Hyderabad, Telangana	Mudcrab hatchery development, seed production, and farmer training, Supports the establishment of commercial mudcrab hatcheries
6.	Mudcrab Hatchery, Department of Fisheries and Aquaculture	Dibrugarh, Assam	Seed production and distribution within the state, Supports local mudcrab farming
7.	Andaman and Nicobar Islands Fisheries Department	Port Blair	Mudcrab hatchery development and seed production, Supports the growth of mudcrab farming in the Andaman and Nicobar Islands
8.	Marine Products Export Development Authority (MPEDA)		Support for mudcrab hatchery establishment and development, Provides subsidies and technical guidance to hatchery operators
9.	Pilot Scale hatchery of Mudcrab, TNJFU, Pazhaverkadu	Thiruvallur District, Tamil Nadu	Experimental seed production facilities are being established for Pulicat fisherfolks

Collection of Broodstock

Broodstock is essential to the success of mudcrab breeding. Live, fully grown *S serrata* male and female collected from wild sources such as brackish and inshore seas. After that, each crab needs to be cleaned for 30 minutes in 100 parts per million formalin before being placedin the broodstock holding tank. For the breeding studies, only adult mated females were chosen. By looking at the females abdominal segments, it was possible to identify when mating had occurred recently. Abdominal segments of immature/unmated females are firmly linked to the thoracic sternum, whereas abdominal segments of mated/mature females are loosely attached.

Depressing the first abdominal segment next to the carapace allowed observers to examine ovarian maturation, which is determined by the color of the ovary (Shelley and Lovatelli, 2011).

Broodstock management and spawning

Brood stock were maintained in separate 500liter containers and formalin disinfection process at 100 parts per million for 6 hour. A recirculation system with a 1 L per second water flow rate was installed in these tanks. The crabs were divided into three categories: extralarge (> 700 g), large (501–700 g), and medium (400–500 g). A single female crab was placed in each tank, to mature in 380 liters of seawater. The tanks had a bare bottom and a single plastic tray (30 cm in diameter and 7 cm in height) filled with sand. To reduce the chance of bacterial contamination, the sand was replaced frequently. These trays were maintained to help the female crab deposit their eggs and gather them into a mass of eggs.Feed twice a day on a freshly prepared squid, fish, and clam meat. The temperature was not regulated, but the tanks were maintained in low light.

Hormonal control: Eye-stalk ablation

The majority of the endocrine system in crabs is controlled by the eye stalk. In mudcrabs, the X-organ and sinus gland complex is crucial to the control of metabolism (Keenan 1999). Hyperglycemic hormone (HGH) and moult inhibiting hormone (MIH), which are in charge of metabolic processes, are found in eye stalks. Mudcrab life cycle altered from DoF Australia 2013 Sea Estuary control and suppression of Y-organ secretion. Therefore, eye-stalk ablation, which is done to regulate the sources of HGH and MIH, boosted food intake, accelerated ovarian growth, and also markedly enhanced the weight and size of oocytes. For breeding purposes, adult females should often have their eye stalks removed; however, males are not required to do the same.

Following a week of acclimatization in the maturation system, heated pliers were used to unilaterally ablate the crabs' eyestalks. A digital scale and caliper were used to measure each crab's body weight (bw) and carapace width (cw). The incubation tank held the spawning crabs, which were raised there until they hatched. For one hour, vigorous crabs were treated with 100 parts per million formaldehyde. In addition to eyestalk ablation, hormonal preparations like GnRH and serotonin are also administered to induced maturation in captive maintained crab. Also, vitamin and dietary incorporation may be done to induce maturity in captivity.

Spawning and larval rearing

After ten days of eyestalk ablation, spawning occurs. Farmed species, including fish, marine worms (polychaetes), shellfish, and squid, are fed at a rate of five to ten percent of biomass. A prepared diet is fed at a rate of one to three percent in addition to natural food. The hatchling, known as zoea, is moved to a hatchling tank, where its stocking density is eighty to one hundred per liter. The zoea are fed rotifers and Artemia nauplii, while the early megalopa are given processed food of ≥five-day-old Artemia to provide larger-sized prey. Once the megalopa settle on the bottom, they are fed minced mussel meat or fish.

Nursing Tank

The last stage involves putting the crablets into the nursing pond. The size of the pond is between 200 and 800 m^2. Sometimes ponds with net cages are used as hatcheries. Less than 1.0 centimeter crabs are raised in net cages at 20–50/m^2 to 1.5–2.0 cm (Carapace width). Some farmers raise crabs to 3.0-4.0 cm in ponds with nets or net fences lining the dikes at a rate of 5–10/m^2 because they prefer larger crabs. Depending on the target size for pond stocking, each phase's culture time lasts between three and four weeks. In cases where the culture time is shorter than four weeks,

stocking density may be raised. Currently, crabs are fed a mix of two or more foods, such as shellfish, chicken waste, minced low-value fish, or formulated feeds at satiation once or twice daily.

Conclusion

The world's mudcrab industry is expanding quickly, particularly in Australia and Asia. The past few years have seen an upsurge in the production of mudcrabs worldwide due to the introduction of hatcheries and breeding techniques in different Asian countries. In order to maintain the industry and enhance the overall performance of mudcrabs maintained in captivity, induced seed production and improving larval survival is essential. This seed not only boosts global output but also alleviates environmental stress and generates employment opportunities for millions of people.

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UNDERSTANDING THE SIGNIFICANCE OF CODEX ALIMENTARIUS IN ENSURING FOOD SAFETY

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ABSTRACT

The Codex Alimentarius, established by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), serves as a pivotal international standard-setting body for food safety and quality. This abstract explores the significance of the Codex Alimentarius in ensuring global food safety. The Codex develops harmonized standards, guidelines, and codes of practice to facilitate fair international trade and protect the health of consumers. The Codex Alimentarius plays a crucial role in fostering consensus among its member countries, promoting a science-based approach to risk assessment and management in the food sector. Its standards cover a wide range of aspects, including food additives, contaminants, residues, labelling, and hygiene practices. By providing a common framework, the Codex facilitates communication and understanding among nations with diverse regulatory systems. Furthermore, the Codex Alimentarius supports the implementation of food safety measures at every stage of the food supply chain. Its influence extends beyond national borders, encouraging adherence to standardized practices that contribute to the prevention of food borne illnesses. As a result, the Codex Alimentarius serves as a cornerstone in the global effort to ensure the safety and quality of food, promoting public health and facilitating international trade in a manner that is both transparent and equitable.

Keywords : Codex Alimentarius, Food Standards, Food Code.

Introduction

In an era defined by intricate global food networks and diverse culinary choices, the assurance of food safety is a universal concern. The Codex Alimentarius, a Latin term meaning “Food Code,” emerges as a keystone in the pursuit of establishing international standards that guarantee the safety, quality, and fairness of the food we consume. Envisioned and enacted by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) the Codex Alimentarius Commission serves as a critical architect of regulations aimed at harmonizing practices, safeguarding consumer health, and fostering equitable international trade in the

domain of food. Codex Alimentarius in shaping a global framework for food safety and ensuring the well-being of consumers worldwide.

The Genesis of Codex Alimentarius

Founded in 1963, the Codex Alimentarius Commission emerged in response to the need for international standards to address food safety, quality, and fairness in trade. Recognizing the potential risks associated with an increasingly complex global food supply chain, the FAO and WHO joined forces to establish a framework that would harmonize standards and guidelines.

Key Objectives:

1. **Protecting Consumer Health:**
   At the core of Codex Alimentarius is the commitment to safeguarding consumer health. The Commission achieves this by developing science-based standards that set maximum limits for contaminants, additives, and residues, ensuring that the food we consume is safe and wholesome.

2. **Facilitating International Trade:**
   Codex standards serve as a common language for international trade. By providing a unified set of regulations, the Commission facilitates the smooth flow of food products across borders, promoting fair practices and preventing the imposition of arbitrary trade barriers.
3. **Harmonizing Regulations**:
   In a world with diverse regulatory frameworks, Codex Alimentarius plays a crucial role in harmonizing regulations. The standards set by the Commission encourage consistency, allowing countries to adopt similar practices in their food production and trade, thus enhancing global cooperation.

Key Focus Areas

1. **Food Safety Standards:**
   Codex Alimentarius sets standards related to food safety, addressing issues such as contaminants, pesticides, and foodborne pathogens. These standards are grounded in scientific evidence, providing a robust foundation for ensuring the safety of the food supply.

2. **Labelling and Consumer Information:**
   Clear and accurate information on food labels is paramount. The Commission establishes guidelines for labelling and packaging, ensuring that consumers have access to transparent information about the content and origin of the products they purchase.
3. **Nutritional Guidelines:**

Recognizing the importance of informed choices, Codex provides guidelines on nutrition and health claims. This empowers consumers to make decisions based on accurate information and promotes healthier dietary practices.

Global Impact

The Codex Alimentarius standards have a global impact, as they are recognized by the World Trade Organization (WTO) as the international reference for resolving trade disputes related to food safety and quality. Countries that adhere to Codex standards facilitate smoother international trade by ensuring that their food products meet the same safety and quality criteria as those set by the Commission.

Conclusion

In an era of globalized food supply chains, the Codex Alimentarius plays a pivotal role in fostering international cooperation and setting standards that protect the health of consumers worldwide. By promoting science-based regulations, the Commission contributes to the establishment of a robust and harmonized framework for food safety, ensuring that the food we consume is of high quality and safe for consumption. As the Codex Alimentarius continues to evolve, its impact on global food safety and trade remains essential for a healthier and more transparent international food market.

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NUTRIENT MANAGEMENT FOR THE BUILD-UP OF ABIOTIC STRESS IN CROPS

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Abstract
Abiotic stresses caused disorders in plants like osmotic stress in cells, retardation in cell development, reduction photosynthetic activity, seed dormancy and late reproduction and eventually show a negative effect on yield. The applications of plant nutrients are found to reduce the increasing problem of abiotic stresses under climate change situation. ROS activities through elevating antioxidants quantity that can scavenge the ROS effect and finally leading to the reduction in cell membrane leakage and increase the photosynthetic ability in the plant by recuperating the chlorophyll cells. This paper highlights the alteration of metabolic activities caused by abiotic stress in crops, the changes of vital functions through nutrient management.

Introduction
By 2050, the world will be home to another 3 billion people. The need to scale up agriculture is getting more acute with rising population and decreasing arable land. Today, farmers are on the front line of climate change – both in terms of the impact felt as well as the potential to achieve measurable improvement. To ensure safe, affordable and enough food and overcome farmers challenges around low productivity and income, it is critical to transform agriculture. Nowadays, the unpleasant situation of abiotic stress triggers crop improvement by affecting the different metabolic pathways of yield and quality advances worldwide. Abiotic stress like drought, salinity, cold, heat, flood, etc. in plants under climate change situation diverts the energy required for growth to prevent the plant from shock and maintain regular homeostasis. Hence, the plant yield is drastically reduced as the energy is utilized for overcoming the stress in plants. According to the International Panel on Climate Change report, the predicted temperature rise for India is in the range of 0.88–3.16°C by 2050 and 1.56–5.44°C by the year 2080. Studies predict significant negative impact of climate change, envisaging yield reduction by 4.5% to 9.0%, depending on the magnitude and distribution of warming. Studies showed significant negative impacts of climate change, predicting yield reduction by 4.5% to 9.0%, depending on the magnitude and distribution of warming. This paper highlights the alteration of metabolic activities caused by abiotic stress in crops, the changes of vital functions through nutrient management.

Nutrient Management for the build-up of Abiotic stress resilence in crops.
All the seventeen essential nutrients of plants are more or less responsible for abiotic stress alleviation in their own way. The various stresses primarily cause nutrient deficiency and reduce the nutrient uptake of plants. The application of plant nutrients like N, K, Ca, and Mg are also involved in ROS scavenging activities through elevating antioxidants properties and finally decreasing cell membrane leakage and increasing the photosynthetic ability by resynthesizing the chlorophyll pigment.

Nutrients and their roles to mitigate abiotic stresses
Plant mineral nutrient status plays a vital role in improving plant resistance to stress conditions. Crop response to macro and micronutrient applications towards mitigation of various abiotic stresses depends on the crop, growth stage and concentration of the nutrient solution. The key

mechanisms affecting the ability of macro and micronutrients to alleviate the effects of drought stress include enhancing water uptake and transport, regulating stomatal behaviour and transpiration. Foliar application effectively improves transpiration rate under drought conditions. It is observed that in response to several abiotic stresses, nitrogen can enhance the photosynthesis of plant, phosphorus can be able to produce proliferate and strong root system, calcium can enhance the membrane stability and cellular integrity in plant, the micronutrients can able to regulate the cellular activity and mitigate abiotic stress by activating numerous enzyme and selenium can protect the plant from ROS activities.

Stress is defined as an event that restricts crop productivity or destroys biomass. In the current climate change scenarios, crops are exposed more frequently to episodes of biotic and abiotic stresses such as drought, salinity, elevated temperature, submergence, nutrient deficiencies and pest-diseases infestation etc. These stresses can persistently limit choice of crops and agricultural production over large areas and extreme events can even lead to total crop failures. In recent years, advances in physiology, molecular biology and genetics have greatly improved our understanding of crops response to these stresses and the basis of varietal differences in tolerance.

Management of abiotic stress is one of the most difficult challenges facing agriculture. Abiotic stress is a consequence of several environmental disturbances caused by the continuous encroachment of urbanization, industrialization, and some human interferences with the natural ecosystem that influence the quality and quantity of agriculture production every year. Abiotic stresses comprise potentially negative effects of drought, salinity, metal toxicity and extreme temperature etc. Among the remedies for abiotic stress, nutrient regulations or management are considered as the cost-effective and eco-friendly techniques. The roles of different nutrients in reference to abiotic stresses are being described here.

***Nitrogen*:** The most important plant nutrient, nitrogen (N) has an impact on physiology, growth, the reduction of biotic and abiotic stress, and structural integrity. It has a significant impact on crop plants' ability to effectively use solar energy, increase photosynthetic activity, and synthesize chlorophyll. Nitrogen is a major component of all cellular and metabolic activities in crop plant as it is a major element of proteins, chlorophyll, nucleic acids, amino acids, plant hormones, enzymes, and osmolytes, all of which are involved in plant abiotic stress tolerance mechanisms through different pathways. The application of N enhances the plasticity and water extraction capacity of plant roots from the soil, which helps to maintain optimal relative leaf water content and increase water use efficiency in environments with limited moisture. Under the salinity stress condition application of N can improve growth attributes, physio-biochemical parameters, nutritional enrichment, and yield attributes in plants. Application of nitrogen fertilizer to crops promotes antioxidative defense mechanisms and reduces leaf senescence. These processes include carbon partitioning, carbohydrate buildup, cellular membrane stability, and osmoregulation, cell synthesis and expansion of plant cells and increased photosynthetic capacity. N can boost the root system in crops as well as improve xylem transport, photosynthetic enzyme activity, antioxidant defense, delay cell senescence, control stomata, increase proline accumulation, and encourage profuse branching.

***Phosphorus*:** Phosphorus not also improves root architecture and proliferation in the soil even in soil drying conditions, but also stimulates root volume and hydraulic conductivity. The modulation of numerous morphological, physiological, and biochemical processes by phosphorous within the plant system helps them to withstand stress better. Plant growth and development under stress are strongly and positively correlates with the use of phosphoric fertilizers. Under drought

conditions, phosphorus promotes root architecture and proliferation in the soil, which increases root volume and hydraulic conductivity. Application of phosphorous during the early stages of the crop boosts root growth and establishment. The application of P reduces the formation of ROS caused by drought by energizing enzymatic antioxidants which consequently increases resistance to stress. P treatment has also been linked to the remodeling of nitrogenous compounds in terms of buildup and absorption of NH_4 and NO_3 in water-stressed agricultural plants. Phosphorus fertilization significantly increases all growth parameters, chlorophyll content, nucleic acid content and minerals content of the plants under salinity stress.

Potassium : Potassium is a crucial nutrient for many fundamental physiological and metabolic processes including photosynthesis, stomatal control, photosynthesizing, carbohydrate metabolism, preservation of cell turgidity, enzyme activations, etc. Potassium is also essential for improving crops' tolerance to various abiotic stresses. Protective effect of potassium application on salt stress results more dry biomass production, shoot K+ concentration, chlorophyll contents, stomatal conductance, and K+/Na+ ratio under saline condition. Exogenous K fertilizer treatment under water stress enhances grain yield, harvest index, and other physiological indicators K can increase the photosynthetic process and glucose metabolism in a stressed crop.

Secondary nutrients

Sulphur : In the abiotic stress response, cellular acclimatization, and adaptability to challenging circumstances, sulphur performs protective roles. An exogenous dose of sulphur increases crop productivity while maintaining regular metabolic processes that enable plants survive in harsh settings. Sulphur helps to nullify the oxidative stress produced due to drought stress by increasing the activities of ROS scavengers, higher H_2S and soluble sugar contents along with reducing H_2O_2.

Calcium : Calcium an important secondary nutrient, acts as a signalling molecule in a number of physiological and biochemical processes that are necessary for a plant to develop stress tolerance. Calcium is also necessary for food uptake, enzymatic and hormonal up-regulations, and stabilization of cell membranes, improves the ability to preserve water. Ca^{2+} alters the plasma membrane's level of hydration, which enhances the cohesiveness of the cell walls and raises the viscosity of the protoplasm, enhancing the resistance of cells to dehydration.

Magnesium : Magnesium (Mg) is essential for the conformational stabilization of macromolecules such as nucleic acids, proteins, cell membranes, and walls and is a structural component of the ribosome. Its absence can have an impact on photosynthesis because it is a crucial element of the chloroplast, which controls photosynthetic activity. Magnesium can produce photosynthetic pigments, accumulate higher proline content and encourage better root proliferation.

Micronutrients

Micronutrients have been mainly recognized as essential elements for plant growth. In addition, these also play an irreplaceable role in alleviating stress imposed by biotic and abiotic factors. Micronutrients activate number of antioxidants in plants which serve as scavengers for reactive oxygen species (ROS). Micronutrients, serving as the components of many vital enzymes play an important role in various physiological and biochemical pathways in plants. In addition, micronutrients are required for a wide range of biological functions like photosynthesis, chlorophyll synthesis, respiration, nitrogen fixation, nutrient uptake mechanisms and DNA synthesis etc. Currently, the importance of micronutrients to impart the tolerance to plants against stresses as an emerging field of research is gaining attention. Therefore, adequate application of micronutrients is essential and pre-requisite for sustaining plant productivity under stress as well as non-stress conditions. The term 'micronutrients' represents essential nutrients that are required in small quantities for the normal growth and development of plants. These

include zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), boron (B), molybdenum (Mo) chlorine (Cl) and nickel (Ni). The role of micronutrients in biotic and abiotic stress management and tolerance strategies in crops is presented below.

Abiotic Stress Management through Micronutrients

Boron : Boron promotes the resistance of crop plants by improving hormone synthesis, lipid metabolism, pollen formation, sugar transport, photosynthetic efficiency, seed germination, flower retention, and seed yield during drought stress. Under water scarce conditions, B improves water uptake, and nutritional status from the rhizospheric soil by enhancing the growth of more root hairs and mycorrhizae, ROS detoxification process in chloroplasts preventing photooxidative damage hence establishes membrane integrity and improves drought tolerance in plants.

Zinc : Zn as an important micronutrient has been observed to improve the synthesis of IAA and gibberellic acid (GA3) like plant hormones under moisture stress conditions and thereby improving plumule length and increase shoot dry weight under drought stress. Zn application also helps in a significant expansion in leaf surface area, stomatal conductance, relative leaf water content, and improvement in chlorophyll and accumulation of osmolyte, thus resulting in enhancing cellular growth, plant harvest and prevention the destructive impacts on leaf cell due to moisture deficiencies. Also, Zn micronutrients can be used to maintain the permeability of cellular membrane and the optimum dose of Zn can mitigate plants from the devastating impacts of heat stress.

Iron : Spraying with Fe reduces oxidative stress by depleting H_2O_2 content along with breakdown of lipid peroxidation activities by accelerating the enzymatic antioxidant mechanisms underwater scarce situations and also shows a major impact in triggeringthe quality and resistance of protein under drought stress.

Copper : While going for role of copper under drought condition, Copper chlorophyllin (Cu-chl) has been proved to be an important modified water-soluble and semi-synthetic bio-stimulant that helps to improve the antioxidative capacity which leads to decreased oxidative stress in plant. Further foliar application of micronutrients could be useful for improving the nutrient status, root features, and physiological performance of plants.

Beneficial Nutrients

The functional aspects of beneficial nutrients, i.e., cobalt (Co), selenium (Se) and silicon (Si) in the regulation of plant physiological processes to relieve various abiotic stresses are illustrated in **Figure 1.**

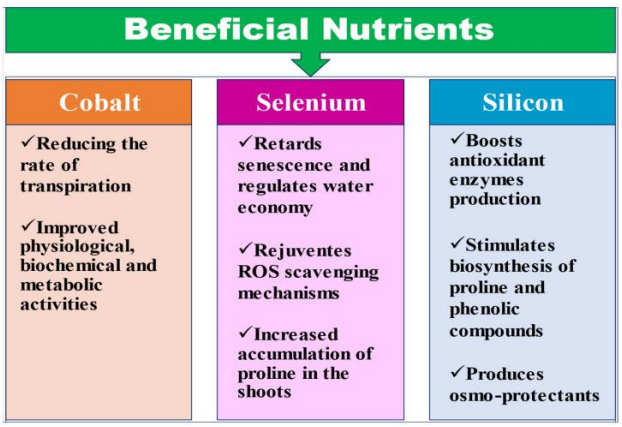

Figure 1. Activation of various plant mechanisms by application of beneficial nutrients to alleviate plant stress. Source: Venugopalan et al. (2022)

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Cobalt : Cobalt (Co) exemplifies an impressive example of a beneficial element to regulate vital physiological and metabolic functions in plants, with special reference to leguminous crops. It synthesises leg haemoglobin protein for the purpose of rhizobial activity as well as biological nitrogen fixation in legumes, thereby exerting a significant impact on enzyme systems. Cobalt also imparts drought tolerance in plants by virtue of efficient utilisation of water in addition to reducing the rate of transpiration. The substantial effect of Co has been reported to curb moisture stress by activating the antioxidant defence mechanisms in plants under heat and drought-stressed conditions. Thus Cobalt imparts drought tolerance in plants by increasing water use efficiency by reducing the rate of transpiration, further it activates the antioxidant defence mechanisms in plants.

Silica : Among the other nutrients, there are several elucidations of the alleviation effects of Si in salt-induced osmotic stress and oxidative stress. Si-mediated up-regulation of aquaporin gene expression and osmotic adjustment play important roles in alleviating salinity-induced osmotic stress.

Selenium (Se) : Selenium is known for its major role in synthesis of glutathione peroxidase (GPX) and ultimately prevents the plants from the negative impact of ROS. Application of Se can induce tolerance to abiotic stresses alone or in combination with several other plant nutrients by retarding senescence and regulating water economy, photosynthesis and Na^+ homeostasis, thereby promoting growth.

A brief account of abiotic stress alleviation using plant nutrients has been depicted in **Figure 2**.

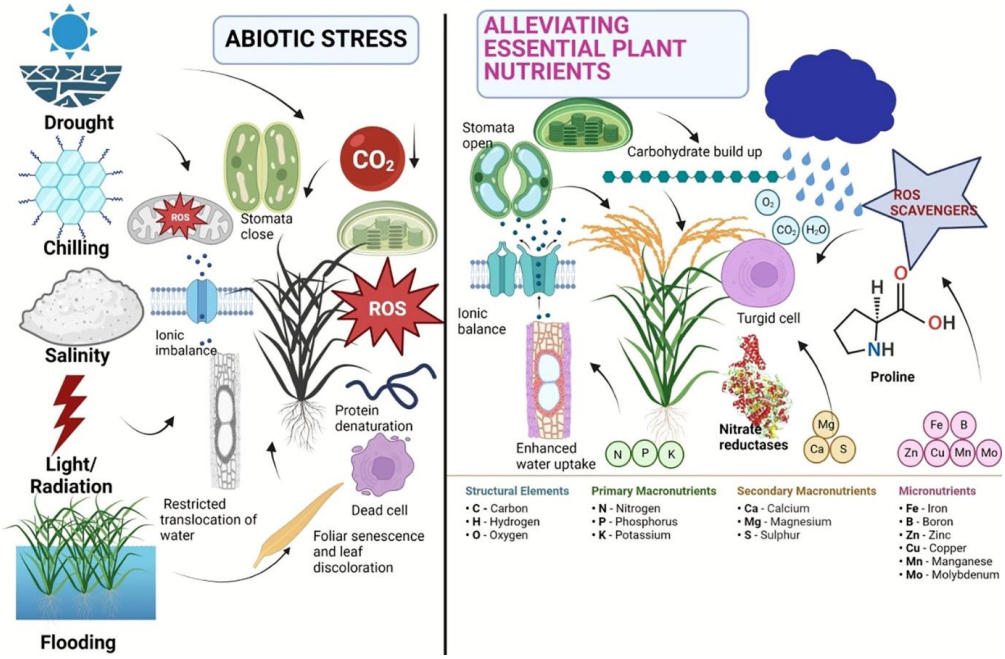

Figure 2. Negative impacts of abiotic stress and their alleviation using plant nutrients in plant. Source: Swain et al. (2023)

Nutrients in combination with phytohormones can also alleviate water-logging stress and temperature stress. For example, it is reported that application of boron can improves the activity of the antioxidant system significantly and which leads to nullify the toxic effects of ROS produced by heat stress.

Nano-fertilizers (NFs)

Nano-Fertilizers Mitigate Abiotic Stresses : The management of macro-micronutrients is a big task globally, as it relies predominantly on synthetic chemical fertilizers which may not be environmentally friendly for human beings and may be expensive for farmers. Nano-fertilizers (NFs) significantly improve soil quality and plant growth performance and enhance crop production with quality fruits/ grains. NFs may enhance nutrient uptake and plant production by regulating the availability of fertilizers in the rhizosphere; extend stress resistance by improving nutritional capacity; and increase plant defense mechanisms. They may also substitute for synthetic fertilizers for sustainable agriculture, being found more suitable for stimulation of plant development. They are associated with mitigating environmental stresses and enhancing tolerance abilities under adverse atmospheric eco-variables. Recent trends in NFs explored relevant agri-technology to fill the gaps and assure long-term beneficial agriculture strategies to safeguard food security globally. Nano fertilizers increase the phyto-availability of nutrients because of their highest surface area, small size and high reactivity, which results in better growth of plants under abiotic stresses (Verma et al., 2022).

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FROM FIELD TO SKY: THE INTEGRATION OF DRONES IN MODERN AGRICULTURAL PRACTICES

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The challenge of global agriculture is to meet demand of rapidly growing population, which is predicted to approximately nine billion around the year 2050. It is important to crystallize the innovative technologies in agriculture and subsequent modification as per local conditions for apt digestion to farm. The knitting of information and modern electronic technology with agricultural production system to determine, analyze and manage the critical temporal and spatial factors of farm for maximizing profitability, sustainability and environmental protection is need of hour. Enhancing yield and simultaneously minimizing fertilizer and pesticide applications, needs high resolution data of fields for micro-level application. Conventionally, agronomists estimate various crop parameters such as biomass and nitrogen concentration. Information and communication technologies (ICTS) are playing an increasing role in addressing problems faced by agriculture. One of the latest developments is the increase in the use of small, unmanned aerial vehicles (UAVS), commonly known as drones, for agriculture. Drones are remote controlled aircraft with no human pilot on-board. These have a huge potential in agriculture in supporting evidence-based planning and in spatial data collection. Despite some inherent limitations, these tools and technologies can provide valuable data that can then be used to influence policies and decisions.

Different types of drones used in Agriculture

1. Fixed-Wing Drones

Fixed-wing drones are a type of unmanned aerial vehicle (UAV) that resemble a miniature airplane. Unlike multi-rotor drones, they have a fixed-wing design that allows them to stay in the air for longer periods of time and cover more ground. Fixed-wing drones are commonly used in agriculture for mapping fields, monitoring crops, and identifying potential issues such as pests or irrigation problems. They are also used for surveying, mapping, and aerial photography. Due to their long flight time and ability to cover larger areas, fixed-wing drones are a popular choice for precision agriculture applications.

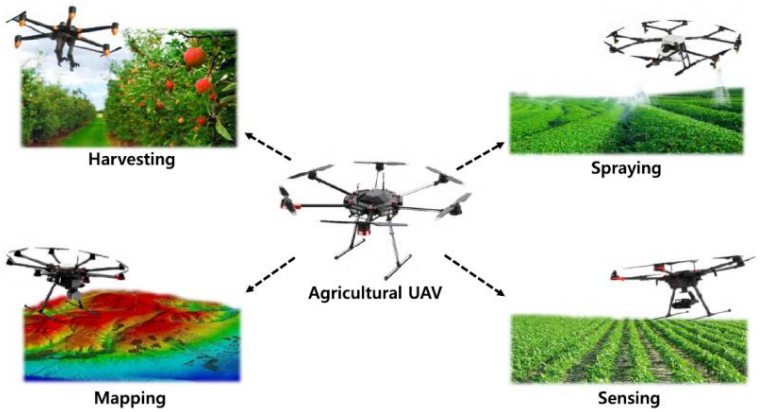
2. Single-Rotor Drones

Single-rotor drones, also known as helicopter drones, are unmanned aerial vehicles (UAVs) used in agriculture to capture high-quality images and data for crop mapping and analysis. Single-rotor drones are typically larger and more expensive than multi-rotor drones, but they offer longer flight times and the ability to carry heavier payloads, making them ideal for more advanced applications like precision agriculture. They are also equipped with advanced sensors and cameras to collect data on crop health, soil conditions, and other environmental factors. Overall, single-rotor drones are a valuable tool for farmers and agricultural researchers looking to improve crop yields and efficiency, as well as reduce costs and environmental impact.

3. Multi-Rotor Drones

Multi-rotor drones are a popular type of drone used in agriculture, consisting of multiple rotors mounted on the body of the drone. These drones are highly manoeuvrable and can fly in any direction, making them ideal for close-range operations. Multi-rotor drones are often used for mapping and surveying large agricultural areas, providing high-resolution aerial imagery that can

be used to identify crop health, detect irrigation issues, and monitor pest and disease outbreaks. They can also be equipped with advanced sensors such as thermal cameras to detect temperature variations in crops, helping farmers to detect stress in plants and adjust irrigation and fertilization accordingly. Multi-rotor drones have the advantage of being able to hover in place, which allows for more precise data collection and monitoring. However, they have shorter flight times and lower ranges compared to fixed-wing drones, which can limit their utility in larger agricultural operations.



(Source: Islam *et al*., 2021)

Applications of Drones in Agriculture

Drone technology quickly re-establishes traditional agrarian practices and is subsequently accomplishing them as follows:

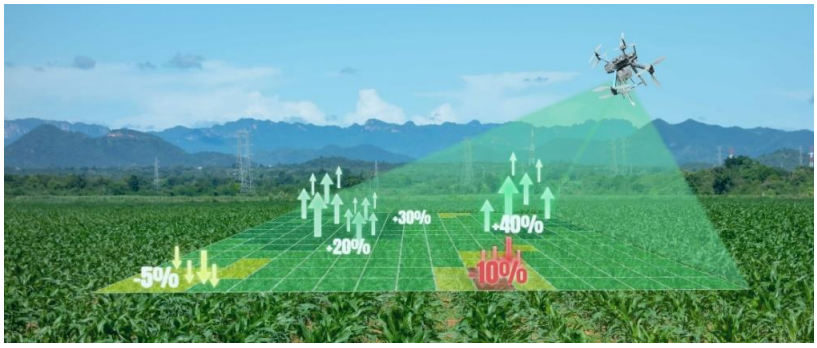
1. Irrigation Monitoring

Drones, including hyperspectral, thermal, or multispectral sensors, recognize areas that are too dry or need improvement by the farmer. Drone survey helps improve water efficiency and disclose potential pooling/leaks in irrigation by providing irrigation monitoring yields calculations of the vegetation index to help realize the health of crops and emitted heat/energy.

2. Crop Health Monitoring and Surveillance

It is crucial to track the health of the vegetation and spot bacterial/fungal plagues in the early stages. Agriculture drones can see which plants reflect different amounts of green light and Near-infrared spectroscopy (NIRS) light. This data helps produce multispectral images to track crop health. Quick monitoring and discoveries of any defects can help save crops. In circumstances of crop failure, the farmer can also document the damages for accurate insurance claims.

3. Crop Damage Assessment



Crop damage assessment

Agricultural drones fitted along with multispectral sensors and RGB sensors also detect field areas inflicted by weeds, infections, and pests. According to this data, the exact amounts of chemicals needed to fight these infestations are known, and this helps diminish the costs inflicted by the farmer.

4. Field Soil Analysis

The drone survey allows farmers to obtain information about their land's soil conditions. Multispectral sensors allow seizing data useful for seed planting patterns, thorough field soil analysis, irrigation, and nitrogen-level management. Precise Photogrammetry/ 3D mapping permits farmers to analyze their soil conditions thoroughly.

5. Planting

Drone start-ups in India have invented drone-planting systems that allow drones to shoot pods, their seeds, and crucial nutrients into the soil. This technology doesn't only reduce costs by almost 85% but also increases consistency and efficiency.

6. Agricultural spraying

Pesticides spraying

Through drone crop spraying, human contact with such harmful chemicals is limited. Agri-drones can carry out this task much quicker than vehicles/airplanes. Drones with RGB sensors and multispectral sensors can precisely identify and treat problematic areas. Professionals say that aerial spraying is five times faster with drones when compared to other methods. Aerial spraying by drone can complete at five-time faster rate than traditional spraying (**Hensh *et al.,* 2018**).

7. Livestock tracking

The drone survey allows the farmers not to keep track of their crops only but also monitor the movements of their cattle. Thermal sensor technology helps find lost animals and detect an injury or sickness. Drones can carry out this function favourably, and this adds comprehensively to the production of vegetation.

Benefits of Drone Technology

As innovators introduce new technologies, their commercial uses increase day by day. The government has been easing restrictions for drone usage and is supporting startups to come up with novel ideas. As drone surveys become more common, they also become more cost-effective. In agriculture, they have a plethora of advantages. Some are as follows:

1. **Enhanced Production** : The farmer can improve production capabilities through comprehensive irrigation planning, adequate monitoring of crop health, increased knowledge about soil health, and adaptation to environmental changes.

2. **Effective and Adaptive Techniques :** Drone usage results in regular updates to farmers about their crops and helps develop strengthened farming techniques. They can adapt to weather conditions and allocate resources without any wastage.
3. **Greater safety of farmers** : It is safer and more convenient for farmers to use drones to spray pesticides in terrains challenging to reach, infected areas, taller crops, and power lines. It also helps farmers prevent spraying the crops, which leads to less pollution and chemicals in the soil.
4. **10x faster data for quick decision-making :** Drone surveys back farmers with accurate data processing that encourages them to make quick and mindful decisions without second-guessing, allowing farmers to save the time invested in crop scouting. Various sensors of the drone enable capturing and analyzing data from the entire field. The data can focus on problematic areas such as infected crops/unhealthy crops, different colored crops, moisture levels, etc. The drone can be fixed with several sensors for other crops, allowing a more accurate and diverse crop management system.
5. **Less wastage of resources** : Agri-drones enables optimum usage of all resources such as fertilizer, water, seeds, and pesticides.
6. **99% Accuracy rate** : The drone survey helps farmers calculate the precise land size, segment the various crops, and indulge in soil mapping.
7. **Useful for Insurance claims :** Farmers use the data captured through drones to claim crop insurance in case of any damages. They even calculate risks/losses associated with the land while being insured.
8. **Evidence for insurance companies** : Agricultural insurance sectors use Agri-drones for efficient and trustworthy data. They capture the damages that have occurred for the right estimation of monetary payback to the farmers.

Conclusion

Drones have great potential to transform Indian agriculture. With the advancement of technology in the future, the production of drones is expected to become economical. Drones provide real-time and high quality aerial imagery compared to satellite imagery over agricultural areas. Also, applications for localizing weeds and diseases, determining soil properties, detecting vegetation differences and the production of accurate elevation models are currently possible with the help of drones. Therefore, drones may become part and parcel of agriculture in the future by helping farmers manage their fields and resources in a better and sustainable way.

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UNLOCKING THE POTENTIALITY OF PALMYRAH PALM: IMPORTANCE AND DIVERSE VALUE-ADDED PRODUCTS

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Abstract

The palmyrah palm is said to have vast economic importance because of its multiple uses for each part; hence, it is referred as 'Kalpaga tharu'. The palm is widely spread in the southern part of India and it remains as an underexploited crop in India. Value addition in Palmyrah by-products is not standardized and the products made from it, such as tuber flour, jaggery, nungu, wine and delicate fruit endosperm, haven't been commercialized yet. Even though palmyrah palm products are rich in nutritional aspects, they have not gained acceptable attention from agricultural researchers due to slow growth, long pre bearing and it is generally predominantly wild habitat in nature. Therefore, understanding its properties and developing value-added products is essential for its widespread, adoption and popularity.

Introduction

Palmyrah palm (*Borassus Flabellifer L*) is known as Kalpagatharu, toddy palm/sugar palm, belongs to plant family Arecaceae and is indigenous to Tropical Africa but grows extensively in the drier parts of India, Srilanka, Burma, Thailand, Vietnam, Malaysia and in parts of Indonesia. In India it beautifies the arid landscapes of Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, Bihar, Karnataka and Maharashtra in diverse geography, soil and climatic conditions of coastal belt and wastelands. India is having approximately 102 million palms, around half of them located in Tamil Nadu. In the year of 1978, Govt. of Tamil Nadu recognized it as the state tree of Tamil Nadu because of its significance. This palm is perennial, often reaching height of 30 m, dioecious in nature which produces male and female inflorescence on separate palm, fruit is drupe and normally 3 seeded. Traditionally all the part of the plant such as root, leaves, seed, fruit are used for various purpose, hence this palm is known as 'Tree of life'. This is a slow grower one, having long juvenility period, comes to flowering in about 13-15 years after, which is ready for tapping for neera or padaneer, a transparent, pleasant smelling and sweet sap from inflorescence.

Fig 1. Palmyarh palm

Neera (Poor man's beverage): It is sap extracted from the inflorescence of palms which is used as a drink. Neera contains 12-16 % sugar, essential amino acids, Vitamin C and B complex, hence it acts as good tonic for the asthma, anemia, leprosy, improves appetite and to cure digestive troubles. This neera is used for preparation of value added products after some processing. Yield of the neera on an average is 10-12 litres per day from each palm.

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Important value added products from neera:

Toddy: Toddy is produced through the uncontrolled fermentation of sap/neera by natural action of yeasts and bacteria on sap which is having alcohol content is approximately 5%. Sugars present in the partially fermented toddy are sucrose, glucose and fructose, which are gradually transformed into ethyl alcohol during fermentation. This drink is popular in India and Southeast Asian countries.

Fig-2: Fermented Neera

Palm Jaggery: Jaggery is made by gradual boiling of neera in a galvanized iron pan at 110˚C, which results in a solid mixture of reducing and non-reducing sugars. It is also called as palm gur.Production of one kilogram of jaggery requires about eight liters of neera. After processing, jaggery is darker and richer in colour, has an intense, slightly salty, earthy taste or reminiscent of chocolates in its taste. The composition of palm jaggery is moisture (8.97 %), ash (3.25 %), reducing sugar (3.41 %), and total sugars (73.87 %), protein (1.41%), organic matter (11.1%) and possess a vitamins like B_{12} and C. adequate amounts of Ca, low sodium, high potassium and high iron content which varies from 5 – 10 mg/100g palm gur. Palm jaggery fetches higher price in the market than jaggery that is made out of sugar cane due to its medicinal properties like to cure anemia, hypertension and oedema due to heart and liver diseases, diabetic acidosis and as a general diuretic.The eminent levels of sucrose and glucose support the utilization ofpalm gur as a beneficial energy source for individuals recovering from illness, particularly during the initial phase when easily available energy-providing food is needed.

Fig 3: Palm Jaggery

Palm sugar: Palm sugar acts as an alternative source to cane sugar. To prepare palm sugar, neera is being filtered with wire mesh to remove any debris or impurities, Subsequently neera is boiled uniformly in alloy vessel, it must be allowed to cool and remove the all the sediments from liquid. In order to achieve clarification, adding triple super phosphate which reacts with the lime which is already present, to form insoluble calcium phosphate. Following, it is boiled to a temperature of 110°C for 2 hours until liquid reach consistency similar to honey, later which it is allowed to cool and passes through a crystallizer which makes sugar crystals.

Palm tamarind candy: Neera is heated around a 2 hours until it reaches a consistency resembling honey. Then the syrup is transferred to mud pots and dry, ripe tamarind fruits without seeds, shell and fiber are added to mud pots which already contains a syrup in the ratio of 1 kilogram of fruit per 10 liters of syrup. Pots are tightly covered with cloth and stored in a cool, dry, and shock-proof environment for about 130 to 180 days. During this period, sugar crystals form on the sutures of the tamarind, which make fruits more delicious.

Palmyrah arrack: Pot still and patent still distillation are used to make arrack from toddy and around 10% of the potable alcohol can be recovered.

Fig 4: Palm wine

Palm Wine: To make palmyrah wine, Sap or padaneer with a pH 6-7, could be sterilized, fermented with inoculation of proper amount of wine yeast. This method of preparing wine yields clear straw coloured wine, devoid of the distinct toddy

flavour and sour taste of the acids present in toddy. Palm wine contains a high content of amino acid, potassium, zinc and iron.

Palm cola: Palm cola is an aerated soft drink having 11% sugar with other ingredients are cola concentrate, citric acid and food color. It is prepared by, mixing palm sugar with mik, boiling to a temperature of 110-115°C. Boiling stops when the mixture reaches a 53 brix, followed by filtering with filter press. Cola essence is added to a cooled mixture of about 250ml/1000bottles of palm cola. Later carbonated with Carbon dioxide and sterilized water, filled into bottles. Approximately 1 kg of purified palm sugar is required to produce 300 bottles of palm cola.

Palm pickle: The tender fruit of palmyrah is called as nungu, used as a pickle in vinegar. These fruits are rich in delicious, rich in carbohydrates, Phosphorous, iron, vitamin B and C.

Value addition from non-edible products

Palmyrah leaves: Tender Palmyrah leaves are in ivory colour that can be used for making toys, flowers, garlands and fancy goods. Whereas matured leaves are utilized for making of containers and brooms.

Palmyrah fibre: Fibre is extracted from leaf stalk which is having good export potential in countries like Australia, United Kingdom and Japan. It is having many industrial applications due to its high tensile strength. Naar is the fibrous material obtained from stalk of the fronds. Karukku are longitudinal splits obtained by soaking the stalks in water after discarding the sharp serrated edges of the petiole and they serve for tying purposes.

Palmyrah timber: Palmyrah timber is generally used for the construction of houses in the villages, as rafters and beams and also used as fire wood.

Conclusion

Palmyrah palm plays a significant role in human life as every part of the tree is utilized in one or the other way and having many health benefits. However, everyone is not aware of this tree's potential. Hence, it is necessary to create awareness about palm and its value added products. Value addition is modifying the physical form of agricultural products to raise their acceptability, availability and market viability and also increasing the cost-benefit ratio for the producers. To strengthen agriculture's resilience in India is the introduction of new species into agricultural production system. In this context, Palmyrah palm is one such under exploited crop which is having both fresh form and value added form of food and has the ability to overcome the problem of malnutrition in developing countries. It helps to generates income, improve food security to the small and marginal farmers.

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VEGETABLE VARIETIES FROM SKUAST- JAMMU, CHATHA

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Vegetable demand is rising rapidly as the value of these foods becomes more widely recognized for ensuring nutritional security. But it is not practicable to increase the agriculture area proportionately because of the growing population. Increasing productivity is the means to keep up with this growing demand. To satisfy the increasing demand and diversify the selection of vegetables, it is imperative to develop superior vegetable varieties. Accordingly, the Sher-e-Kashmir University of Agricultural Sciences and Technology-Jammu, Chatha has been continuously employed in the development of enhanced varieties for a range of vegetable crops. These efforts aim to not only meet the rising demand for vegetables but also to ensure the availability of nutritious and high-quality produce for consumers. Through ongoing research and breeding programs, SKUAST-Jammu, Chatha is committed to contributing to the sustainable production of vegetables and addressing the challenges posed by population growth and changing dietary preferences.

The Division of Vegetable Science under Faculty of Horticulture has developed and released a varieties of vegetables as highlighted below:

Knol-khol

G-40 (SJKK-01)	
Year of Released	2013
Parentage	White Vienna
Breeding Method	Mass selection
Production conditions	Transplanted crop
Recommended areas	Subtropical and mid hill zone
Duration	30-35 days
Average Yield	300-350 q/ha
Characteristics	✓ Possesses good globular flat knob with earliness to knob formation, sweet in taste and remain non-fibrous till marketable maturity (6-7.5 cm diameter) and erect leaf habit. ✓ Knob is less fibrous even at higher weight so suitable for pickle purpose. ✓ Short stalk length, smooth green leaves with erect plant type. ✓ An early maturing variety with 30 days to marketing. ✓ Round dark brown seed with test weight of 3-4 g. ✓ Tolerant to Alternaria blight, stalk rot, downy mildew diseases and cabbage butter fly and semiloopers. ✓ Fits well for seed production under sub-tropical conditions of Jammu

Broccoli

Jammu Broccoli (Early Green)	
Year of Released	2017
Parentage	Selection from KTS-1
Breeding Method	Individual plant selected
Production conditions	Transplanted crop
Recommended areas	Sub-tropical plain and mid hill conditions of Jammu region
Duration	150-160 days (seed to seed)
Average Yield	180-200 q/ha (curd), 5-6 q/ha (seed)
Characteristics	✓ Produces dark green coloured curds of the size of 120-140g and produces 7-8 lateral shoots of the size of 50-70g per plant after harvesting of main curd. ✓ Yield superiority of 22 per cent over the check (KTS-120) ✓ Upright plant type, dark green leaves with wavy margins and takes 22-24 days to 50% knob formation ✓ Ready for harvest after 75-80 days after Harvesting ✓ Seeds are brown in colour, round shaped with test weight of 12-15g ✓ Low chilling requirement. ✓ Ability to set quality seed under sub-tropical plains of Jammu

Coriander

Jammu Coriander-07(Khushboo)	
Year of Released	2017
Parentage	Selection from local germplasm collected from Marh (Jammu)
Breeding Method	Mass selection
Production conditions	Direct sown crop
Recommended areas	Subtropical and mid hill zones of Jammu
Duration	100-120 days (green leaves)
Average Yield	150-160 q/ha (green leaves), 10-15q/ha (seed)
Characteristics	✓ Semi spreading plant type ✓ Leaves are dark green and rich in fragrance/aroma ✓ Short duration, ready for first cut in 30 days ✓ Late bolting and multi-cut variety, 4-5 cuts in winter season ✓ First cutting 28-35 days after sowing and subsequent cutting 22-25 days after first cutting ✓ Round shaped light brown seed with test weight of 10-12g ✓ Yield advantage of 24 % over check ✓ Moderately resistance to Alternaria leaf spot, blight, viruses and aphids

Okra

Jammu Okra-08 (Seli Special)	
Year of Released	2017
Parentage	Varsha Uphaar x VRO-05 -01

Breeding Method	Hybridization
Production conditions	Direct sown crop
Recommended areas	Subtropical and mid hill zones of Jammu
Duration	40-45 days (seed to fruiting), 100-120 days (seed to seed)
Average Yield	120-150 q/ha (fruits),5-6 q/ha (seed)
Characteristics	✓ The fruits are dark green in colour, medium in size with high shelling percentage, table purpose, tender and straight ✓ Fruits remain tender 7 days after fruit set and comparatively less mucilaginous ✓ Medium tall (90-100 cm) with short inter nodal distance and profuse bearing ✓ Early maturing variety ✓ First flower appears at 3rd to 4th node making it early fruit bearing variety ✓ The plant bear 25-30 fruits with edible fruit length (17-20 cm), seed fruit length (17-20cm)and average fruit weight of 10-15 g ✓ 15% superiority over check (Pusasawani) ✓ Seeds are greenish, round shaped with test weight of 8-9g. ✓ Resistance to lodging, shattering and heavy response to fertilizers. ✓ Field resistant to yellow vein mosaic virus

Fenugreek

Jammu Methi-07 (Kasuri Supreme)	
Year of Released	2017
Parentage	Selection from local germplasms.
Breeding Method	Pure line selection
Production conditions	Direct sown crop
Recommended areas	Subtropical and intermediate zones of Jammu
Duration	100-120 days (vegetable crop), 190-210 days (seed crop)
Average Yield	200-250 q/ha(green leaves), 6-7 q/ha (seed)
Characteristics	✓ Dwarf variety with plant height of 25-30 cm and dark green, broad lobed leaves ✓ Plants are fragrant at flowering, fruits sickle shaped, leaves small and relatively less bitter ✓ Bushy type and ready for first cut after 30-35days of sowing ✓ Short duration, a multi-cut variety giving 4-5cuts in rabi season each at 25-30 days intervals and can left for seed production after 4 cuts ✓ Seeds are light yellowish brown colour, cuboid shaped with test weight of 1.60-1.75g ✓ Uniform and stable in reproduction through seed ✓ Performed consistently better over check. ✓ An alternative to the other popular varieties/Hybrids ✓ Yield advantage of 16% over check

	✓ Possesses field tolerance to Alternaria, Rhizoctonia and viruses

Spinach

Jammu Palak-07 (C-13)	
Year of Released	2017
Parentage	A selection from 13 diverse genotypes collected from different parts of the country
Breeding Method	Mass selection
Production conditions	Direct sown crop
Recommended areas	Subtropical and intermediate zones of Jammu
Duration	120-130 days (green leaves)
Average Yield	150-160 q/ha (green leaves), 8-10 q/ha (seed)
Characteristics	✓ Short duration, a multi-cut variety with smoothdark green semi erect leaves with entire margins and the plant type is erect with a plant height of 35-45 cm ✓ Is ready for first harvest after 25-30 days of sowingand subsequent cuts are taken after 20-25 days ✓ For green leaves, 4-5 cuts can be taken within aspan of 120–130 days ✓ Very high yielding strain performing consistentlyover the checks ✓ Seeds are light brown, lenticular shaped with testweight of 4-5g ✓ Good seed setting capability under Jammu plain ✓ 16 % yield superiority over check ✓ Moderately tolerant to blight and Aternaria leafSpot

Cherry Tomato

Jammu Cherry tomato-09 (SJCT-01)	
Year of Released	2017
Parentage	Selection from material selected from North Western Himalayan Region
Breeding Method	Single plant selection
Production conditions	Direct sown crop
Recommended areas	Subtropical and mill hill zone
Duration	170-210 days
Average Yield	300-350 q/ha (fruits), 60-70kg/ha (seed)
Characteristics	✓ Indeterminate type ✓ Plant height: 1.25 - 1.50 m (Under open condition) , 2:00-2.50 m (Under protected condition) ✓ Fruit colour: Red ✓ Number of clusters/plants: l5 - l8 ✓ Number of flowers/clusters: 8 – 1 ✓ Number of fruits/plants: 400 – 500

	✓ Average fruit weight: 5:0 - 7.0 g ✓ Average yield/plant: 1|5 - 2.0 kg ✓ Average fruit yield: 300-350 q/ha ✓ Hot set shows fruit setting at temperature between 35.0 - 40.01 ^{0}C and cold set showing fruiting at temperature 10 - l5 ^{0}C. ✓ Shows field resistance, to nematodes and moderately tolerant to fruit borer ✓ Moderately tolerant to Alternaria leaf spot and blight

Broad Bean

SJBB-01/RK-01	
Year of Released	2017
Parentage	Local collections from North Western Himalayan region
Breeding Method	Single plant selection
Production conditions	Direct sown crop
Recommended areas	Subtropical and mill hill zone
Duration	120-140 days
Average Yield	50-100q/ha, 60-70q/ha (seed)
Characteristics	✓ Plant height 150-160cm ✓ No. of pods per plant 75-80 ✓ Pod length 5-6cm ✓ No. of seeds per pod 3-4 ✓ Average yield 80-100 q/ha ✓ The variety showed resistance to salinity and has the good ability to fix atmospheric nitrogen to the tune of 15-20 kg/ha. ✓ The variety can be an alternative to problematic soils with low fertility ✓ Shows field resistance to, Aphid and Leaf minor ✓ Moderately tolerant to Alternaria leaf spot and blight

Radish

Jammu Radish-45 (CR-45)	
Year of Released	2017
Parentage	Inbred developed out of cross between Japanese White x Local White
Breeding Method	Selection of chance transgants
Production conditions	Direct sown crop
Recommended areas	Subtropical and mill hill zone
Duration	40-50days
Average Yield	350q/ha, 6-8q/ha (seed)
Characteristics	✓ 20-25 leaves/roots ✓ Root shape tapering with no forking ✓ Root length 25-30 cm ✓ Root diameter 3-4 cm ✓ Root weight 200-250 g ✓ Root skin colour: Ivory white with no pithiness as maturity stage.

	✓ Elongate, non-branching stem, supporting compact auxiliary buds, semi erect leaf habit. ✓ The variety CR-45 IS tolerant to major diseases like Alternaria leaf spot and blight prevalent in the region ✓ Shows field resistance to, Aphid and Leaf minor ✓ Tolerant to major insect-pests like semi-loopers and cabbage caterpillars prevalent in the region.

Vegetable varieties from Skuast-Jammu, Chatha


Knol-khol (G-40)


Cherry Tomato (SJCT-01)


Fenugreek (Jammu Fenugreek-07)


Radish (CR-45)


Coriander (Jammu Coriander-07)


Spinach Beet (Jammu Spinach Beet-07)


Broccoli (Jammu Broccoli-07)


Broad Bean (RK-01)


Okra (Jammu Okra-05)

Source : Directorate of Research, Sher-e-Kashmir University of Agricultural Sciences& Technology of Jammu, Main Campus, Chatha- 180 009 (J&K).

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SCIENTIFIC CULTIVATION OF LENTIL : TO OVERCOME HIDDENHUNGER

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Abstract

Lentil (*Lens culinaris* Medik) is one of the oldest crop brought under cultivation by humans It is native to Mediterranean region & South western Asia Lentil can be a multipurpose crop as it con benefit humans as food & nutrition also acting as helping hand for animal feed & enhances soil fertility. Study of Scientific cultivation of Lentil can benefit farmers as it may increase production with same amount of input. Lentil can be eaten in a variety of raw, cooked and processed forms, it is excellent source of protein, vitamins, fibre& micronutrients like iron, zinc, magnesium & folate. As it is such a nutritious food, it is best tool to Fight against malnutrition. One of the practical ways to address widespread deficiencies of zinc & iron in humans is to bio-fortify pulse crops like lentil with those elements.

Introduction

Among the first few crops that humans have introduced to cultivation, lentil is one of the major pulse. Asia continues to be the primary producer, consumer & importer of lentils, with India being the most significant nation in terms of production & consumption. Dal is the most common form of lentil consumption in the Indian subcontinent. Lentil is from Leguminosae or Fabaceae Family. Thus, it plays a vital function in crop rotation improves overall soil fertility status. Due to its great biological value & ease of being cooked, it is also referred to as a patient food. Total biological yield (except roots) can be used for cattle feed purpose.

Crop status

Estimated Area under cultivation of Lentil in the world is around 4.34 million ha. While production is around 4.95 million tonnes, having productivity of 1260 kg/hectare. Globally Canada is leading cultivator of Lentil followed by India.

In India, in 2022, area under Lentil cultivation was around 1.42 million ha production was 1.28 million tones the other hand having productivity of 904 kg/hectare. In 2022 Uttar Pradesh was highest yield producing state in India. In 0.49 million ha area, production of 0.47 million tonnes. Total contribution of Uttar Pradesh in Lentil production in India was about 36.4% Second leading State in India is Madhya Pradesh with 0.49 million hectare area under lentil cultivation & 0.44 million tonnes of yield.

- **Nutritional Value (per 100gm):**

Energy	346 KCal
Protein	27.2 grams
Fats	1.0 gram
Carbohydrate	60 grams
Total dietary Fiber	11.5%

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Table 1- Source: Pulses for Human Health and Nutrition, Indian Institute of Pulse Research.

•**Vitamins (per 100 gm)**

Vitamin	Content
Thiamine	0.8mg
Riboflavin	0.2mg
Niacin	2.9mg
Pantothenic acid	2.12mg
Vitamin B6	0.54mg
Folate	479 ug
vitamin C	44 mg
Vitamin E	0.3 mg

Table 2- Source: Pulses for Human Health and Nutrition, Indian Institute of Pulse Research.

•**Mineral content (per 100gm dry weight)**

Minerals	Mineral content
Iron	7.5 mg
Zinc	4.7 mg
Calcium	56 mg
Magnesium	122 mg
Potassium	955mg
Sodium	6mg
Selenium	8.2 mg

Table 3- Source: Pulses for Human Health and Nutrition, Indian Institute of Pulse Research.

• Some Important Minerals and its use in Human body-

1)Iron-Make Haemoglobin- Protein in red blood cells which carries O_2 from lungs to all parts of body.Myoglobin- Protein which provides O_2 to muscles.

2)Calcium-Carry messages from brain to body & body to brain and to build stronger bones.

3)Zinc- Acts as helping hand for immune system to fight against incoming bacteria & viruses and is responsible for proper sense of taste.

• **Variety selection:-**
1)Rust Resistance & wilt tolerant- DPL-15 (Priya),DPL -62 (Sheri)
2)Rust & wilt tolerant- IPL-81 (Noori),IPL-406(Angoori),IPL-526
3)wilt & Rust resistance- IPL-316,IPL 225, IPL-329
4)Early Maturing- IPL-534 (crop duration- 100-107 days)(Resistant to rust, wilt & stem Phylum blight)
5)Biofortified variety- IPL-220 (Fe- 94mg/kg) (Zn- 57mg/kg)(Zinc & iron)

•**Soil & Climate Requirement :**Deep Sandy loam soil with neutral pH& gooddrainage is considered to be very good for lentil cultivation. Acidic soil is not suitable for lentil cultivation.With respect to the climate, Lentil requires cold climate for its vegetative growth & warm climate (temperature) at reproductive growth & as well as maturity.

•**Field preparation:** One deep ploughing & 2 to 3 harrowing should be done followed by plank levelling. To facilitate irrigation a mild slope should be given.

•**Seed treatment:**
Fungicide- Thiram @3g or Carbendazim @2.5 g or Thiram (2g) + Carbendazim (1g) /kg of seed.
ii)Insecticide- chlorpyriphos 20%EC @8ml/kg of seed.
iii)Culture- Rhizobium +PSB (250gm/10kg)

• **Sowing:-**1)Sowing time:-
I) Rainfed condition - First fortnight of October. (South & central India)
Second fortnight of October. (North India)
II) Irrigated condition - First fortnight of November.
2) Seed rate:-Seed rate for lentil (Bold lentil seeds) is 45-60 kg/hectare.
For small seeded variety 40-45 kg/hectare.
In case of Late sowing around 50-60kg/hectare seed should be sown.
3) Spacing & Depth of Sowing:-
i)Ideal Spacing in row planting- 30cm x10cm ii)Ideal depth of sowing- 3-4 cm

•**Water Requirement:**
Light irrigation should be given at 40-45 DAS if rain is not in schedule in cold climate.Timely irrigation at Pod-formation stage gives moderate increase in yield.

•**Nutrient Requirement:**
Recommended dose of fertilizer for Lentil Crop is20kg nitrogen 40 kg phosphorus 20kg k & 20kgs potassium per hectare should be applied as a basal dose.

If Soil has Sulphur deficiency which is diagnosed by soil testing then the Sulphur dose should be at 40kg S per hectare. Basal dose as well as Foliar sprays should be the dream combination for lentil for its better growth and yield. Foliar spray of B@ 0.2% & Fe @0.5% is seen to be super effective.

•**Weed Management:**
A weed-free environment is necessity for at least first 45-60 days for lentil crop to do so pendimethalin 30% EC @ 0.75-1kg ai per hectare is used as pre-emergence spray immediately after sowing. Followed by 2 weedings at 25-30 DAS & 45-50 DAS to keep nutrient flow to the crop plants.

•**Plant protection:-**

- **Disease**

I) Seedling Mortality- •Symptoms-It is a fungal disease. Seedling First turn yellow & then dries up This happens within the first month of sowing lentil.
• control measures-
1) Use of resistant varieties (Pant L-406)
2) Seed treatment with Systemic Fungicide Carbendazim @2.5 g/kg of seed

II) wilt •Symptoms- Plant growth is checked, leaves start yellowing plant drying Starts, drooping & wilting of uppermost leaflets. Plant becomes completely yellow & dies.
•Control Measures-
1) Clean cultivation of field can reduce wilt incidence
2)Use of tolerant & resistant varieties like IPL-316, RVL-31, IPL-225
3) Max disease control was obtained by Metalaxyl (8%)+ 2.5gm/kg Mancozeb (64%) + neem leaf extracts (5%) + Tricoderma viridae (82.76%)

III) Rust- •Symptoms-Yellowish pustules on leaflets & pods. Light brown pustules on both surface of leaves and other aerial parts. Pustules finally turn dark brown.
• control measures-
1) Cultivation of resistant / tolerant varieties of Lentil like Pant L-6, Pant L-7, IPL-329, IPL-316.
2) Spray crop with Mancozeb 75wp 2g/Liter. i.e. 0.2% for total one to two sprays at 50 Days after sowing for controlling rust.

- **Pest-**

1) Aphid-Aphids are majorly responsible for Sucking away the cell Sap from plant body. If there is serious attack of aphids then plant growth may suppress.
• Control Measure-
Spray Dimethoate 30 EC @ 1.7ml/lit of water or spray Imidacloprid SL@0.2ml/lit of Water

2) Pod borer-Caterpillar damages young leaves & bores in to green pods & feeds on grains. In severe attack condition it damages almost all pods of a plant.
Control Measures-
1)Spray of Neem Seed KernalExtract (5%) i.e. 50ml/lit of water.
2) Spray of Emammectin benzoate 5 SG@ 0.2g/lit of water.

•Harvesting, Threshing & storage:-
Harvesting time for lentil is around end of Spring season. When leaves of lentil start to shed, stem & pods turn brown in colour.Harvesting could be done by both methods mechanically & manually. Around at 15% moisture in seeds is when the harvesting should take place. Then the harvested crop is dried on threshing floor for 4-7 days. Threshing done manually or with the help of thresher then the cleaned seeds obtained after winnowing sundried for 3-4 days. Drying bring moisture percentage at 9-10% which is suitable for storage. For storage, desired bins should be used
I) for small seed quantity - Tin storage bins.II) for larger seed quantity - Scientific storage facilities.
•In small seed quantity storage use of neem leaves should be done.

•Yield:-
Average yield of Lentil with proper management & Cultural practices is around 15-20 quintal grains/hectare.

•What is Malnutrition:-
Malnutrition is not only a deficiency or many deficiencies of nutrition, but also excess &

imbalance in nutrient intake of a person can be stated under Malnutrition.Malnutrition has majorly 3 groups-
i)Under nutrition ii) Micronutrient related malnutrition.iii) Overweight, obesity

•Micronutrient Malnutrition:- (AKA Hidden hunger)
When intake & absorption of vitamins and minerals are too low in a diet to maintain a good health is known as Micronutrient malnutrition.As food intake is completed, but micronutrients are not enough for proper body function then it is called as hidden hunger.

•Ways to overcome Hidden Hunger:-
1)Providing foods Fortified with micro-nutrients i.e. 'Bio-fortified food'-
Application of $ZnSO_4.7H_20$ (0.5%) + $FeSO_4.7H_20$ (0.5%) in lentil at pre-flowering stage will help to concentrate those minerals at the seeds. (sinks in plants)
2) Nutri-sensitive Agriculture-
Nutrition Sensitive agriculture can help reduce the gap between available nutrition (food) and required nutrition (food) for all population to be healthy.It should be done to farm or cultivate for the required nutrition in more quantity.

Conclusion
1)Increase in production, productivity by farmers with the knowledge of scientific cultivation.
2)Lentil as a weapon to fight against malnutrition as it contains Zn, Fe and protein in major amount.
3)Increase awareness about bio-fortified varieties like IPL-220(Fe & Zn biofortification)
4)Use of Nutri-sensitive agriculture to break free from hidden hunger.

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UTILIZATION OF PROBLEMATIC AND WASTE LANDS THROUGH AGRICULTURE

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Introduction

Waste lands are basically areas that are left unused or not being used to its full potential due to various complications. It is broadly divided as non-cultivable (snow covered, glacial or barren outcrops) and cultivable wastelands as the former cannot be put to any productive use but the latter can be reclaimed and again made useful. The contemporary issues such as over-population and disparity in the production and supply of food produce can becurbed to a certain extent if proper efforts are carried out to convert these barren lands into fertile fields without compromising on the health of the environment.

Causes of Land Degradation

- Soil Erosion
- Deforestation
- Intensive agriculture
- Mining

Types of Problematic and Wastelands

1. Water eroded lands: This is the most widespread form of wasteland, especially in all agroclimatic zones of India. Water causes the complete displacement of top soil or even terrain deformation through different types of erosion like splash, sheet, rill and gully erosion.

2. Wind eroded lands: This type of land is formed by the transfer of soil particles by the action of wind. Rate of wind erosion is dependent on wind velocity, soil characteristicsand land use, accordingly it could be sheet erosion or it can carve out hollow terrain. In India, the effect of wind erosion is limited to the arid regions like Rajasthan and Gujarat.

3. Acid Soil: These lands are located in areas of heavy rainfall and excessive leaching of cations. This lowers the soil pH, which causes the availability of certain micronutrients to increase upto toxic levels and make nutrients like calcium, nitrogen, phosphorus unavailable.

4. Salt-Affected Soil: These soils contain excessive amount of either soluble salts or exchangeable sodium, known as sodic soils. They severely inhibit crop yield, crop production, and degrade soil health. Observed in many swampy, marshy and waterlogged areas.

5. Physically Degraded land: It includes the barren rock, stony waste lands, mining and industrial wastelands, snow-covered, icecapped and waterlogged areas.

Utilization of Problematic and Wastelands:

Even though wastelands are a huge set backfor agriculture and environment they are not a permanent damage majority of times. By taking proper and timely decisions and reclamation of barren lands they can be utilized for farming or into mini-forests. Wasteland reclamation provides a source of income for the rural population in few years time. It supplies food, fodder and timber

for local use. Reclamation helps the environment by increasing soil fertility, green cover, reduces soil erosion and retains soil moisture.

1. Agro-forestry: It is the simultaneous planting of trees along with agricultural crops. The land is first conditioned with mulching or FYM and then forest species are planted either as rows or on the boundaries as wind breaks.

2. Forest Conservation: This is brought about by reinstating the soil biome and establishing an ecological balance. The most beneficial method is by planting tree species and perennial grasses that hold the soil together. Afforestation can be carried out by plant species such as *Suaeda salsa, Kalidium folium, Tetragonatetragonioides, Sesuviumportulacastrum, Arthrocnemum indicum, etc.*

3. Permaculture: Permaculture design is a system that ensures the permanent maintenance of agricultural fields, as well as their ecosystems. Simultaneously, this system provides to the people in the form of food, energy, and shelter in a very sustainable manner. The permaculture system needs to customized according to the, topography, sunlight orientation, water availability and drainage pattern. Generally, permaculture fields after its full-fledged operation does not require irrigation, tillage and application of fertilizers. An impressive permacultural initiative was started by Mr. Narsanna Koppula and his wife Mrs. Padmavathi Koppula inTelengana, India. Telenganasituated on the Deccan plateau lies in the rain shadow of the Western Ghats, hence it is hot and dry for majority of the year. Aranya farm was founded on a wasteland declared by the government. The plateau was severely eroded that the exposed soil surface was in fact the laterite bed rock. Mr. Narssanabegan by afforestation practices, followed by water conservation and composting of organic waste. Within 6 to 8 years itself there was a clear rise in the water table and currently hold a huge diversity of trees, perennial crops, flowers and domesticated animals.

4. Reclamation of Salt-affected soils: The moderately saline sodic soils are utilized by adding gypsum or by application of sulphur but this is more common in soils with high Sodium Adsorption Ratio (SAR) and high Exchangeable Sodium Percentage (ESR). For calcareous salt-affected soil FYM, green manuring and mulching is strongly recommended. Other effective methods are using a rice-berseem cropping pattern, cultivation of leguminous crops, raising Kallar grass (*Leptochloafusca*), etc.

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WAX MOTH: A NOTORIOUS LEPIDOPTERAN PEST OF HONEY BEE

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Abstract

Greater wax, *Galleria mellonella* is an important pest of honey bee. This article delves into a intricate relationship between the greater wax moths and honey bees, which highlights the various aspects of their interactions, viz., life cycle of wax moths, their feeding habits and the resultant damage inflicted upon honey bee colonies. Additionally, we have discussed the existing control measures and potential strategies for mitigating the detrimental effects of wax moth infestations and their practical applications in beekeeping management practices.

Introduction

The greather wax moth, *Galleria mellonella* L. is a lepidopteran insect pest belongs to the family Galleriidae. It is a pest of worth mentioning which causes damage to the *Apis* species (Kwadha et al., 2017). While it is uncommon at high altitudes in South India, it is frequently observed wreaking havoc in the plains and lower elevations. It is one of the most often noticed throughout the year, but from July to October and from November to December, it is more frequent and intense. All *Apis* species' combs are openly attacked. One of the most significant bee colony adversaries, it may do significant harm, especially to weak colonies when there are not enough bees to cover all the combs.

Beeswax combs may be swiftly destroyed by wax moth larvae since they are exceedingly destructive. In particular, combs that have held pollen and brood are targeted by them when they burrow through and devour them.Healthy, populous honey bee colonies do not tolerate wax moth larvae in the hive. Wax moth larvae can harm combs that are not covered and protected by bees in weaker colonies, but they are never the primary cause of colony collapse.

Distribution: The greater wax moths are distributed particularly in the warmer climate region of tropics and subtropical countries including India.

Biology: The life cycle consists of 4 stages viz., egg, larva, pupa and adult (Figure 1).

Egg: In microscopic crevices in the hive material or in clusters on comb, female moths typically lay 300 to 600 eggs. The almost spherical, pinkish to white eggs have a diameter of 0.5mm.When temperatures range from 29 to 35 degrees Celsius, the eggs hatch in 3 to 5 days. When the temperature is lower, hatching takes longer, starting around 30 days after egg laying at 18°C.

Larva: Larvae that have just hatched may go to nearby honey bee colonies. Newly hatched larvae may move more than 50 metres.When larvae reach their maximum growth, which can be up to 28 mm in length, they change from creamy white to grey. The tiny, extremely energetic larvae tunnel in comb after hatching. As they go from comb to comb across a sea of webbing, they coat their tunnels with silky web.

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Larvae of wax moths are highly active during warm weather but become dormant during the bitterly cold winter months. At 19 days after hatching, they complete full growth at the ideal temperature of about 32°C. The larval phase may last up to five months in colder climates and during periods of food scarcity.The propolis, pollen, and wax in the combs serve as food for the caterpillars, who reside in silken tunnels they have constructed. Wax fragments are loosened and fall into the cells and in the hive when they penetrate the wax layers. The first sign of an attack is the presence of loose, loosened particles in the hive. When the infestation is severe, the comb is observed coated in silken webs filled with a lot of black caterpillar faeces. Weaker colonies and exposed or partially covered combs are typically harmed. Under such situations, the bees leave the colony (Figure 2).

Pupa: The silky cocoons that fully grown larvae create may be seen in the comb as a mass of webbing as well as on the frames and internal surfaces of the hive. In order to spin their cocoons, larvae may create tiny depressions in the wooden hive components that resemble canoes. Moreover, larvae are able to pierce the wooden bars of frames. The pupal stage, which lasts for around 14 days when temperatures are high but up to two months when temperatures are lower, begins after the larvae spin the cocoon.

Adult: Mature moths are around 20mm long and light brown to grey in colour. When folded over the body, the grey wings, which are frequently speckled, take on the appearance of a roof or boat.The life cycle of the male and female can live up to 21 and 12 days. Adult moths mate after emerging, they do not feed for their life span.

Life cycle

a. Egg

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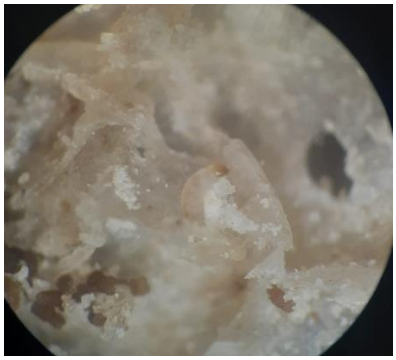

a. Larva

b. Pupal cocoon

c. Adult

d. Adult feeding the combs

Figure 1. Life stages of greater wax moth
(*Photograph by:Aman Kumar, LPU, Phagwara*)

Importance of the wax moth: Due to the fact that they naturally remove old combs once a colony abandons a hive or goes extinct, wax moths can have a significant positive impact on the environment. Yet, these moths may also invade apiaries and seriously harm colonies, hives, and the capacity for honey and comb production in general.

Figure 2: Symptoms of wax moth on honey bee frame
(*Photograph by Aman Kumar, LPU, Phagwara***)**

Management of greater wax moth:

Cultural methods : Preventive measures for management of greater wax moth are keeping the colony strong and healthy is one of the important methods to reduce the wax moth attack. The hive colonies should be free from other pest and diseases. The hygienic instinct of honey bee will kill the wax moth and keep the hive pest free.

Weak colonies should make strong by uniting two colonies.

Hive entrance should minimize and all the cracks and crevices should sealed to avoid entry of the moth and serve as egg laying site.

The damaged and infested combs should be exposed to sunlight.

There is no chemical recommended for control of wax moth application in living bee hive colonies. Management methods for reducing the greater wax moth is regularly inspecting every crevice of the hive and eliminating all debris, the moth may be managed.

Mechanical method:
Freeze the comb, let it defrost and dry in an area free of wax moths, and then store the frames in tightly closed bags. Some treatments are cold treatment andcarbon dioxide treatment.
Installing yellow sticky trap with the old comb on top cover of the bee hive can prevent the wax moth (Vijayakumar et al., 2019)

Physical method:
Keeping the empty combs and stored at low temperature (0 to – 10^{o} C).

Chemical method:
Fumigation of the empty combs can be done with sulphur powder @ 230g/m^3 (Anonymous, 2014). The spare should be kept in firmly closed containers in the storage areas.

Conclusion
In conclusion, the wax moth, *Galleria mellonella,*emeges as a formidable adversary to honey bee colonies, exerting considerable pressure on beekeeping endeavors worldwide. By deepening our understanding of the wax moth biology and its impact on heny bees, we can strive towards more resilient and thriving ecosystems with sustainable management practices.

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THE RISE OF THE EARTH'S SILENT HEROES: VERMICOMPOST'S JOURNEY TO AGRICULTURAL PROMINENCE

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Abstract
As worms break down organic waste, vermicompost is produced, which not only improves soil fertility but also helps to protect the environment. Enhancing soil structure, controlling pests and diseases, providing essential nutrients to plants, and increasing crop yield are all benefits of it. Because it is flexible, it may be used in a variety of farming environments, from urban gardening to small-scale organic farming. Redirecting organic waste from landfills, vermicomposting reduces reliance on synthetic fertilizers and helps manage greenhouse gas emissions while preserving soil. Its effectiveness in promoting environmentally friendly agriculture and conservation is being refined via ongoing research efforts.

Introduction

In the world of agriculture, a silent revolution is underway, led by a group of unsung heroes: worms. Vermicompost, the product of worms digesting organic matter, has emerged as a game-changer in sustainable farming practices. This article explores the transformative impact of vermicompost on agricultural systems, focusing on its benefits, applications, and potential for addressing contemporary environmental challenges.

Traditional farming methods have often relied on chemical fertilizers and pesticides, which can have detrimental effects on soil health, biodiversity, and human health (Chaudhary et al., 2004). In contrast, vermicompost offers a natural alternative that enriches soil fertility while minimizing environmental harm. The process enhances the bioavailability of basic nutrients by consuming raw nutrients and reproducing useful byproducts. Vermicast is also reported for having descended of growth-sufficient hormones i.e., ethylene, auxin, gibberellin, and enzymes i.e., cellulose, nitrogenase, Phosphatase, etc. These nutrients are produced during the passage of degradable mass through the gut of earthworms. In this article, the authors are presenting about vermicomposting and its frontline processes responsible for nutrient enrichment by earthworms.

The Science of Vermicompost

Vermicompost is created through the process of vermicomposting, where worms, typically species like ***Eisenia fetida*** or ***Lumbricus rubellus,*** break down organic waste materials into nutrient-rich compost. This decomposition process involves the ingestion and digestion of organic matter by earthworms, leading to the formation of vermicastings—nutrient-dense pellets that enhance soil structure and fertility. Mostly ***Eisenia fetida*** belonging to the phylum Annelida is used in these regions.It is a type of surface-born, waste-born, and fertilizer-maker and its inhabitants are mass manure, horticultural land with large quantities of organic material, etc. The intake and reproduction rate of food in these worms is high so these worms use the daily equivalent of half their weight of organic waste. Vermicomposting involvesthe degradation and stabilization of solid

organic waste frictions into fine organic-rich manure derived from the processing that can be efficiently reserved, handled, and integrated into fields without any negative impact.

Benefits of Vermicompost

The benefits of vermicompost are manifold. Firstly, it serves as a potent organic fertilizer, supplying essential nutrients such as nitrogen, phosphorus, and potassium to plants in a slow-release form. Additionally, vermicompost improves soil structure, promoting better water retention and aeration, thus mitigating issues like soil erosion and water runoff. Moreover, vermicompost acts as a natural biopesticide, suppressing plant diseases and pests through the release of beneficial microorganisms and enzymes.

(Fig-1: *Eisenia fetida*)

(Fig-2: Preparation of Vermicompost)

(Fig-3: Vermicompost applied in Cabbage field)

Applications in Agriculture

Vermicompost finds extensive applications across various agricultural sectors. From small-scale organic farms to large-scale commercial operations, farmers are increasingly incorporating vermicompost into their soil management practices. Its versatility allows for use in diverse cropping systems, including horticulture, viticulture, and sustainable forestry. Furthermore, vermicompost plays a crucial role in organic farming certification processes, as it aligns with principles of environmental stewardship and ecological sustainability.

Environmental Implications

In an era marked by concerns over climate change and environmental degradation, vermicompost offers a ray of hope. By reducing reliance on synthetic fertilizers and chemical inputs, vermicomposting contributes to soil conservation, carbon sequestration, and greenhouse gas mitigation. Moreover, the utilization of organic waste streams for vermicomposting helps divert valuable resources from landfills, thereby reducing methane emissions and promoting circular economy principles.

Challenges and Future Directions

Despite its numerous benefits, vermicomposting still faces challenges in terms of scalability, cost-effectiveness, and regulatory support. Addressing these hurdles requires interdisciplinary collaboration among researchers, policymakers, and agricultural practitioners. Moreover, continued research into optimizing vermicompost production techniques and exploring novel applications will be crucial for maximizing its potential in sustainable agriculture.

The Rise of Vermicompost:

Vermicompost, also known as worm castings or worm humus, is the product of decomposed organic matter digested by earthworms. Dating back to ancient civilizations, the use of

earthworms to improve soil fertility has been documented in various agricultural practices. However, it wasn't until recent decades that vermicomposting gained widespread recognition as a sustainable farming technique.

How Vermicompost Works:

The process of vermicomposting begins with earthworms consuming organic waste materials such as kitchen scraps, agricultural residues, and manure. As the earthworms digest this organic matter, they excrete nutrient-rich castings, which are teeming with beneficial microorganisms, enzymes, and plant nutrients. These castings are then collected and used as a potent fertilizer and soil conditioner.

Advantages of Vermicompost:

1. **Vermicompost** is renowned for its high nutrient content, including essential elements such as nitrogen, phosphorus, potassium, calcium, and magnesium. These nutrients are released slowly, providing a steady supply to plants and promoting healthy growth.
2. **Improved Soil Structure:** The humic substances present in vermicompost help improve soil structure by enhancing aggregation, aeration, and water retention. This results in better root development, increased water infiltration, and reduced soil erosion.
3. **Suppression of Plant Diseases:**Vermicompost contains beneficial microorganisms such as bacteria, fungi, and actinomycetes, which contribute to the suppression of soil-borne pathogens. This natural disease control mechanism reduces the need for chemical pesticides, promoting eco-friendly farming practices.
4. **Enhanced Plant Growth and Yield:**Studies have shown that the application of vermicompost leads to increased crop yields and improved quality of agricultural produce

Applications of Vermicompost:

1. **Crop Production:** Vermicompost can be used as a soil amendment for various crops, including fruits, vegetables, grains, and ornament dressing, incorporated into the soil, or used to prepare potting mixes for container gardening.
2. **Organic Farming:**Organic farmers favor vermicompost as a natural alternative to synthetic fertilizers and pesticides. Its compatibility with organic farming principles makes it an ideal choice for environmentally conscious growers seeking to minimize their ecological footprint(Lazcano and Domínguez, 2011).
3. **Urban Agriculture:**In urban areas where space is limited, vermicomposting offers a scalable solution for recycling organic waste and producing nutrient-rich compost for community gardens, rooftop farms, and urban green spaces.ental plants. It can be applied as a top. Back in ancient civilizations, the use of earthworms to improve soil fertility has been documented in various agricultural practices. However, it wasn't until recent decades that vermicomposting gained widespread recognition as a sustainable farming technique.

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4. **Enhanced Plant Growth and Yield:**Studies have shown that the application of vermicompost leads to increased crop yields and improved quality of agricultural produce.Its balanced nutrient profile and biologically active components stimulate plant growth, flowering, and fruiting, resulting in healthier and more resilient crops.

Conclusion

Vermicompost offers a natural, sustainable solution to improve soil fertility and promote eco-friendly farming practices. By harnessing the power of earthworms to convert organic waste into nutrient-rich compost, vermicomposting contributes to healthier soils, increased crop yields, and reduced environmental impact. Despite facing challenges, its benefits extend far beyond the farm, making it a promising tool for building resilience in agriculture and fostering a more sustainable future for our planet.

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