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Growing seed

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AGRIBOTS: ARCHITECTS OF THE AGRICULTURAL REVOLUTION

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In the vast expanse of agricultural landscapes, a silent revolution is unfolding, reshaping the very foundation of how we grow our food. At the heart of this transformation lie the architects of the agricultural revolution – agribots. These sophisticated machines, powered by advanced technology and artificial intelligence are composed to redefine the future of farming. From planting seeds to harvesting crops, agribots are revolutionizing every aspect of agriculture, promising increased efficiency, sustainability and productivity.

What are Agribots?

Agribots also known as agricultural robots or agri-robots, are autonomous or semi-autonomous machines designed to perform various tasks in agriculture. These tasks can range from planting and weeding to harvesting and monitoring crop health. Agribots utilize advanced technologies such as artificial intelligence, machine learning, sensors and robotics to carry out their functions with precision and efficiency. By introducing automation to farming, agribots reduce the need for manual labour and the time required for various agricultural activities, ultimately leading to increased efficiency and productivity in the farming business.

Types of Agribots

- **Flying Agribots:** Flying agribots, also known as agricultural drones or UAVs (Unmanned Aerial Vehicles), are aerial vehicles equipped with various sensors, cameras, and imaging technology. They are designed to fly over fields and gather valuable data on crop health, soil conditions, and other agricultural parameters. Flying agribots provide farmers with aerial imagery and data that can be used for crop monitoring, pest detection, irrigation management and yield prediction. They offer a cost-effective and efficient way to monitor large agricultural areas and make informed decisions to optimize crop production.

- **Field Agribots:** Field agribots, also referred to as ground-based agribots or field robots, operate directly on the ground and perform various tasks within the field. These robots are equipped with specialized tools and technology to carry out tasks such as planting, weeding, harvesting, and soil sampling. Field agribots can be autonomous or remotely controlled by farmers and are designed to navigate rough terrain and work in various weather conditions. They offer farmers increased efficiency, reduced labour costs, and improved crop management practices by automating labour-intensive tasks and providing precise and timely interventions.

Role of Agribots in Farming

- **Planting:** Agribots can autonomously plant seeds in fields with precision and efficiency. They are equipped with technology such as GPS and sensors to ensure accurate spacing and depth, optimizing seed placement for optimal growth.
- **Weeding:** Using advanced sensors and artificial intelligence, agribots can identify and remove weeds from fields without damaging crops. This reduces the need for manual labour and minimizes the use of herbicides, promoting sustainable farming practices.
- **Monitoring:** Agribots equipped with cameras, sensors, and other monitoring equipment can collect data on crop health, soil moisture levels, temperature, and other environmental factors in real-time. This data enables farmers to make informed decisions about irrigation, fertilization, and pest management.
- **Harvesting:** Robotic harvesters can autonomously harvest crops such as fruits, vegetables, and grains. These machines use computer vision to identify ripe produce and robotic arms to gently harvest them without damage, increasing efficiency and reducing labour costs.
- **Spraying:** Agribots equipped with sprayers can apply fertilizers, pesticides, and other chemicals to crops with precision and accuracy. By targeting specific areas of the field based on data collected from sensors and drones, these machines minimize chemical usage and environmental impact.
- **Pruning and Trimming:** Some agribots are designed to prune or trim plants to promote healthy growth and maximize yields. These machines use robotic arms and cutting tools to remove unwanted branches or foliage, improving overall crop quality.

- **Data Analysis:** Agribots collect large amounts of data on crop growth, soil conditions, weather patterns, and more. This data can be analysed using artificial intelligence and machine learning algorithms to identify trends, predict crop yields, and optimize farming practices for better outcomes.
- **Transportation:** Autonomous vehicles and drones can be used to transport crops, equipment, and other materials around the farm. This reduces the need for manual labour and increases efficiency in logistics and supply chain management.
- **Soil Preparation:** Agribots equipped with tillers or plows can prepare the soil for planting by breaking up compacted soil, incorporating organic matter, and creating seedbeds. They can also perform tasks such as levelling and contouring to optimize water distribution and soil health.
- **Seeding and Transplanting:** Agribots can accurately sow seeds or transplant seedlings into the soil at precise intervals and depths. This ensures uniform germination and plant spacing, leading to improved crop establishment and yield potential.
- **Thinning and Thinning:** During the early stages of crop growth, agribots can thin out crowded seedlings or plants to provide adequate space for optimal growth. This process helps reduce competition for resources such as water, nutrients, and sunlight, resulting in healthier plants and higher yields.
- **Pollination:** With the decline in natural pollinator populations, agribots are being developed to assist with pollination tasks. These robots mimic the behaviour of bees or other pollinators, transferring pollen between flowers to facilitate fertilization and fruit set in crops such as apples, almonds, and cherries.
- **Weather Monitoring:** Agribots equipped with weather stations or sensors can monitor meteorological conditions such as temperature, humidity, rainfall, and wind speed. This data helps farmers make informed decisions about crop management practices, irrigation scheduling, and risk mitigation strategies in response to changing weather patterns.
- **Livestock Management:** In addition to crop farming, agribots can assist with livestock management tasks such as feeding, herding, and monitoring animal health. Autonomous feeding systems, robotic milkers, and wearable sensors are examples of agribots used in animal agriculture to improve efficiency and animal welfare.
- **Post-Harvest Handling:** After crops are harvested, agribots can assist with post-harvest handling tasks such as sorting, grading, packing, and palletizing. These robots

help streamline the processing and packaging of agricultural products, reducing labour costs and improving product quality and consistency.

- **Waste Management:** Agribots can aid in waste management practices on farms by composting organic waste, recycling agricultural byproducts, and minimizing environmental pollution. Robotic compost turners, biomass digesters, and bioenergy systems are examples of agribots used to convert farm waste into valuable resources.
- **Remote Sensing and Mapping:** Agribots equipped with remote sensing technologies such as LiDAR (Light Detection and Ranging) and multispectral cameras can create high-resolution maps of farm fields. These maps provide valuable insights into soil variability, crop health, and yield potential, allowing farmers to implement site-specific management practices for optimal resource allocation.

By performing these diverse tasks, agribots contribute to increased efficiency, productivity, and sustainability in agriculture while reducing labour requirements and environmental impacts. As technology continues to advance, the potential applications of agribots in farming are limitless, offering innovative solutions to the challenges facing modern agriculture.

Conclusion

The rise of agribots represents a transformative shift in agriculture, ushering in an era of unprecedented efficiency, sustainability, and productivity. These advanced machines, equipped with cutting-edge technology and artificial intelligence, are revolutionizing every aspect of farming, from planting to harvesting and beyond. By automating labour-intensive tasks, optimizing resource management and minimizing environmental impact, agribots are empowering farmers to meet the challenges of feeding a growing global population while ensuring the long-term health of our planet. As we continue to innovate and integrate new technologies, the potential of agribots in farming is boundless, promising a future where agriculture is not just sustainable, but truly regenerative. In this silent revolution, agribots stand as the architects of a brighter and more resilient food system for generations to come.

References

Moundekar, D., Nakhate, P., Ghosh, S. and Kasetwar, A. R. (2020). Agricultural Robot (Agribot): A Future of Agriculture. *Agriculture International*, **6(4)**, 06-10.

Umarkar, S. and Karwankar, A. (2016). Automated seed sowing agribot using arduino. *In 2016 international conference on communication and signal processing (ICCSP)* IEEE.1379-1383.

Vimala, J. and Mahalakshmi, P. (2023). A Case Study of Selecting Suitable Agribots in Agri-Farming. In *International Conference on Computer Vision and Robotics*. Singapore: Springer Nature Singapore. 273-284.

Gowrishankar, V. and Venkatachalam, K. J. G. R. (2018). IoT based precision agriculture using Agribot. *Global Research and Development Journal for Engineering*, **3(5)**, 2455

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MULTIVARIATE TECHNIQUES FOR RESEARCH ANALYSIS IN PLANT BREEDING

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Plant breeding is a continuously evolving field. From the discovery of Mendel's laws of heredity to the development of gene-based markers, advances on analytical tools and emerging use of big data from trials, plant breeders have constantly utilized scientific breakthroughs to increase the rate of genetic gain and optimize breeding processes. Thus, multivariate analysis helps plant breeders in finding the pattern between variables, analysing the effects that different factors have on each other and the relationships between them. Multivariate data arise when a researcher takes measurements for two or more variables. Multivariate analysis offers a more complete examination of data by looking at all possible independent variables and their relationships with each other. In design and analysis, this technique is used to perform trade studies across multiple dimensions as multivariate techniques consider the effects of all variables on the responses of interest. The development of multivariate methods emerged to analyse large databases and increasingly complex datasets. Multivariate methods are designed to simultaneously analyse data sets. Always keeping in mind that all variables must be treated accurately reflect the reality of the problem addressed. There are different types of multivariate analysis and each one should be employed according to the type of variables to analyse: dependent, interdependence and structural methods.

Plant breeding is the purposeful manipulation of qualities in plants to create new varieties with a new set of desired characteristics. Multivariate techniques are the most common methods used for data analysis in plant breeding. Multivariate analysis is preferred over univariate analysis in plant breeding research studies because it can exploit correlated traits and environments. Genetic study based on the multivariate analysis is a powerful tool for determining the degree of divergence between populations, the relative contribution of different components to the total divergence and the nature of forces operating at different levels (Sanwal *et al*., 2015). In this article three main multivariate techniques used in plant breeding i.e. Principal Component Analysis (PCA), Factor Analysis (FA) and Discriminant Analysis will be discussed.

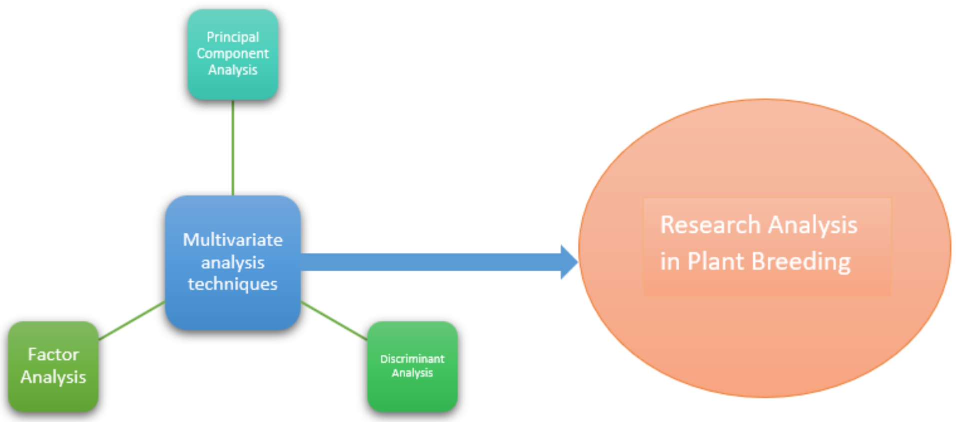

Figure 1

Discussion

I. Principal Component Analysis

A principal component analysis is concerned with explaining the variance-covariance structure of a set of variables through a few linear combinations of these variables. Its general objectives are data reduction and interpretation. Usually, p components are required to reproduce the total system variability, often much of this variability can be accounted for by a small number k of the principal components. If this is the case, k components give as much information as there is in the original p variables. The k principal components can then replace the initial p variables, and the original data set, consisting of n measurements on p variables, is finally reduced to a data set consisting of n measurements on k principal components. There is always a question of how many components to retain. There is no definite answer to this question. Things to consider while retaining principal components include the amount of total sample variance explained., the relative sizes of the eigen values and the subject-matter interpretations of the components. A useful aid to determine an appropriate number of principal components is a scree plot. With the eigen values ordered from largest to smallest, a scree plot is a plot of λ_i versus i- the magnitude of an eigen value versus its number. The number of principal components to be retained depends on the elbow (bend) in the scree plot.

In plant breeding, our objective is to construct uncorrelated linear combinations of the measured characteristics that account for much of the variation in the sample. The uncorrelated combinations with the largest variances will be called the sample principal components. In plant breeding, PCA is used to estimate the contribution of each trait for the total observed variations in the genotypes, identify the major traits accounting for the greater share in observed variations, focus on specific traits of interest for crop improvement, predict the breeding value of hybrids from the genetic divergence of their parents. Magudeeswari *et al.* (2019) conducted a study to evaluate the plant nutrient traits in 12 baby corn genotypes by using Principal Component Analysis and revealed that the first three principal components together accounted for 87.49 % of variability. Anandhinatchiar *et al.* (2023) studied the genetic diversity and genetic relationship among seed traits in ricebean and using PCA revealed that the traits viz., length breadth ratio, bulk density, hundred seed weight, seed volume, seed length and seed thickness contributed to the maximum genetic variability.

II. Factor Analysis

The purpose of factor analysis is to describe, if possible, the covariance relationships among many variables in terms of a few underlying, but unobservable, random quantities called factors. Suppose all variables within a particular group are highly correlated among themselves, but have relatively small correlations with variables in a different group. Then it is conceivable that each group of variables represents a single underlying construct, or factor, that is responsible for the observed correlations. Factor analysis can be considered as an extension of principal component analysis. Both can be viewed as attempts to approximate the covariance matrix $\sum$.

In plant breeding, factor analysis helps to reduce large number of variables into fewer number of factors and is a way to find hidden patterns and show what characteristics are seen in multiple patterns. It provides a way of explaining the observed variability in behaviour in terms of these traits. Filipovic *et al.* observed interrelationships of yield and yield components of 15 commercial maize hybrids using factor analysis and pointed out significant effect of two factors on grain yield.

III. Discriminant Analysis

Discriminate analysis is a multivariate technique concerned with separating distinct sets of objects and with allocating new objects to previously defined groups. Discriminant analysis is exploratory in nature, it is employed on a one-time basis to investigate observed differences when causal relationships are not well understood. To describe, either graphically or algebraically, the differential features of objects from several known collections, find "discriminants" whose numerical values are such that the collections are separated as much as possible.

In plant breeding, discriminant analysis measures the efficiency of various traits combinations in selection and provides information on yield components and thus aids indirect selection for genetic improvement of yield. Discriminant Analysis provides information on weight coefficient, general selection index and restricted selection index. Kanbar *et al* (2010) conducted a study to determine the effectiveness of discriminant analysis in recognizing deep rooted types of rice based on a few plant measurements.

Conclusion

Multivariate methods are ideal for the analysis of large data sets and to find the cause-and-effect relationships between variables. Multivariate statistical technique is a form of statistics encompassing the simultaneous observations and analysis of more than one statistical variable at a time. In this article we tried to clarify how multivariate statistical methods such as principal component analysis (PCA), factor analysis (FA), and discriminant can be used as methods to explain relationships among different variables and making decisions for future works with examples relating to the agriculture and plant science.

References

Anandhinatchiar S, Jayamani P, Kumaresan D, Bhuvaneswari K and Sudha M. (2023) Principal Component Analysis and Genetic Association of Seed Related Traits in an Underutilized Pulse Crop, Ricebean (*Vigna umbellata*). *Agricultural Science Digest* 10: 1-8.

Filipovic M, Babic M, Delic N, Bekavac G and Babic V. (2014) Determination relevant breeding criteria by the path and factor analysis in maize. *Genetika* 46(1): 49-58

Kanbar A, Motohashi T, Kondo K and Shashidhar G. (2010) Evaluation of discriminant analysis in identification of deep and shallow rooted plants in early segregating generation of rice (*Oryza sativa* L.) using single tiller approach. *Australian Journal of Basic and Applied Sciences* 4(8): 3909-3916.

Magudeeswari P, Sastry Divakara EV and Devi Renuka Th. (2019) Principal Component (PCA) and cluster analyses for plant nutrient traits in baby corn (*Zea mays* L.). *Indian Journal of Agricultural Research* 53(3): 353-357.

Sanwal S, Singh B, Singh V and Mann A. (2015) Multivariate analysis and its implication in breeding of desired plant type in garden pea (*Pisum sativum*). *The Indian Journal of Agricultural Sciences* 85(10): 1298-1302.

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COLONY ORGANIZATION AND SOCIAL BEHAVIOR OF HONEY BEES

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Honey bees are social insects and live in colonies consisting of different developmental stages such as eggs, larvae and pupae which are collectively known as brood. Among various insect orders, only 8 have been acknowledged by insect taxonomists for displaying communal life. Out of these 8 orders only Isoptera and Hymenoptera exhibit well developed social organization (Kalpana *et al.*, 2017). In the Hymenoptera order, specifically in the superfamily Apoidea, only two families, namely Halictidae and Apidae, contain fully social species. The majority of other bee species live solitary life (Mulatu and Gebissa, 2021).

The earliest evidence of this association is evident in rock paintings created by primitive humans. Thousands of years ago, Egyptians were well acquainted in bee keeping before the Christian Era. References to bees and honey are found in the Rigveda. The commercialization of beekeeping gained prominence during the 19th century as a result of scientific research (Grimaldi and Engel, 2005). Apiculture is now a flourishing industry in many advanced countries like USA, Australia, Germany and Canada.

Colonization of Honey Bee

A normal colony, during active season is composed of 3 kinds of individuals which may vary in size (Fig. 1).

Castes and Their Activities

1. Queen - only one; functional female
2. Workers - 20000-30000, sterile females
3. Drones - few only, functional males (prior to swarming).

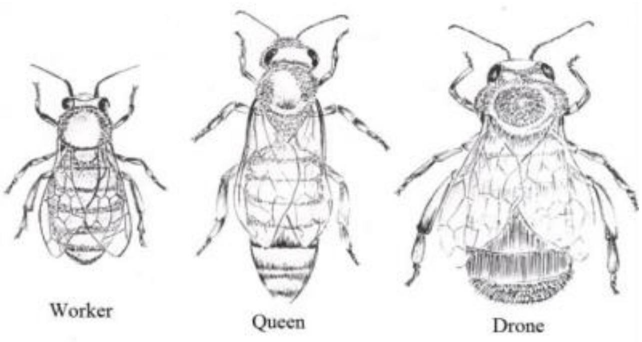

Fig.1: Different castes of honey bee
(Image source: J.K. Gupta; Apiculture, Agrimoon.com)

1. Queen Bee

- The queen bee is the only fully developed female with well developed ovaries and other organs of the female reproductive system.
- It is the largest in size.
- Wings are smaller and shriveled.
- Mouth part for sucking food is shorter compared to workers.
- The queen has no wax glands.
- She lives for about 3-4 years, laying eggs at the rate of 800-1500 per day.

Events in the life of queen bee:

Usually, around the age of 7-10 days within her parent hive, after the old queen along with some workers have departed to initiate another hive, the new virgin queen goes out for nuptial (marriage) flights. The drones from the same hive chase her during these flights. This swarm may also attract drones (male bees) from other hives. Mating occurs while flying, on an average, the queen mates with about six drones before returning to the hive. The sperms she acquires during these flights are sufficient for her entire reproductive life, and she never mates again. The queen has a control mechanism for releasing sperms from the spermatheca (sperm store). She can lay two types of eggs, fertilized and unfertilized.

2. Worker Bee

- Worker bees are imperfectly developed females and smaller than the queen.
- These have strong wings to fly for pollen and nectar collection.
- Workers have a large and efficient proboscis (mouth parts packed together like a thin tube) for sucking nectar.
- A well developed sting is present in abdomen.

- Pollen basket is present on hind legs for collecting pollen.
- Life span of worker is about 35 days.

Table 1: Different duties which they perform age wise are as follows:

S.No.	Age of Worker Bee	Duties performed
1.	Till 3rd day of emergence	Maintain wax cells in sanitary state, cleaning their floors and walls after the emergence of young bees.
2.	From 4th -6 th day of emergence	Feed older larvae with mixture of honey and pollen and flies around the hive for getting layout of the hive, (orientation flights)?
3.	From 7th -11th day of emergence	Hypopharyngeal glands (food glands) get developed and start secreting royal jelly and feed younger larvae.
4.	From 12th to 18th day	The bees develop wax glands and work on building of comb, construction of cells etc., Receive the nectar, pollen, water, propolis etc., from field gatherers, deposit in the comb cells and help in keeping the brood warm.
5.	From 18th to 20thday	Perform guard duty
6.	From 20th day onwards	The worker bees take the duty of field i.e. foraging for nectar and pollen, collecting propolis and water.

Foraging behavior of worker:

For foraging, some scout bees venture out in the morning. Upon finding good sources of nectar (i.e., flowers), they return to their hive and perform characteristic movements (bee dances) on the comb. These dances convey the distance and direction of the food source to other worker bees, leading to the deployment of more workers in food gathering. The workers visit flower to flower, collect nectar and pollen, and return to their nest, guided by the position of the sun as well as by certain amount of memory and the smell of their specific hive (Fig. 3).

3. Drone

Drones are male bees produced from unfertilized eggs. Their production in the hive synchronizes with the production of new (virgin) queens. At the age of 14-18 days, drones engage in mating flight, chasing the virgin queen in the air. Drones can live for about 60 days, although they are stung and killed after mating. The schematic representation of the formation of various castes of bees is shown in Fig. 2.

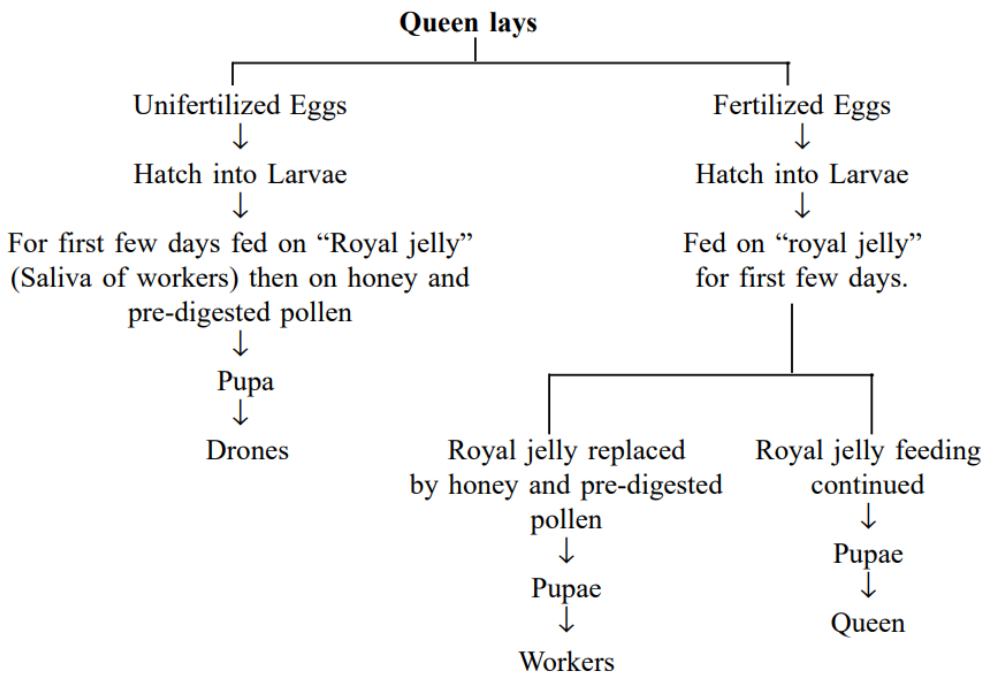

Fig. 2: Schematic representation of the formation of different castes in honeybee

Emergence of new Queen and Swarming of Other One

When the queen gets older, usually in the third year, her body releases a chemical stimulus to the workers to construct a few rearing cells for queens. She places one fertilized egg in each of these brood cells. Larvae are fed royal jelly (saliva of workers) and turn into the pupae and then queens. The first queen emerged from the brood cell, kills the remaining ones. The old queen then takes to swarming along with workers of all ages, leaves the old hive to develop a colony at a new site. The new queen in the old hive engages in a mating flight with the drones and returns to the same hive, as described earlier.

Social Behavior of Honey Bee

Honey bees are fully social insects, having an overlap of many generations within the same nest. The colony functions as a well organized social group with a division of labor, encompassing tasks such as egg laying, nursing, comb building, guarding, food collection with storage. Their communication system is highly developed, involving various types of dances and trophallaxis.

Biological Communication

It can be defined as an action by one organism that modifies the probability pattern of behavior in another organism in an adaptive manner. The term "adaptive" implies that both signaling and response are genetically programmed to some extent through natural selection.

Trophallaxis

This is a form of food transmission or exchange of food which is common between workers and also extends from workers to queen and drones. It serves as a means of communication regarding the availability of food and water, as well as a medium for the transfer of pheromones.

In honey bees, recruit communication is a crucial mode of communication which is defined as a communication that brings nest mates to a specific point in space where work is required. Dances performed by honey bees play a significant role in recruit communication.

Dances of Honey Bee

Father Spitzner, in 1788, was the first to describe bee dances as a method of communication among hive inhabitants, conveying information about the volume of honey flow and the location of nectar sources. These observations gained attention when Frisch (1920) published his findings. Karl von Frisch was awarded the Nobel Prize in 1973 (in Physiology & Medicine, shared with two other animal behaviorists) based on his work published in 1946.

Types of Dances

In honey bees, a portion of the foraging force (5-35%) functions as scout bees or searcher bees, covering considerable distances, with some traveling many kilometers. The average foraging radius of a colony is only a few hundred meters in agricultural areas and approximately 2 km in forested regions. Scouts communicate information about the distance, direction, and quality of flowers using different types of dances, leading to the recruitment of additional workers foraging on the best available sources.

Scout bees engage in two types of dances:

(1) Round dance

(2) Wag-tail dance

1. Round Dance:

This dance is executed when the food source is nearby (within 100 meters in the case of *Apis mellifera* and 10 meters in *Apis cerana*). The performing bee takes quick, short steps and moves around in narrow circles on the comb, alternating between right and left for several seconds. The dance excites the bees, prompting them to touch the performer with their antennae before leaving the hive to search for the food source. There is no indication of the food direction in this dance, and foragers explore within 100 meters in all directions, guided by the floral odor clinging to the hairy body of the scout bee and the sips of nectar they receive during the dance.

2. Wag-tail Dance:

This dance is performed when the food source is more than 100 meters away from the hive. The bee starts dancing on the comb, creating a half circle to one side, takes a sharp turn, and runs in a straight line to the starting point. It then completes another half circle in the opposite direction to form a full circle. The bee runs in a straight line to the starting point, making wiggling motions with her body during the straight run, hence the name "wag-tail dance". The location of the food is indicated by the direction of the straight run in relation to the line of gravity. If the food aligns with the sun, the bee wags its tail upwards, and if it is away from the sun, it performs downwards. When the food source is to the left of the sun, the bees dance at an angle counter clockwise to the line of gravity, whereas if it is to the right of the sun, the bees dance to the right of the line of gravity (Figure 3).

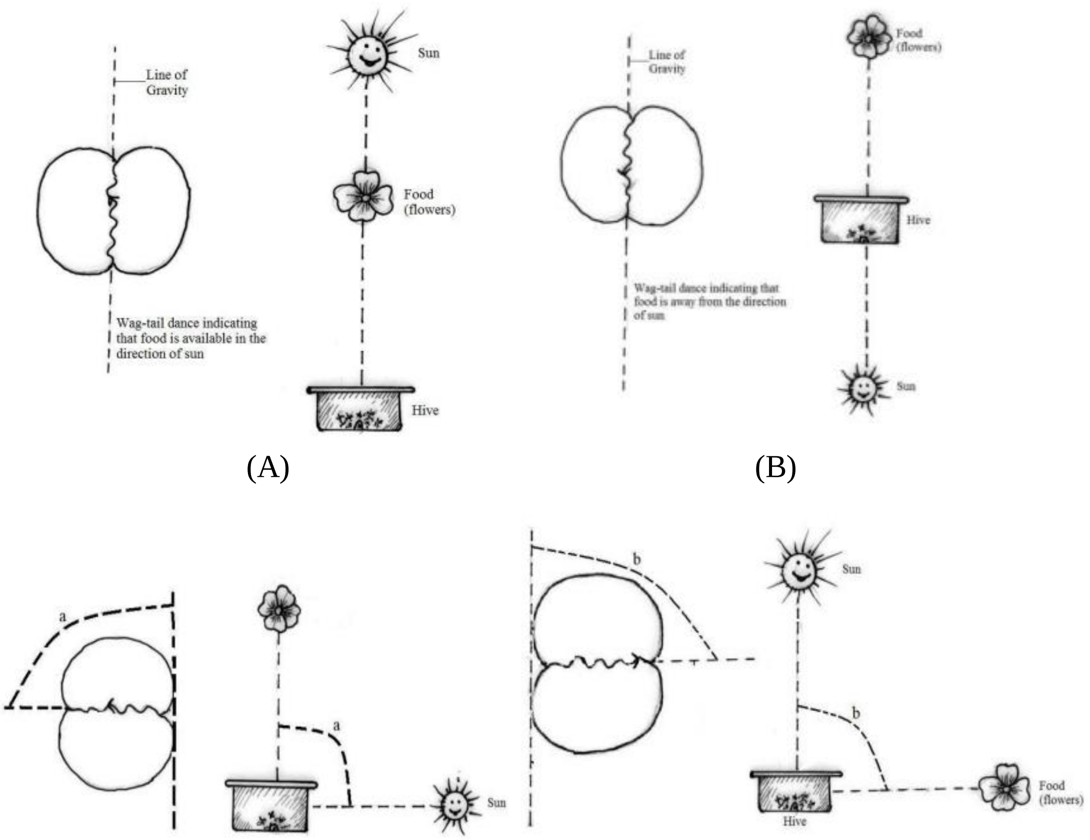

Fig. 3: Wag-tail dance in relation to direction of sun

(A). Direction indication in wag-tail dance when food is in the direction of sun

(B) Dance when food is away from direction of sun

(C). If food is to the left of the sun, bee dances at an angle counterclockwise to the line of gravity

(D). If food is to the right of the sun, bee dances to the right of the line of gravity

(Image source: J.K. Gupta; Apiculture, Agrimoon.com)

The distance is identified by the number of straight runs per 15 seconds as given below:

S. No.	Distance of food from hive (m)	No. of straight runs/15 sec.
1.	100	9-10
2.	600	7
3.	1000	4
4.	6000	2

Conclusion

Honeybee colonies remain active year-round and can be trained to pollinate specific crops. This training involves feeding the bees extracts of flowers from the target crop mixed with sugar syrup. As the bees become accustomed to the aroma of the crop, they visit the flowers, thus facilitating pollination.

Reference

Grimaldi, D. and Engel, M. S. (2005). Evolution of the Insects Cambridge University. Firers, pp 521.

Gupta J.K., Belavadi V.V. and Singh M. (2018). Apiculture, Agrimoon.com. PP: 14-22.

Kalpana, B., Mishra, V.K., Yadav, S.K. and Kumar, R. (2017). Efficacy of Some Essential Oils against The Greater Waxmmoth (Galleria mellonella L.) Under Storage Condition. *Environment & Ecology*, 35(4): 2760-2763.

Mulatu, W., & Gebissa, Y. (2021). Honeybee keeping constraints and future prospects, Cogent *Food & Agriculture*. 7:1, DOI: 10.1080/23311932.2021.1872192.

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HARNESSING FLY ASH IN AGRICULTURE

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The intensive use of coal for electrical power generation led to production of large amount of coal residue which needs to be disposed safely. Since coal residue has a variety of potentially hazardous heavy metals, improper disposal and management could have a much environmental impact. Coal residue is produced during the combustion of solid fuel and can be carried with the flue gas, which is called fly ash (FA) or deposited as a bottom ash (BA), flue gas desulfurization (FGD) gypsum and boiler slag (BS). Fly ash is that part of the ash stream composed of particles small enough (0.001 to 0.1 mm) to be carried from the boiler in the flue gas. These particles are either mechanically captured or emitted *via* the stack. Bottom ash and boiler slag are residues found in the furnace and are common to all types of coal combustion. Both materials generally have a particle size within the range of 0.1 to 10 mm. Coal combustion byproducts can be used in agriculture because of their special physical, chemical and biological properties. They contain almost all the nutrients necessary for proper plant growth and development. One of the important byproduct of coal combustion is fly ash which holds significant importance due to its versatile applications across various industries. Initially seen as a waste material, its potential for beneficial reuse has garnered attention globally. The importance of fly ash lies in its ability to address environmental challenges, enhance sustainability, and contribute to economic development.

What is Fly Ash?

- Fly ash is a fused residue of amorphous ferro-alumino silicate produced after combustion of coal at high temperature generated in thermal power plants, which transforms the clay minerals into a variety of fine spherical particles that rise with flue gases.
- Fly ash is a light coal dust coming out with the gases of coal-fired boilers

- It is a residue of burning of coal and lignite, the organic sources of energy

Applications of Fly Ash in Agriculture

Effect of Fly ash on Physical Properties of Soil

- Fly-ash application to sandy soil could permanently alter soil texture, increase microporosity and improves the water-holding capacity (Ghodrati *et al*., 1995; Page *et al*., 1979).
- The particle size range of fly-ash is similar to silt and changes the bulk density of soil. Thus, application of fly ash decreases bulk density of soil.
- Fly ash improves the soil structure, which in turn improves porosity, workability, root penetration and moisture-retention capacity of the soil (Kene *et al*., 1991).
- The Ca in fly-ash readily replaces Na at clay exchange sites and thereby enhances flocculation of soil clay particles, keeps the soils friable, enhances water penetration and allows roots to penetrate compact soil layers (Jala and Goyal, 2006).

Effect of Fly ash on Chemical Characteristics of Soil

- Lime in fly ash (FA) readily reacts with acidic components in soil and releases nutrients such as S, B and Mo in the form and amount which is beneficial to crop plants.
- Most of the fly-ash produced in India is alkaline in nature; hence, its application to agricultural soils increases the soil pH and thereby neutralizes acidic soils (Phung *et al*., 1978).
- Fly ash cause gradual increase in soil pH, conductivity, available phosphorus, organic carbon and organic matter.
- Fly ash is considered to be a rich source of Si

Table 1: Physico-chemical properties of Fly ash

Parameters	Content
pH	6.0-10.0
EC (µS m^{-1})	0.14
Bulk density (g cm^{-3})	0.99
WHC (%)	62.0
Surface area (m^2 gm^{-1})	0.96
N (%)	0.009
P (mg Kg^{-1})	19.02

K (mg Kg^{-1})	52.0
Mg (mg Kg^{-1})	101.5
Ca (mg Kg^{-1})	238.0

Effect of Fly ash on Biological Properties of Soil

Fly ash improves population of *Rhizobium* sp. and P-solubilizing bacteria

Advantages of Fly Ash Utilization

There are numerous advantages of fly ash utilization some of them are follows:

- Fly ash addition generally increases plant growth and nutrient uptake
- Use of fly-ash along with chemical fertilizers and organic materials in an integrated way can save chemical fertilizer as well as increase the fertilizer use efficiency
- Improves physical, chemical and biological properties of the soil
- Provide micro nutrients (Fe, Zn, Cu, Mo) and macro nutrients (K, P, Ca, etc.)
- Reduces the use of soil ameliorants fertilizers and lime
- It decreases the metal mobility and availability in soil
- Saving of space for disposal
- Saving of scare of natural resources
- Energy saving, firstly because the material is automatically produced as a byproduct and no energy is consumed for its generation and Secondly because it can replace material which otherwise would need to be produced by consuming energy
- Protection of environment, as in construction it can partly replace cement, production of which entails energy consumption and CO_2 emissions.

Conclusion

Fly ash can be used as a potential nutrient supplement for degraded soils thereby solving the solid waste disposal problem to some extent. However, the bioaccumulation of toxic heavy metals and their critical levels for human health in plant parts and soil should be investigated. An ultimate goal would be to utilize fly ash in degraded/marginal soils to such an extent as to achieve enhanced fertility without affecting the soil quality and minimizing the accumulation of toxic metals in plants below critical levels for human health. There are several potential beneficial and few harmful effects of fly ash application in soil.

References

Ghodrati, M., Sims, J. T. and Vasilas, B. S. (1995). Evaluation of fly ash as a soil amendment for the Atlantic coastal plain. I. Soil hydraulic properties and elemental leaching. *J. Water Soil Air Pollut*., 81, 349

Jala, S. and Goyal, D. (2006). Flyash as a soil ameliorant for improving crop production-a review. *Bioresour. Technol*., 97, 1136-1147.

Kene, D.R., Lanjewar, S. A. and Ingole, B. M. (1991). Effect of application of flyash on physico-chemical properties of soils. *J. Soils Crops*, 1, 11-18.

Page, A.L., Elseewi, A. A. and Straughan, I. R. (1979). Physical and chemical properties of fly ash from coal-fired power plants with reference to environmental impacts. *Residue Rev*., 71, 83-120.

Phung, H.T., Lund, L. J. and Page, A. L. (1978). Potential use of Fly Ash as a Liming Material. In: Environmental Chemistry and Cycling Processes, Adriano, D.C. and I.L. Brisbin (Eds.). US Department of Commerce, Springfield, VA, pp: 504-515.

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IMPACT OF HIGH TEMPERATURE ON PHYSIOLOGICAL TRAITS OF RICE

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Rice is the main cereal crop on which more than 50% of the livelihood is dependent. Besides it is also a primary source of caloric intake among majority of the population. Rice during its life cycle faces obstacles in form of both biotic as well as abiotic stress. Of the abiotic stress rise in temperature has become a primary concern keeping in view the global warming associated with climate change. The Intergovernmental Panel Change on Climate Change (IPCC) stated that there is more than 50% chance that global temperature rise will reach or surpass 1.5 degrees°C (2.7 degrees F) between 2021 and 2040 and under a high-emissions pathway, specifically, the world may hit this threshold even sooner — between 2018 and 2037.

Rice is a C-3 plant and is influenced by rise in temperature. Every stage of its life cycle is affected by increase in temperature however, it is the flowering and booting stage in particular which is highly sensitive to increase in ambient temperature. Increase in temperature affects the germination, tillering ability, leads to reduction in spikelet fertility, affects the grain filling and ultimately results in reduction of yield.

Impact of High Temperature on Physiological Traits

Cell membrane thermostability: Sustained function of cellular membranes under stress is pivotal for processes such as photosynthesis and respiration. The first impact of rise in temperature is alteration in the membrane permeability and its fluidity leading to electrolyte leakage. These are mainly due to changes in the lipid composition or interactions between lipids and specific membrane proteins. Heat stress accelerates the kinetic energy and movement of molecules across the membranes thereby loosening chemical bonds within molecules of biological membranes. This makes the lipid bilayer of biological membranes more fluid by either denaturation of proteins or an increase in unsaturated fatty acids (Savchenkoetal.,2002).

Chlorophyll fluorescence: Photosystem II indicates the overall photosynthetic efficiency of the plant and of all the components it is affected the most by high temperature stress by reduction in electron transport (Mathur et al, 2011). It is also considered as heat sensitive component of photosynthesis. Fv/Fm that indicates the PSII photochemistry is used as a selection criterion under heat stress condition. Apart from PSII, D1 and D2 proteins are also disrupted by heat stress.

Gas exchange traits: Exposure of plants to heat stress leads to structural alterations in chloroplast protein complexes, reduced activity of enzymes (Ahmad et al, 2010) as the enzymes involved in C3 cycle are inhibited even at lower levels of heat stress. All the gas exchange traits viz., photosynthetic rate, stomatal conductance, transpiration rate and intercellular CO_2 concentration are affected by heat stress. The most important and sensitive physiological phenomenon effected by high temperature stress is photosynthesis mainly due to the influence on the activity of Rubisco, the key enzyme for photosynthetic regulation.

Photosynthetic pigments: Chlorophyll is an important plant pigment involved in photosynthesis. Reduction in chlorophyll content under high temperature stress is due to the enhanced activity of chlorophyllase. The reduction in chlorophyll content can be either because of impaired biosynthesis or degradation of the pigment or both. This reduction may result in damage to the electron transport ultimately reducing the photosynthetic ability of plants. Apart from chlorophyll there are accessory pigments called carotenoids located in light harvesting complex that play an important role in light harvesting as well as photoprotection. These pigments are also affected with increase in temperature.

Grain filling: It is the most important process occurring in the rice grain and the rate of grain filling accompanied with duration decides the grain weight. This process is highly influenced by heat stress. Under low to moderate heat stress, a reduction in source and sink activities may occur leading to severe reductions in growth, economic yield and harvest index. Grains developed under high temperature appear chalky and have lower amylose content. High temperature at grain filling period affects the process thus resulting in reduction in seed set and weight and ultimately reduction in yield. The underlying reason may be due to diversion of photosynthates to cope up with heat stress instead of utilizing for the process of grain filling.

Conclusion

Rice is influenced by increase in temperature. High temperature exerts negative effect on plant growth and development and results in reduction of yield of the plant. Temperature is an external ambient factor which cannot be controlled. The IPCC predicts an increase in global temperatures over the coming years. Hence, to address this issue identification or development of tolerant rice varieties that can withstand high temperatures is the need of the hour.

References

Savchenko, G. E., Klyuchareva, E. A., Abrabchik, L. M., Serdyuchenko, E. V., (2002) Effect of periodic heat shock on the membrane system of etioplasts. *Russ. J. Plant Physiol*. 49,349–359.

Mathur S, Jajoo A, Mehta P, Bharti S. (2011) Analysis of elevated temperature induced inhibition of photosystem II using chlorophyll a fluorescence induction kinetics in wheat leaves (*Triticum aestivum*). *Plnt Biol*, 13 (1): 1-6.

Ahamed K U, Nahar K, Fujita M, Hasanuzzaman, M. (2010) Variation in plant growth, tiller dynamics and yield components of wheat (Triticum aestivum L.) due to high temperature stress. *Adv Agric Bot*, 2: 213-224.

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THE ROLE OF NANOTECHNOLOGY IN AGRICULTURE: A PATH TO SUSTAINABLE FARMING

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This abstract explores the transformative potential of nanotechnology in agriculture, presenting it as a pathway towards sustainable farming practices. With global food security facing unprecedented challenges due to population growth, climate change, and unsustainable agricultural practices, the integration of nanotechnology offers innovative solutions to enhance crop productivity, resource efficiency, and environmental stewardship. By leveraging nano-enabled formulations for precision farming, targeted nutrient delivery, and eco-friendly pest management, stakeholders can mitigate the adverse effects of chemical inputs, reduce resource wastage, and improve overall agricultural sustainability. This abstract highlights the pivotal role of nanotechnology in reshaping the agricultural landscape, driving towards a future where food production is not only sufficient but also environmentally responsible and resilient.

Scientists and farmers have been concentrating on enhancing the quality and yield of crops by harnessing cutting-edge technologies like nanotechnology to overcome challenges to sustainable and resilient agriculture. Given the rising global population and the increasing prevalence of monoculture, it is imperative to urgently tackle the issue of food shortages that impact around 800 million people each year (Shukla et al, 2019). According to predictions, the global population is expected to reach 9 billion by 2050, which means that food production would need to grow by 50% (Roberts, 2011). Nanotechnology, ranked as the 6th most groundbreaking technology, has the potential to make a substantial contribution towards the United Nations' objective of eradicating hunger completely. The green revolution that took place in the 1960s had a substantial impact on increasing agricultural output, sustainability, and stability (Conway and Barbie, 1988). Nanotechnology is currently transforming the agricultural industry by providing remedies for issues such as overdependence on chemical fertilizers, resistance to pesticides, and the impact of climate change. The unsustainability of mono-cropping and the extensive utilization of pesticides on a global scale emphasize the necessity for improved resource management and creative alternatives. Agri-nanotechnology is becoming increasingly important for researchers and agriculturists as it helps improve the overall status of the worldwide agri-food sector. Ensuring food security relies heavily on maintaining stability in agriculture. Nano agrochemicals, which include nano pesticides, insecticides, fertilizers, fungicides, and herbicides, provide researchers and agriculturist's additional ecologically sustainable options to consider (Singh et al, 2021). By adopting nanotechnology in agriculture, stakeholders may tackle the issues presented by unsustainable farming methods, climate change, and food shortages, ultimately making a significant contribution to a more secure and sustainable global food system.

Types of Nanoparticle

Nanoparticles, with sizes typically ranging from 1 to 100 nm, display unique characteristics as a result of their extremely small dimensions (Khan et al., 2019). Natural occurrences of these substances include hemoglobin and milk lipoproteins, whereas controlled laboratory settings are used to artificially produce substances like carbon nanotubes for various applications. Engineered nanoparticles (ENPs), often referred to as manufactured or industrial NPs, have become notable because of their distinct physiological and chemical characteristics (Prajitha et al., 2019). These nanoparticles possess attributes such as a significant ratio of surface area to weight, a variety of shapes and sizes, the ability to penetrate cells, and a high capacity for adsorption. Their unique characteristics arise from the significant surface area-to-volume ratio at the nanoscale, resulting in unusual behaviors compared to larger materials. Engineered nanoparticles (ENPs) possess a diverse set of characteristics such as catalytic, antibacterial, optical, mechanical, electrical, magnetic, and sterical capabilities. These traits make ENPs highly attractive for a wide range of applications in agriculture and associated industries. ENPs, which are classified into five types based on their composition, have a wide range of applications in various fields.

Potential of Nanotechnology in Agriculture

Nanotechnology has the potential to greatly transform agriculture by tackling important issues encountered by the agri-food industry. Nanomaterials, regarded as the foremost particles of the current period, are being employed in diverse agricultural applications including crop protection, crop enhancement, pathological analysis, precision farming, and stress resilience. Salinity stress is a significant abiotic factor that negatively impacts worldwide crop yield, resulting in decreased production and stagnant yield. Wahid et al., (2020), conducted a study on wheat plants and found that treatment with silver nanoparticles (Ag NPs) resulted in a decrease in oxidative stress when the plants were exposed to salt stress. Salinity stress is caused by reactive oxygen species (ROS), which consist of hydrogen peroxide (H2O2), superoxide anion radical (O2-), hydroxyl radicals (OH), and oxygen (O2). The nanobiotechnological method seeks to control the balance of reactive oxygen species (ROS) and increase the ability of plants to tolerate salt, providing a hopeful path for enhancing agriculture. Nanoparticles function as effective carriers for agricultural inputs such as fertilizers, insecticides, synthetic hormones, and genetic material (An et al., 2022). Nanotechnology has become a transformative force in agricultural fields, fundamentally changing the way we package and preserve food. Conventional ways of packing food have restrictions in terms of their capacity to break down naturally, ensure safety, and minimize the danger of infection. To address these issues, nanotechnology provides a hopeful solution by creating polymer nanocomposites (PNCs) that include different nanomaterials (Adhikari, 2021). These PNCs, which can be in the shape of nanotubes, nanosheets, nanoplatelets, nanorods, and nano whiskers, are regarded as innovative materials for packaging food. Clay and silica nanoparticles, carbon nanotubes, titanium dioxide, and zinc oxide are frequently employed as fillers in polymer matrices. Researchers and enterprises are using nanotechnology to improve the quality, safety, and shelf life of packaged food goods by combining it with standard packaging methods. Nanotechnology has not only resulted in the enhancement of packaging materials, but it has also facilitated the creation of active packaging solutions. These involve the use of biopolymer matrices containing nanoparticles, namely silver nanoparticles (Ag NPs), which are embedded in materials such as cellulose, chitosan, agar/banana, and gelatin (Kumar et al, 2021). The nanocomposite films possess antibacterial characteristics, efficiently battling pathogens such as *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus cereus*, and *Salmonella* (Tian et al, 2022). In addition, nanofillers such as titanium dioxide (TiO2) nanoparticles (NPs), zinc oxide (ZnO) NPs, and silicon dioxide (SiO2) NPs are used in biopolymer nanocomposites to achieve antibacterial properties, remove oxygen, and prevent oxidation.

Nano Fertilizers Offer Several Advantages Over Traditional Fertilizers, Including

High Nutrient Use Efficiency: Nano fertilizers provide better nutrient uptake and utilization by plants, leading to increased efficiency in nutrient delivery (Mahanta et al, 2019).

Increased Nutritional Value: Nano fertilizers can enhance the nutritional content of crops by ensuring optimal nutrient absorption (Elemike et al, 2019).

High Yields: The targeted delivery of nutrients through nano fertilizers can promote plant growth and increase crop yields (Solanki et al., 2015).

Reduced Production Cost: Nano fertilizers can be used in smaller amounts compared to traditional fertilizers while maintaining effectiveness, thus reducing production costs (Seleiman et al., 2020).

Environmental Benefits: Nano fertilizers have less environmental impact due to their controlled release mechanisms and high solubility, minimizing nutrient leaching and runoff. Studies have shown that nano fertilizers, such as those based on silicon dioxide (SiO2), zinc oxide (ZnO), and iron (Fe), have positive effects on seed germination, plant growth, and nutrient absorption in various crops like tomatoes, rice, soybeans, and wheatgrass. These nano fertilizers offer a promising alternative to conventional fertilizers by providing targeted and efficient nutrient delivery to plants (Fig.1) (Iqbal, 2019).

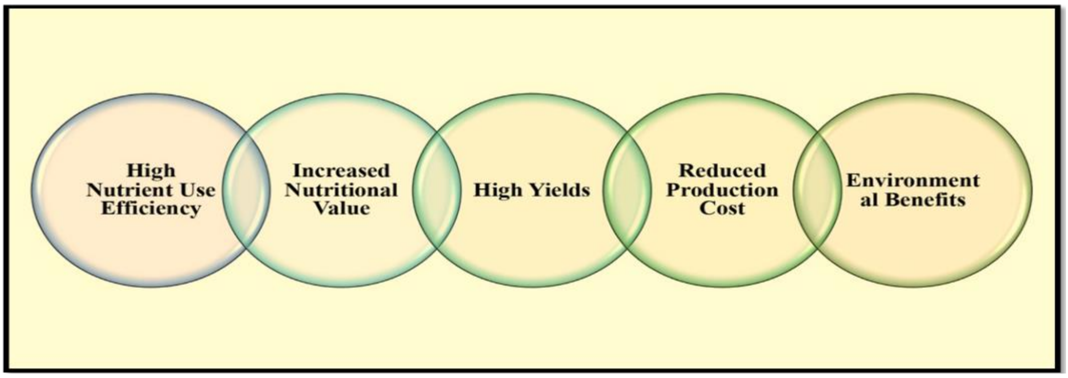

Fig.1 Advantages of nano fertilizers over traditional fertilizers

Here Are Some Ways in Which Nanotechnology Is Utilized for Disease and Pest Management in Agriculture

Nano Herbicides: Nano herbicides are designed to target specific weeds while minimizing the impact on non-target plants and the environment. Nanoparticles can enhance the efficacy of herbicides by improving their delivery and absorption, leading to better weed control (Muchhadiya et al., 2022).

Nano Fungicides: Nano fungicides are developed to combat fungal diseases in crops. These nanomaterials can penetrate plant tissues more effectively, providing enhanced protection against pathogens and reducing the need for frequent fungicide applications (Siddhartha et al., 2022).

Nanoemulsions: Nanoemulsions are nano-sized formulations that can encapsulate active ingredients such as pesticides or fungicides. These nanoemulsions improve the stability and efficacy of the active compounds, allowing for targeted delivery and controlled release on plant surfaces (Gupta et al., 2016).

Targeted Delivery: Nanoparticles enable targeted delivery of pesticides or fungicides to specific plant tissues or pests, reducing the amount of chemicals needed and minimizing off-target effects (Fig.2) (Santana et al, 2020).

Fig.2 Various methods utilized for employing nanotechnology in the pests and diseases management

Conclusion

By harnessing the unique properties of nanomaterials, such as their small size, high surface area, and controlled release capabilities, nanotechnology offers more precise and sustainable solutions for disease and pest management in agriculture. These advancements contribute to safer and more effective pest control strategies while minimizing the negative impacts on ecosystems and human health. Nano fertilizers are an advanced method in agriculture that provide sustainable solutions for enhancing crop yield, nutrient use, and environmental sustainability in current farming systems. Nanotechnology plays a crucial role in disease and pest management in agriculture by providing inventive alternatives to address the constraints of conventional pesticides. Nano agrochemicals, such as nano herbicides, nano fungicides, and nanoemulsions, have proven to be highly efficient in managing crop diseases and pests. Nanotechnology provides accurate and sustainable solutions for disease and pest management in agriculture by utilizing the distinctive characteristics of nanoparticles, including their small size, large surface area, and controlled release capabilities. These technological breakthroughs enhance the safety and efficacy of pest management methods, while reducing their adverse effects on ecosystems and human health.

References

Adhikari, C., (2021) Polymer nanoparticles-preparations, applications and future insights: A concise review. *Polymer-plastics technology and materials*, *60*(18), pp.1996-2024.

An, C., Sun, C., Li, N., Huang, B., Jiang, J., Shen, Y., Wang, C., Zhao, X., Cui, B., Wang, C. and Li, X., (2022) Nanomaterials and nanotechnology for the delivery of agrochemicals: strategies towards sustainable agriculture. *Journal of Nanobiotechnology*, *20*(1), p.11.

Conway, G.R. and Barbie, E.B., (1988) After the green revolution: sustainable and equitable agricultural development. *Futures*, *20*(6), pp.651-670.

Elemike, E.E., Uzoh, I.M., Onwudiwe, D.C. and Babalola, O.O., (2019) The role of nanotechnology in the fortification of plant nutrients and improvement of crop production. *Applied Sciences*, *9*(3), p.499.

Gupta, A., Eral, H.B., Hatton, T.A. and Doyle, P.S., (2016) Nanoemulsions: formation, properties and applications. *Soft matter*, *12*(11), pp.2826-2841.

Iqbal, M.A., (2019) Nano-fertilizers for sustainable crop production under changing climate: a global perspective. *Sustainable crop production*, *8*, pp.1-13.

Khan, I., Saeed, K. and Khan, I., (2019) Nanoparticles: Properties, applications and toxicities. *Arabian journal of chemistry*, *12*(7), pp.908-931.

Kumar, S., Basumatary, I.B., Sudhani, H.P., Bajpai, V.K., Chen, L., Shukla, S. and Mukherjee, A., (2021) Plant extract mediated silver nanoparticles and their applications as antimicrobials and in sustainable food packaging: A state-of-the-art review. *Trends in Food Science & Technology*, *112*, pp.651-666.

Mahanta, N., Dambale, A., Rajkhowa, M., Mahanta, C. and Mahanta, N., (2019) Nutrient use efficiency through nano fertilizers. *Int J Chem Stud*, *7*(3), pp.2839-2842.

Muchhadiya, R.M., Kumawat, P.D., Sakarvadia, H.L. and Muchhadiya, P.M., (2022) Weed management with the use of nano-encapsulated herbicide formulations: A review. *J. Pharm. Innov*, *11*, pp.2068-2075.

Prajitha, N., Athira, S.S. and Mohanan, P.V., (2019) Bio-interactions and risks of engineered nanoparticles. *Environmental research*, *172*, pp.98-108.

Roberts, L. 9 Billion. (2011)p. 540-543.

Santana, I., Wu, H., Hu, P. and Giraldo, J.P., (2020) Targeted delivery of nanomaterials with chemical cargoes in plants enabled by a biorecognition motif. *Nature communications*, *11*(1), p.2045.

Seleiman, M.F., Almutairi, K.F., Alotaibi, M., Shami, A., Alhammad, B.A. and Battaglia, M.L., (2020) Nano-fertilization as an emerging fertilization technique: Why can modern agriculture benefit from its use. *Plants*, *10*(1), p.2.

Shukla, P., Chaurasia, P., Younis, K., Qadri, O.S., Faridi, S.A. and Srivastava, G., (2019) Nanotechnology in sustainable agriculture: studies from seed priming to post-harvest management. *Nanotechnology for Environmental Engineering*, *4*, pp.1-15.

Siddhartha, Verma, A., Bashyal, B.M., Gogoi, R. and Kumar, R., (2022) New nano-fungicides for the management of sheath blight disease (Rhizoctonia solani) in rice. *International Journal of Pest Management*, *68*(3), pp.217-226.

Singh, H., Sharma, A., Bhardwaj, S.K., Arya, S.K., Bhardwaj, N. and Khatri, M., (2021) Recent advances in the applications of nano-agrochemicals for sustainable agricultural development. *Environmental Science: Processes & Impacts*, *23*(2), pp.213-239.

Solanki, P., Bhargava, A., Chhipa, H., Jain, N. and Panwar, J., (2015) Nano-fertilizers and their smart delivery system. *Nanotechnologies in food and agriculture*, pp.81-101.

Tian, Y., Cai, R., Yue, T., Gao, Z., Yuan, Y. and Wang, Z., (2022) Application of nanostructures as antimicrobials in the control of foodborne pathogen. *Critical Reviews in Food Science and Nutrition*, *62*(14), pp.3951-3968.

Wahid, I., Kumari, S., Ahmad, R., Hussain, S.J., Alamri, S., Siddiqui, M.H. and Khan, M.I.R., (2020) Silver nanoparticle regulates salt tolerance in wheat through changes in ABA concentration, ion homeostasis, and defense systems. *Biomolecules*, *10*(11), p.1506.

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NAVIGATING THE WATERS: CHALLENGES AND STRATEGIES FOR LIVE AQUATIC ORGANISM TRANSPORT

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Aquatic animal transport is a crucial aspect of aquaculture, aquarium trade, and conservation efforts, involving the relocation of fish, invertebrates, and other aquatic organisms from one location to another. During transport, maintaining optimal water quality parameters such as temperature, dissolved oxygen levels, and pH is essential to prevent stress and ensure the health and welfare of the animals. Proper container design, including adequate space, cushioning, and oxygenation, helps minimize physical injuries and discomfort during transit. Additionally, careful handling procedures and species-specific considerations are vital to reduce stress and avoid injuries.

Continuous monitoring of water quality and animal behaviour during transport allows for timely interventions in case of emergencies or deviations from optimal conditions. Upon arrival at their destination, transported aquatic animals may undergo quarantine periods and health assessments to detect and manage any potential health issues acquired during transport. By implementing appropriate strategies and protocols, aquaculture practitioners, aquarium professionals, and conservationists can ensure the safe and welfare-centric transportation of aquatic animals, supporting the sustainability and well-being of aquatic ecosystems. Aquatic animal transport is a critical aspect of aquaculture, aquarium trade, and conservation efforts. Whether relocating fish for commercial purposes or transferring species for conservation initiatives, ensuring the health and welfare of aquatic animals during transport is paramount.

Challenges of Aquatic Animal Transport

Transporting aquatic animals poses various challenges due to the unique physiological and environmental requirements of different species. Some of the primary challenges include:

1. **Water Quality Maintenance:** Maintaining optimal water quality parameters, including temperature, dissolved oxygen levels, pH, and ammonia concentration, is crucial during transport to prevent stress and respiratory problems in aquatic animals.
2. **Handling Stress:** Handling and confinement during transport can induce stress in aquatic animals, leading to weakened immune systems, increased susceptibility to diseases, and reduced survival rates.
3. **Physical Injury:** Rough handling, overcrowding, and inadequate container design can result in physical injuries such as abrasions, fin damage, and skeletal trauma among transported aquatic animals.
4. **Disease Transmission:** Proximity and high-density during transport facilitate the transmission of pathogens and parasites, increasing the risk of disease outbreaks among susceptible individuals.

Strategies for Health Management During Transport

i. Pre-Transport Preparation:

(a) **Health Assessment:** Conduct pre-transport health checks to identify and segregate diseased or stressed individuals to prevent the spread of pathogens.

(b) **Water Quality Optimization:** Ensure water quality parameters in transport containers match the conditions of the source environment to minimize stress and physiological disturbances (APPELBAUM & HERWITZ, 1989).

(c) **Acclimatization:** Gradually acclimate aquatic animals to transport conditions by adjusting water temperature and gradually reducing feeding to minimize stress. Anaesthetising fish is another common procedure that could reduce the transportation-induced stress on the fish ((Harmon, 2009)

ii. Container Design and Management:

(a) **Adequate Space:** Provide sufficient space in transport containers to reduce crowding and minimize aggressive interactions among aquatic animals (Hong et al., 2019).

(b) **Cushioning and Protection:** Use soft, non-abrasive materials and padding inside containers to minimize physical injuries during transport.

(c) **Oxygenation and Filtration:** Install efficient aeration and filtration systems in transport containers to maintain optimal oxygen levels and remove metabolic wastes.

iii. **Handling and Loading Procedures:**

(a) **Gentle Handling:** Train personnel in gentle handling techniques to minimize stress and physical trauma during loading, unloading, and transportation.

(b) **Species-Specific Considerations:** Understand the behavioural and physiological needs of different species to tailor handling procedures accordingly (De Kinkelin & Hedrick, 1991)

(c) **Avoiding Temperature Shock:** Gradually adjust water temperature during loading and unloading to prevent temperature shock and thermal stress.

iv. **Monitoring During Transport:**

(a) **Continuous Observation:** Assign trained personnel to monitor the health and behaviour of aquatic animals throughout the transport process, intervening promptly in case of emergencies.

(b) **Water Quality Monitoring:** Regularly test water quality parameters during transport and make necessary adjustments to maintain optimal conditions.

(c) **Emergency Response Plan:** Develop and implement a comprehensive emergency response plan to address unforeseen events such as equipment failure, water quality issues, or accidents during transport.

v. **Post-Transport Quarantine and Health Assessment:**

(a) **Quarantine Period:** Subject transported aquatic animals to a quarantine period upon arrival to monitor for signs of disease and prevent the potential introduction of pathogens into recipient environments (Bondad-Reantaso et al., 2005).

(b) **Health Screening:** Conduct post-transport health assessments, including physical examinations, pathological analysis, and disease testing, to detect and treat any health issues acquired during transport.

Conclusion

Health management of aquatic animals during transport is a multifaceted process that requires careful planning, preparation, and execution to minimize stress, injuries, and disease transmission. By implementing appropriate strategies and protocols, aquaculture practitioners, aquarium professionals, and conservationists can ensure the safe and welfare-centric transportation of aquatic animals for various purposes, ultimately contributing to the sustainability and well-being of aquatic ecosystems.

References

Harmon, T. S. (2009). Methods for reducing stressors and maintaining water quality associated with live fish transport in tanks: a review of the basics. Reviews in Aquaculture, 1(1), 58-66.

APPELBAUM, S., & HERWITZ, S. (1989). A technique for maintaining water quality in fish tanks containing eels and fish larvae. *Aquaculture Research*, *20*(1), 107–110. https://doi.org/10.1111/j.1365-2109.1989.tb00446.x

De Kinkelin, P., & Hedrick, R. P. (1991). International veterinary guidelines for the transport of live fish or fish eggs. *Annual Review of Fish Diseases*, *1*, 27–40. https://doi.org/10.1016/0959-8030(91)90020-k

Hong, J., Chen, X., Liu, S., Fu, Z., Han, M., Wang, Y., Gu, Z., & Ma, Z. (2019). Impact of fish density on water quality and physiological response of golden pompano (Trachinotus ovatus) flingerlings during transportation. *Aquaculture*, *507*, 260–265. https://doi.org/10.1016/j.aquaculture.2019.04.040

Bondad-Reantaso, M. G., Subasinghe, R. P., Arthur, J. R., Ogawa, K., Chinabut, S., Adlard, R., Tan, Z., & Shariff, M. (2005). Disease and health management in Asian aquaculture. *Veterinary Parasitology*,*132*(3-4),249–272.https://doi.org/10.1016/j.vetpar.2005.07.005

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SUPERCHARGING PRODUCE: THE POWER OF INDUCED RESISTANCE IN FIGHTING POSTHARVEST DISEASES

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Postharvest losses of fruits and vegetables are a significant global concern, ranging from 5-25% in developed nations to 20-50% in developing nations. Factors such as senescence, mechanical injury, and decay contribute to these losses. The withdrawal of synthetic fungicides has led to an increase in decay-causing fungi. Research on induced resistance has emerged as an alternative to synthetic fungicides, enhancing plant defenses against pathogens. Advances in molecular biology and genomics have improved our understanding of postharvest quality. This study explores how induced resistance is influenced by host maturity, ripening processes, and senescence, offering insights into enhancing crop quality and consumer health.

The estimated postharvest losses range from 5-25% in developed nations and 20-50% in developing nations, depending on factors such as the type of product, variety, and the methods involved in marketing and handling (Kader, 2002). Hence, the mitigation of food loss and food waste is a significant global concern in terms of society, economy, nutrition, and the environment. According to the FAO, around 14% of global food production is lost, excluding the levels of retail and consumption. At these levels, 17% of food is wasted (FAO, 2021). The withdrawal or restrictions on the use of broad-spectrum synthetic fungicides have led to an increase in the occurrence of decay-causing fungi that were previously considered less harmful to most crops. These fungi include pathogens in the genera *Rhizopus*, *Mucor*, *Alternaria*, *Aspergillus*, and *Penicillium* (Romanazzi and Moumni, 2022). As the demand for healthier and more accessible fresh fruits and vegetables increases, the capacity to prevent postharvest illnesses has become a crucial factor in extending the shelf life of crops. Research on induced resistance in stored produce has significantly increased in the past 25 years. This has resulted in the practical use of induced-resistance technologies as viable alternatives to synthetic fungicides for controlling postharvest infections. Activating a plant's natural defense mechanisms in fruits and vegetables involves using external physical, chemical, and biological methods to induce physiological changes. These alterations enhance the plant's ability to protect against fungal diseases causing rot, crucial for integrated disease management during storage. Advances in monitoring processes have improved understanding of postharvest quality affected by technologies used before and during storage, storage conditions, and packing protocols. Comprehensive tools are essential to understand how various elements affect a host's disease resistance, enhancing crop quality and consumer health (Romanazzi et al., 2016). This study articulates how these approaches have facilitated the understanding of the impact of host maturity, ripening processes, and senescence on the mechanism of induced resistance to postharvest disease.

Induced Resistance by Postharvest Treatments

Several treatments that have been shown to trigger resistance in plants after being infected by a pathogen have been administered to harvested fruits and vegetables (Romanazzi et al., 2016). These physical, natural, and synthetic substances cause physiological changes

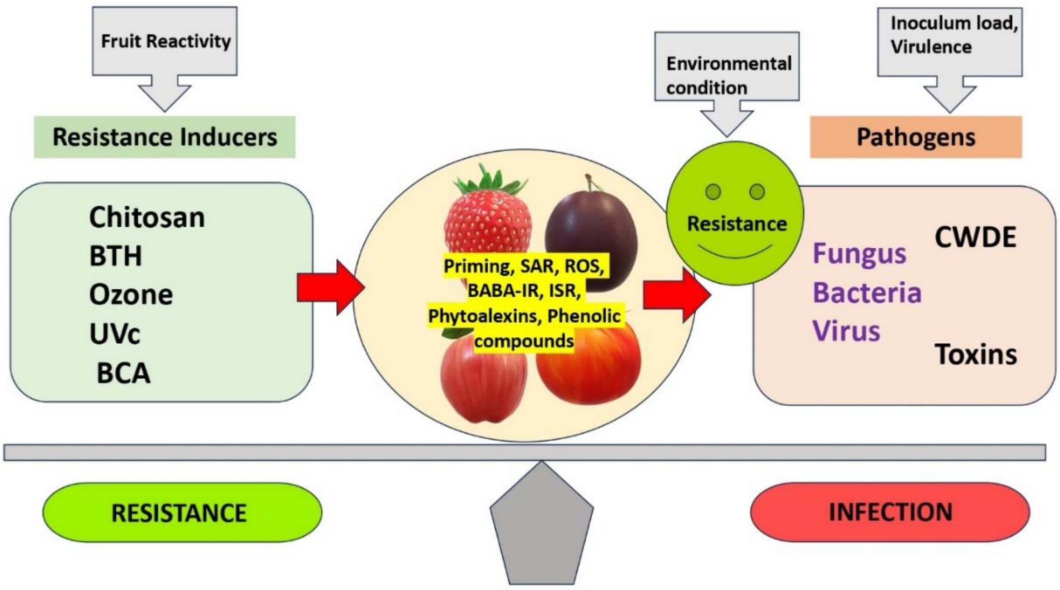

Fig.1 Dynamic balance between host resistance and pathogen infection in fruits and vegetables

that are closely connected to the defense mechanisms in the host tissues. The fruit's resistance or susceptibility to the infection is influenced by these responses, which are depending on the level of interaction with the pathogen. The key groups that they can be categorized into are: (a) the accumulation of PR proteins and hormone-dependent signaling; (b) the decrease in membrane lipid metabolism and improvement in ROS scavenging ability through the activation of antioxidant machinery, including enzymes such as catalase (CAT), POD, ascorbate peroxidase (APX), and superoxide dismutase (SOD); and (c) the synthesis of antimicrobial enzymatic activity of fruit-phenolic compounds, lignin, and enzymes such as CHT, glucanases (GLU), and phenylalanine ammonia-lyase (PAL) (Fig. 1). Host defensive responses that restrict pathogen colonization also impact other vital physiological processes, such as delaying ripening and senescence, which in turn impacts the taste and pace of softening of fruits (Lougheed et al., 1978). There are several factors which induces resistance responses in fruit and vegetables after postharvest treatments like.

I. Chemicals (biopolymer)

Chitosan, a biopolymer derived from crab shells, is a prominent substance that stimulates resistance. It possesses three distinct properties: antibacterial, evoking, and film-forming activities (Romanazzi et al., 2022). In host-pathogen interactions, the enzymes of the pathogens damage the host cell wall, which serves as an eliciting activity. This activity is termed endogenous elicitors that signal to plants that they are being infected by a pathogen. As a result, plants activate their defense mechanisms (Romanazzi et al., 2017). The biopolymer has the ability to directly stimulate the production of plant defense enzymes and the synthesis of secondary metabolites, including polyphenolic compounds, lignin, flavonoids, and phytoalexins, in several plant species (Malerba and Cerana, 2016). Additionally, it can enhance the antioxidant capacity of plants (Landi et al., 2021). Chitosan not only acts as a priming agent, but also forms a protective layer on the surface of the treated fruit. This layer helps maintain the freshness of the fruit by minimizing gas exchange, slowing down respiration and the ripening process, and reducing the fruit's physiological metabolism (Romanazzi et al., 2009). Chitosan exhibited antibacterial activity against a range of decay-causing fungi, resulting in reduced decay development and increased shelf life of various crops. This was achieved through the induction of defensive mechanisms and enhancement of antioxidant activities.

II. Physical therapy (Heat treatment)

Physical therapy also demonstrated a substantial increase in fruit resistance. Peach, strawberry, and mango fruit that were exposed to heat stress exhibited the activation of transcription factors that increase fruit resistance (Luria et al., 2014) and postpone fruit maturity. Exposing strawberries to heat treatment directly stimulated the plant's defense mechanisms, leading to the buildup of PAL, CHT, CAT, APX, and SOD. This resulted in a decrease in the size of gray mold lesions by 60%. Strawberry fruit that were subjected to a hypobaric atmosphere exhibited induced resistance to *Botrytis cinerea* and *Rhizopus stolonifer*. This resistance was associated with enhanced activity of the enzymes CHT, PAL, and POD, as well as better fruit storability (Hashmi et al., 2013). Short-term hypobaric treatments can prevent the aging process of table grapes, strawberries, and sweet cherries. This treatment resulted in a decrease in gray mold lesions in table grapes that were inoculated, as compared to an inoculated control that was kept at ambient pressure Furthermore, physical therapies have been associated with the activation of systemic acquired resistance (SAR), in addition to their direct physiological effects such as reducing ethylene production in tissues treated at low atmospheric pressure (hypobaric conditions) (Conrath et al., 2015). Hence, the results suggest that the defense mechanisms triggered by living organisms and/or non-living factors to prevent pathogen growth might have significant physiological impacts on the host, leading to enhanced fruit preservation. The challenge lies in explaining the phenomenon of resistance induction, which can effectively inhibit the growth of fungi and last for a significant duration (Luna et al., 2012). Furthermore, there is evidence suggesting that this resistance may even be inherited by future generations.

III. Synthetic Chemicals (SA, BABA)

Previous studies have demonstrated that applying SA and BABA treatments before harvesting can decrease the occurrence of *Penicillium digitatum* and *B. cinerea* diseases in orange and tomato fruits, respectively. These treatments delay the start of colony formation by 3-5 days and thereafter suppress colony growth by 50% (Wilkinson et al., 2018). Regarding BABA, the prolonged induced-resistance response was shown to be associated with a delay in fruit maturation (specifically, the ripening of red fruit per plant). This delay was also linked to the differential accumulation of certain metabolites, which were tentatively identified as lipids, alkaloids, terpenoids, and the plant hormone ABA (Wilkinson et al., 2018). Chemical inducers have the ability to initiate defense responses in fruits at a specific location. Additionally, they can stimulate the synthesis of immunological signals that can move throughout the plant, such as SA, methyl salicylate (MeSA), azelaic acid, glycerol 3-phosphate, and abietane-diterpenoid-dehydroabietinal (Chaturvedi et al., 2008).

IV. Genetic modification

Epigenetic mechanisms have been found to be responsible for the enduring nature of induced resistance in fruit. These systems have the ability to precisely regulate the expression of defense responses over extended periods of time, even across generations. The process of fruit development and ripening is affected by alterations in chromatin modifications and DNA methylation patterns (Joyce and Johnson, 1999). Given that fruits mostly consist of maternal tissues and that certain preharvest treatments can initiate enduring induced resistance, numerous research groups have endeavored to establish a connection between this induction and epigenetic alteration. Indeed, it is conceivable that intergenerational epigenetic pathways may contribute to the preparatory stages of fruit generated from authentic seed (Jaskiewicz et al., 2011). According to a recent experiment, potato seeds obtained from primed potato plants have demonstrated elevated levels of induced wound healing and resistance to dry rot in the next crop. To summarize, various categories of chemicals, including naturally occurring metabolites, inorganic compounds, and synthetic chemicals, as well as a variety of physical therapies, such as, can serve as examples of abiotic agents that generate resistance.

Conclusion

Inducing resistance in fruit and vegetable tissues is a method to provide increased protection against decay that occurs after harvesting, both during storage and while on the shelf. The application of various non-living and living factors stimulates the physiological responses of the host, leading to the accumulation of defense compounds that restrict the growth of fungi. This process also delays the aging of fruits, allowing them to maintain their youthful state for extended periods. Additionally, it enhances the plant's capacity to protect itself against harmful pathogens. Induced resistance can provide a defense strategy against plant pathogens that are challenging to control with single resistance genes. It can activate specific mechanisms that trigger defense responses and modify mechanisms that are commonly found in various fruit crops. Additionally, it can activate mechanisms in fruits that are considered safe and potentially enhance fruit quality by increasing beneficial compounds such as phenols with antioxidant activity. Furthermore, induced resistance can be effective during both the growth and development of plants and fruits, offering opportunities for disease control before and after harvest.

References

Chaturvedi, R., Krothapalli, K., Makandar, R., Nandi, A., Sparks, A.A., Roth, M.R., Welti, R. and Shah, J., (2008) Plastid ω3-fatty acid desaturase-dependent accumulation of a systemic acquired resistance inducing activity in petiole exudates of Arabidopsis thaliana is independent of jasmonic acid. *The Plant Journal*, *54*(1), pp.106-117.

Conrath, U., Beckers, G.J., Langenbach, C.J. and Jaskiewicz, M.R., (2015) Priming for enhanced defense. *Annual review of phytopathology*, *53*, pp.97-119.

Fruit, F.A.O., (2021) Vegetables–your dietary essentials. *The International Year of Fruits and Vegetables*, p.36.

Hashmi, M.S., East, A.R., Palmer, J.S. and Heyes, J.A., (2013) April. Strawberries inoculated after hypobaric treatment exhibit reduced fungal decay suggesting induced resistance. In *II International Symposium on Discovery and Development of Innovative Strategies for Postharvest Disease Management 1053* (pp. 163-168).

Jaskiewicz, M., Conrath, U. and Peterhänsel, C., (2011) Chromatin modification acts as a memory for systemic acquired resistance in the plant stress response. *EMBO reports*, *12*(1), pp.50-55.

Joyce, D.C. and Johnson, G.I., (1999) Prospects for exploitation of natural disease resistance in harvested horticultural crops. *Postharvest News and Information*, *10*(3), pp.8-45.

Kader, A.A., (2002) *Postharvest technology of horticultural crops* (Vol. 3311). University of California Agriculture and Natural Resources.

Landi, L., Peralta-Ruiz, Y., Chaves-López, C. and Romanazzi, G., (2021) Chitosan coating enriched with Ruta graveolens L. essential oil reduces postharvest anthracnose of papaya (Carica papaya L.) and modulates defense-related gene expression. *Frontiers in Plant Science*, *12*, p.765806.

Lougheed, E.C., Murr, D.P. and Berard, L., (1978) Low Pressure Storage for Horticultural Crops1. *HortScience*, *13*(1), pp.21-27.

Luna, E., Bruce, T.J., Roberts, M.R., Flors, V. and Ton, J., (2012) Next-generation systemic acquired resistance. *Plant physiology*, *158*(2), pp.844-853.

Luria, N., Sela, N., Yaari, M., Feygenberg, O., Kobiler, I., Lers, A. and Prusky, D., (2014) De-novo assembly of mango fruit peel transcriptome reveals mechanisms of mango response to hot water treatment. *BMC genomics*, *15*, pp.1-15.

Malerba, M. and Cerana, R., (2016) Chitosan effects on plant systems. *International journal of molecular sciences*, *17*(7), p.996.

Romanazzi, G. and Moumni, M., (2022) Chitosan and other edible coatings to extend shelf life, manage postharvest decay, and reduce loss and waste of fresh fruits and vegetables. *Current Opinion in Biotechnology*, *78*, p.102834.

Romanazzi, G., Feliziani, E., Baños, S.B. and Sivakumar, D., (2017) Shelf life extension of fresh fruit and vegetables by chitosan treatment. *Critical reviews in food science and nutrition*, *57*(3), pp.579-601.

Romanazzi, G., Gabler, F.M., Margosan, D., Mackey, B.E. and Smilanick, J.L., (2009) Effect of chitosan dissolved in different acids on its ability to control postharvest gray mold of table grape. *Phytopathology*, *99*(9), pp.1028-1036.

Romanazzi, G., Orçonneau, Y., Moumni, M., Davillerd, Y. and Marchand, P.A., (2022) Basic substances, a sustainable tool to complement and eventually replace synthetic pesticides in the management of pre and postharvest diseases: reviewed instructions for users. *Molecules*, *27*(11), p.3484.

Romanazzi, G., Sanzani, S.M., Bi, Y., Tian, S., Martínez, P.G. and Alkan, N., (2016) Induced resistance to control postharvest decay of fruit and vegetables. *Postharvest Biology and Technology*, *122*, pp.82-94.

Wilkinson, S.W., Pastor, V., Paplauskas, S., Pétriacq, P. and Luna, E., (2018) Long-lasting β-aminobutyric acid-induced resistance protects tomato fruit against Botrytis cinerea. *Plant Pathology*, *67*(1), pp.30-41.

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ADVANCES IN CINNAMON PROCESSING: ENHANCING QUALITY AND FUNCTIONAL PROPERTIES

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Cinnamon is a popular spice derived from the bark of various Cinnamomum species, has been using centuries having valued for its distinctive flavour and medicinal properties. This article provides an overview of recent advancements in cinnamon processing techniques aimed at improving the overall quality and functional properties of this aromatic spice. Modern processing methods discussed and address challenges related to flavour retention, nutritional preservation, and increased consumer demand for high-quality cinnamon products. Innovations in harvesting, drying, and storage practices have been crucial for maintaining the essential oil content and bioactive compounds that contribute to cinnamon's unique sensory profile and health benefits.

Furthermore, this explores novel extraction and encapsulation technologies designed to enhance the bioavailability of cinnamon's bioactive components, such as cinnamaldehyde and polyphenols. These advancements not only contribute to the spice's flavor intensity but also expand its potential applications in the food, pharmaceutical, and cosmetic industries. Quality control measures, including the use of advanced analytical techniques and sensory evaluation, are discussed to ensure the consistency and safety of cinnamon products. Additionally, this provides highlights sustainable and environmentally friendly processing methods to address concerns related to the ecological impact of cinnamon cultivation and processing.

These article underscores the significance of ongoing research and technological advancements in cinnamon processing, emphasizing the potential for creating superior-quality products with enhanced functional attributes, thus cooking preferences of consumers in various industries

Cinnamon, derived from the bark of several species within the Cinnamomum genus, stands as one of the oldest and most prized spices in the world. Renowned for its distinctive aroma, flavor, and therapeutic properties, cinnamon has been an integral part of culinary and medicinal traditions across cultures for centuries. As global demand for high-quality cinnamon continues to surge, the focus on optimizing cinnamon processing methods has become imperative to meet both consumer expectations and industry standards. In India Cinnamon is cultivated in an area 1,000 ha. With an annual production of 1,670 tons. The productivity is 1000 kg/ha. The complex process of transforming raw cinnamon bark into the fine spice we know involves various stages, each critical for preserving its unique characteristics. From harvesting and drying to extraction and packaging, each step plays a pivotal role in determining the final quality of the cinnamon product. In recent years, researchers and industry professionals have been dedicated to refining these processing techniques, addressing challenges related to flavor retention, nutritional preservation, and environmental sustainability.

This article provides a brief information of world of cinnamon processing, setting the stage for a detailed exploration of the latest advancements and innovations in the field. By investigating into these developments, we aim to uncover how modern technologies and sustainable practices contribute to the enhancement of cinnamon's flavor profile, nutritional value, and broader applications across diverse industries. As we navigate through the intricate journey of cinnamon processing, we unravel the layers of tradition, innovation, and science that converge to bring this beloved spice to our tables and beyond.

Processing of Cinnamon

How successfully the bark is cut off the stems determines the quality of the cinnamon. Compared to tiny broken pieces, the larger bark fragments known as quills are sold for more. Because removing the bark from the stem requires a lot of labor and is typically done by hand by professional workers, processing costs make up over 60% of the total cost of producing cinnamon.

Scraping

Epidermal tissue layer on stems is removed by a process called scraping. This is accomplished with a traditional hand tool known as a "Koketta."Two kinds of tools are available: one featuring a short handle and a sharp, curved blade, and the other. "Sawthtuwa" is the Sinhala name for the later. Choose a blade curve that complements the stems' diameter. As a result, this step's automation is challenging. The amount of time it takes to scrape is influenced by the stillness and physical characteristics of the stems, such as their straightness, knob count, and stick diameter.

Rubbing

A copper rod later took its place, and that copper rod was later replaced by a brass rod. The brass rod's average dimensions are 15 mm in diameter, 203 mm in length, and 1.1 kg in weight. The hardest part of processing cinnamon is rubbing, which makes the bark loose enough to separate from the stem's core. Pushpitha (2006) states that only male peelers are used for this task because the rubbing process is quite taxing. The length of time needed for rubbing varies depending on the stem's diameter, eveness, number of knots, season, cultivar, etc .The peeler's productivity decreases after rubbing for 4-6 hours. This may result in damaged bark and low-quality quills. During the rubbing process, bark sap oozes indicating proper rubbing. However, extreme rubbing can damage the bark (Gunasena et al. 1997; Pushpitha 2006).

Peeling

After selecting the proper method for removing the bark, a small pointed knife is used to make two incisions around the stems at the greatest length of intervals. The bark is then peeled off by delicately inserting the knife between the hardwood and bark and lifting and releasing it. The bark is finally split into two parts by making a second longitudinal slit across from the first. Bark can be separated into three or even four strips along a stem when its diameter is large enough. Cinnamon can be harvested at any time of year, although it is best during the monsoon season; in Sri Lanka, this means that it is only picked for roughly two months during the dry spells. When the earth becomes dry and the moisture content decreases, peeling becomes fairly challenging. Conserving soil moisture through mulching with cinnamon leaves is an excellent practice (Wijesekara et al. 1975; Gunarathne 2011). Following the bark's removal, the long, undamaged peels that form the quills' outer covering are allowed to dry for two to three hours in the shade. Bark curls flipped during this time. This interval is prolonged by up to 5–8 hours during the wet season. Currently, racks constructed of steel or coconut rope are utilized to reduce the drying time. Skilled peelers prepare cinnamon quills so that they are consistently thick from end to end. Bark halves are pressed together until they form tubes that resemble cigars. Thin bark fragments that are inappropriate for forming the quill's outer covering are crammed into the hollow inside of the quill. To make quills, one needs a pair of scissors, a 107-cm measuring rod, and a wooden lifter known as a "Pethi Kotuwa" in Singhalese. After trimming the end with scissors when it reaches the desired length, it is carefully lifted and placed on a mat to continue drying. The processed quills are piled into 45 kg bundles, known as bales for sale and transportation purposes. The quills are covered from the sun with gunny sacks or Cadjan leaves (Administration Reports 2009–2018). An experienced cinnamon peeler may peel approximately 50 collected stems in ten to fifteen hours in order to generate 4-5 kg of dry processed cinnamon in a day.

Rolling

Pressing and stacking peeled barks one on top of the other creates a roll. 20cm is the minimum length of peeled bark, which is then heaped up in little enclosures covered in dried leaves or mats to help with mild fermentation and maintain moisture for the following day's operations.

Piping

Slips that have been peeled and rolled are bundled and brought to the piping yard. The horizontal rod that holds these slips is raised on a stand. Using a curved knife, scrape off the outside skin of the slip. Next, grade the scraped slips based on thickness. Finally, roll the graded slips over the outer cover of pipes to construct pipes. Slips are dried after they are piped. We refer to these piping slips as quills. Compound quills are made by inserting tiny quills into larger ones; to prevent warping, the compound quills are then dried in the shade on coir rope racks. The quills are dried for 4-5 days, then the filling is tightened by rolling them on a board before being dried in indirect sunlight. Once they have dried, they are arranged in mats for promotion.

Grading

The quills are categorized into finer and coarser grades, ranging from '00000' to '0'. After the quills are prepared, the minute fragments of bark that remain are categorized as "Quillings."Quills, Quillings, and scrapes (Katta) that are used for oil distillation are the three main commercial groups into which they are divided; yet, during the processing of quills, a number of other valuable by-products are produced (Dayananda 2011). Dry "featherings" are made from the extremely thin inner bark portions. The coarser canes are known as "scrapped chips" because the bark is scraped off rather than peeled. "Un scrapped chips" are bark that has been scraped off without removing the outer bark. "Cinnamon powder" is made by powdering various bark grades. The best quality is always found in the middle of the shoot & not at ends.

Packaging

For commercial purposes, cinnamon quills are often sliced into 10cm long pieces and placed inside moisture-resistant polypropylene bags. Moisture infiltration can be avoided by sealing the bags. All pertinent product and legal details, including the product's name, brand name, manufacturer's details (including name and address), date of manufacturing, expiration date, weight of the contents, and any added ingredients, should be listed on the labels of the bags.

Storage

Dried cinnamon quills should be kept out of direct sunlight in moisture-proof containers. If they have absorbed moisture, they should be dried again until a moisture content of 10%.It is imperative that the storage chamber is pest-free, dry, and cold. A room containing strong-smelling foods, detergents, or paints should not be stored with cinnamon since they will overpower the flavor and aroma of the spice. Mosquito netting should be installed on windows to keep insects and vermin out.

Conclusion

In summary, the processing of cinnamon involve several steps like Scraping, Rubbing, Peeling, Piping, Grading, Packaging & storage. Low efficiency & high labor cost are the drawbacks.

References

Administration Reports (2009–2018) Department of Export Agriculture, Gatambe, Peradeniya, Sri Lanka.

Dayananda KR (2011) Improved cinnamon distillation technology. Abstract of the paper presented to international symposium, “Technology to reach future aspirations of Ceylon cinnamon”, 18–19th July 2011. Faculty of Agriculture, University of Ruhuna, Kamburupitiya.

Gunasena CP, Weerasinghe KDN, Karunarathne G (1997) Technological aspects of cinnamon processing for future mechanization. Proceedings of the Sri Lanka Association for the advancement of science. 53rd annual session, p 108.

Pushpitha NPG (2006) Design and construction of a cinnamon processing device to intensify the cinnamon peeling, M.Phil thesis. Faculty of Agriculture, University of Ruhuna, Kamburupitiya, Sri Lanka.

Wijesinghe KGG, Gunarathna WDL (2011) Characterization of true cinnamon (Cinnamomum zeylanicum Blume.) based on leaf morphology and their relationship with yield and quality. Sri Lanka Association of the Advancement of Science. Proc. 57th Annual Session. Part 1, p 42.

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ROLE OF BIOFERTILIZERS IN MODERN AGRICULTURE

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The role of synthetic fertilizers is major in modern agriculture in order to feed the ever increasing population. The synthetic fertilizers dissolve immediately in water and supply nutrients to plants faster than organic manures. These synthetic fertilizers are rich in plant nutrients but are toxic to the environment and cause soil, water and air pollution. On the continuous use of synthetic fertilizers it destroys the soil fertility due to the buildup of chemicals in soil and reduces soil health (Mazid and Khan, 2014). The role of biofertilizers is necessary in modern agricultural practices. They can supplement the necessary plant nutrients for sustainable agriculture. Biofertilizers are the substances which contain living micro organisms which promote the growth and development of crops. They convert the insoluble form of essential nutrients to soluble form making it available to the plants. They can be applied to seeds, seedlings and soil. Biofertilizers involve in the nitrogen fixation, phosphorus solubilization, and nutrient transformation and synthesize plant growth promoting substances (Mahdi *et al*., 2010). Biofertilizers unlike synthetic fertilizers help in maintaining the soil health without causing contamination and pollution. They improve the soil physical and chemical properties and restrict the activity of harmful pathogens. Therefore the biofertilizers can be used as best supplements to synthetic fertilizers in modern agriculture.

Biofertilizers are cost effective and renewable source of plant nutrients. They are environment friendly and play an important role in maintaining soil health and fertility. Biofertilizers are live formulations of beneficial microorganisms which mobilize the availability of nutrients. The nitrogen fixing bacteria like *Rhizobium* helps in the nitrogen fixation in the root nodules of leguminous crops. *Rhizobium* can fix 15-20 kg/ha nitrogen and increase crop yield upto 20% in pulses. Phosphate solubilizing bacteria like *Bacillus* and *Pseudomonas* and fungi like *Penicillium* and *Aspergillus* have the phosphate solubilizing capacity and solubilize the inorganic tricalcium and rock phosphate. Phosphate mobilizing biofertilizers like Mycorrhiza mobilize phosphorus and helps in its absorption. The plant growth promoting rhizobacteria colonize in the roots or rhizosphere soil and promote the growth of plants by producing growth regulators.

Classification of Biofertilizers

N_2 Fixing Biofertilizers

- Free-living: *Beijerinkia*, *Azotobacter*, *Anabaena*, *Nostoc*
- Symbiotic: *Rhizobium*, *Frankia*, *Anabaena azollae*
- Associative Symbiotic: *Azospirillum*

P Solubilizing Biofertilizers

- Bacteria: *Bacillus megaterium*, *Bacillus subtilis*, *Bacillus circulans*, *Pseudomonas striata*
- Fungi: *Penicillium spp*., *Aspergillus awamori*

P Mobilizing Biofertilizers

- Arbuscular mycorrhiza: *Glomus spp*., *Gigaspora spp*., *Acaulospora spp*.
- Ecto mycorrhiza: *Laccaria spp*., *Pisolithus sp*., *Boletus sp*., *Amanita spp*.
- Ericoid mycorrhizae: *Pezizellaericae*
- Orchid mycorrhiza: *Rhizoctonia solani*

Biofertilizers for Micronutrients

- Silicate and Zinc solubilizers: *Bacillus spp.*

Plant Growth Promoting Rhizobacteria

- Pseudomonas: *Pseudomonas fluorescens*

Factors Affecting Response of Biofertilizers

- The efficiency of the inoculant and micro organism is determined by host plant and genotype.
- The quality of inoculant largely influences its results in term of nitrogen fixation and solubilization of particular nutrients.

- Package of practices and management of crop alters the result of biofertilizers.
- Soil physical and chemical properties highly influence impact of different inoculants and micro organisms.
- Climatic conditions like temperature, relative humidity, rainfall and photoperiod affect response of biofertilizers significantly.

Methods of Application of Biofertilizers

1. Seed treatment: In this method the seeds are treated with the microbial inoculants, dried and sown as early as possible. This method can be followed for cereals (rice, wheat, maize etc.), pulses (soyabean, cowpea, green gram, black gram etc.) and oil seed crops (groundnut, sunflower, safflower etc.).

2. Seedling treatment: In this method the roots of the seedling are dipped in the suspension of biofertilizers and transplanted immediately. This method can be followed in paddy, tomato, chilli, cabbage, cauliflower, onion etc.

3. Soil application: In this method the biofertilizers are mixed with well decomposed organic manure and kept overnight. This mixture is then applied to the soil at the time of sowing or at the time of irrigation in standing crops.

4. Foliar application: Liquid biofertilizers can be applied through fertigation as well as foliar application to the suitable crop.

Advantages of Biofertilizers

- The microbial formulations are eco friendly and cost effective.
- Improve soil organic matter content and microbial activity.
- Improve soil physical properties like soil structure, soil porosity and water retention.
- Promote plant growth by releasing growth promoting substances.
- Improve the availability of nutrients to crops and supplement the use of synthetic fertilizers.
- Improves soil productivity and the yield of crops by 20 to 30% (Prem Baboo, 2009).
- Reduce the risk of crop failure.
- Protect the environment from pollutants as they are natural fertilizers.
- Reduce the activity of harmful pathogens by restricting their growth and control many diseases (Brahmaprakash and Pramod, 2012).

Constraints of Biofertilizers

- They are slow releasing and crop specific.
- Lack of good quality of strain which efficiently provide required nutrients in soil.
- Lack of storage facilities makes it difficult to adopt bio-fertilizers.
- Lack of awareness in the farmers (Mahdi *et al*., 2010).
- Less efficient when compared to synthetic fertilizers.
- Reduction in the population of micro organisms under harsh climate and field conditions like extremely high or low pH and temperature (Mahdi *et al*., 2010).

Precautions to Be Taken Before the Application of Biofertilizers

- Biofertilizers need to be stored in a cool and dry place away from direct sunlight and heat as they are live products (Prem Baboo, 2009).
- Usage of right combinations of biofertilizers is necessary.
- Use the microbial inoculants to specific crops as it is crop specific.
- Other chemicals should not be mixed with the biofertilizers (Suryawanshi *et al*., 2013).
- When purchasing, one should ensure that each packet is provided with all necessary information like name of the product, name of the crop for which it is intended, name and address of the manufacturer, date of manufacture, date of expiry, batch number and instructions for use (Prem Baboo, 2009).
- The packet has to be used before its expiry, only for the specified crop and by the recommended method of application.

Conclusion

The application of biofertilizers is necessary in the modern agricultural practices because they are renewable and environment friendly. The contain microbes which promote plant growth and crop yield. They produce metabolites making the plant resistant to stress and pathogens. It has great potential in not only influencing the soil quality but also in effective utilization of resources. Therefore biofertilizers play an important role in maintaining soil health and helps in sustainable agriculture.

References

Brahmaprakash, G. P., & Pramod, K. S. (2012). Biofertilizers for sustainability. *Journal of the Indian Institute of Science*, 92(1), 37-62.

Mahdi, S. S., Hassan, G. I., Samoon, S. A., Rather, H. A., Showkat A. D., & Zehra, B. (2010). Biofertilizers in organic agriculture. *Journal of Phytology*, 2(10), 42-54.

Mazid, M., & Khan, T. A. (2014). Future of bio-fertilizers in Indian agriculture: An Overview. *International Journal of Agricultural and Food Research*, 3(3), 10-23.

Prem Baboo., (2009). Biofertilizers and eco-friendly approach. *Indian Journal of Environmental Protection*, 29(12), 1046-1054.

Suryawanshi, R. K., Yadaw, K. N., & Umashankar, V. (2013). Importance of bio-fertilizers in agriculture. *Rashtriya Krishi*, 8(1), 21-23.

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SIGNIFICANCE OF RAPD AND ISSR PRIMERS

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RAPD (Random amplified polymorphic DNA) primers; RAPD is a type of polymerase chain reaction. Amplification of genomic DNA is done by PCR using short arbitrary primers (generally 10 bp) of random sequence. These oligonucleotides serve as both forward and reverse primer, and are usually able to amplify fragments from 1-10 genomic sites simultaneously. Amplified fragments, usually within the 0.5-5 kb size range, are separated by agarose gel electrophoresis, presence or absence of bands is detected based on polymorphism by using ethidium bromide staining. These polymorphisms are considered to be primarily due to variation in the primer annealing sites, but they can also be generated by length differences in the amplified sequence between primer annealing sites. Differentiation of the organisms is based on the presence or absence of bands.

ISSR (Inter sequence simple repeat) primers; ISSR is also a type of polymerase chain reaction. Amplification of genomic DNA is done by PCR using short tandem repetitive DNA motifs of 16-18 bp. Inter simple sequence repeat technique, which involves the use of microsatellite sequences as primers in a polymerase chain reaction to generate multilocus markers. The ISSR marker system detects polymorphisms in inter-microsatellite DNA regions without any prior sequence knowledge. About 10-60 fragments from multiple loci are generated simultaneously, separated by gel electrophoresis and scored as the presence or absence of fragments of particular sites.

Comparison Between RAPD and ISSR Markers

- RAPD and ISSR both are polymerase based and dominant molecular markers used for genetic variation among the species.

- Banding pattern is same for both the markers, presence of band is indicated as '1' and absence of band is indicated as '0'. Bands with the same migration distance are considered as homologous.
- Genetic similarity matrix is calculated using the Jaccard's similarity coefficient and a dendrogram is constructed using an unweighted pair-group method with arithmetic mean (UPGMA).

Difference Between RAPD and ISSR Markers

RAPD relies on the amplification of genomic DNA using short primers (10 nucleotides) with a random sequence, whereas ISSR is based on the amplification of regions flanked by repeating sequences (microsatellites or SSR), so the primers used contain those 2-6 nucleotides repeats with usually 2 varying nucleotides to the 3' end. RAPD markers are considered to be uniformly distributed along the genome, whereas ISSR are found only between microsatellite loci.

Pros and Cons of RAPD Marker

Pros

- No prior knowledge of DNA sequences is required
- Random distribution throughout the genome
- Very small amount of DNA is required
- Random decamer primers are commercially available for all type of species
- RAPD bands can often be cloned and sequenced to make SCAR (sequence-characterized amplified region) markers
- Cost effectiveness as compared to other markers.

Cons

- Dominant marker (Cannot separate heterozygous individuals from dominant homozygous individuals
- Sensitivity to changes in reaction conditions, which affects the reproducibility of banding patterns
- Co-migrating bands can represent non-homologous loci
- The results are not easily reproducible between laboratories.

Pros and Cons of ISSR Marker

Pros

- ISSR markers are more reproducible than RAPD
- These are easy to use, cheaper and have high throughput
- They yield multiple polymorphic loci
- A prior knowledge of the template DNA sequence is not required
- Generally, ISSR markers are dominant, but the use of a larger 50 anchored primer can yield co dominant ISSR marker.

Cons

- They aren't highly reproducible
- Some primers generate poorly reproducible band patterns
- Dominant markers

Advantages of ISSR Markers over RAPD

1. Number of polymorphic bands is more generating more percentage of polymorphism among the species.
2. ISSR markers are more reproducible than RAPD.
3. The multiplex ratio (MR) and the effective multiplex ratio (EMR) is more in ISSR marker as compared to RAPD marker. The multiplex ratio (MR) is estimated by dividing the total number of bands amplified by the total number of assays. The effective multiplex ratio (EMR) is the number of polymorphic fragments detected per assay.
4. Polymorphic information content (PIC) is calculated PIC=2fi (1-fi) where fi is the frequency of amplified allele. When average PIC values are calculated, ISSR marker exhibited higher level of polymorphism as compared to RAPD.
5. ISSR marker is a convenient tool for identifying genetic diversity among the genotypes.

Conclusion

Both the primers are used in molecular variability studies. Precise and more accurate information regarding molecular variability will be obtained by using ISSR primers.

Commercial availability of ISSR markers is more as compared to RAPD markers for all the species of disease causing organisms.

References

Khaled, A. G. A., Motawea, M. H. and Said, A. A. (2015). Identification of ISSR and RAPD markers linked to yield traits in bread wheat under normal and drought conditions. *J Genet Eng Biotechnol.*, 13(2):243-252.

Tonk, F. A., Tosun, M., Ilker, E., Istipliler, D. and TATAR, O. (2014). *Bulgarian Journal of Agricultural Science*, 20 (6)1413-1420.