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FOREWORD

It gives me immense pleasure to pen this foreword for the inaugural issue of Enlighten Agriculture. In an era where sustainable farming and innovative practices are imperative, this platform stands as a beacon of knowledge dissemination and collaboration. By bringing together researchers, farming enthusiasts and visionaries, Enlighten Agriculture promises to advance the discourse on agricultural transformation. I commend the founders and contributors for their dedication to this noble cause and encourage readers to actively engage with its insightful content. Together, let us foster a resilient and enlightened agricultural future.

(Ch. Srinivasa Rao)

FOUNDER'S MESSAGE

It gives me immense pleasure to present the inaugural issue of Enlighten Agriculture, a platform dedicated to fostering innovation, knowledge sharing, and sustainable agricultural practices. As Dr. B. R. Ambedkar rightly said, "Cultivation of mind should be the ultimate aim of human existence." This ethos inspires our journey to address critical challenges in agriculture while nurturing intellectual growth.

The future of agriculture lies in the hands of those who embrace innovation and sustainable practices. With this vision, we bring together voices from diverse fields to explore impactful solutions—from combating world hunger with advanced technologies to integrating artificial intelligence and alternative cropping systems.

This magazine is a collective effort of passionate professionals committed to empowering farming communities and enriching agricultural knowledge. I extend my heartfelt gratitude to the contributors, editorial team, and readers for their support. Let's join hands to create an enlightened path for agriculture's future.

Manu Sundavalu
Founder, Enlighten Agriculture

CO-FOUNDER'S MESSAGE

The launch of Enlighten Agriculture marks a significant step toward transforming how we approach and perceive agriculture. This e-Magazine is more than just a platform; it is a clarion call for a new era of agricultural progress. From grassroots farmers to global innovators, Enlighten Agriculture is a bridge that connects the agricultural community, fostering collaboration and the exchange of ideas. Our mission is clear: to empower those who dare to reimagine the future of farming. Through innovative research, sustainable practices, and fresh perspectives, we aim to inspire positive change in agriculture while addressing the challenges of food security, climate resilience, and equitable growth.

This inaugural issue is a testament to the dedication and vision of our team and contributors. Together, we embark on a journey to shine a light on the untapped potential of agriculture, empowering stakeholders across the value chain.

I extend my heartfelt thanks to everyone who has supported this vision. May Enlighten Agriculture continue to inspire, inform, and innovate.

Elakkya Muthukkaruppan
Co-Founder &
Honorary Managing Director
Enlighten Agriculture

EDITOR'S NOTE

It is with great pride that I present the first issue of Enlighten Agriculture. Our commitment to advancing sustainable farming practices, innovative research, and insightful perspectives continues to inspire. I thank our contributors, readers, and the dedicated team for their relentless efforts. Together, let's drive the vision of enlightened agriculture forward.

This edition of Enlighten Agriculture explores pivotal themes, from innovative technologies combating hunger to sustainable farming under heavy rains. Discover how birds influence stomatal activity, AI in agriculture, and alternative cropping systems for tobacco. Each article promises insights to inspire and educate.

Happy reading!

G. K. Dinesh
Editor-in-Chief
Enlighten Agriculture

EDITORIAL TEAM

EDITORIAL TEAM

MESSAGE FROM EDITORIAL TEAM MEMBERS BASED ABROAD

"Enlighten Agriculture represents a new and promising opportunity to bring together all stakeholders, such as researchers, farmers and industry, to move towards more sustainable agriculture and ecological practices. The future of agriculture needs to go hand in hand with the interaction of all actors, and this magazine is a great platform for meeting and common progress."

~Dr. Juan Ignacio Vílchez (Popularly Dr. Nacho!)
Principal Investigator, Lab Head at iPlantMicro Lab,
ITQB-NOVA - Universidade Nova de Lisboa, Lisbon, Portugal

"Enlighten Agriculture is your trusted source for the latest information & cutting-edge insights in the agricultural sector. From groundbreaking discoveries and innovative farming techniques to essential policy updates, we empower the public, farmers, decision-makers, & stakeholders with the knowledge needed to cultivate a sustainable and prosperous future for agriculture."

~Dr. Harsha Somashekar
Postdoctoral Researcher, Max Planck Institute for Plant Breeding Research, Germany

"Enlighten Agriculture sparks a movement, empowering young minds to champion sustainability. By nurturing a deeper connection to farming and the environment, we ignite the passion and knowledge needed to cultivate a future where agriculture and sustainability flourish together."

~Gibi Mariam Thomas
Research Scholar, Auburn University, USA

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IMPACT OF LATEST AGRICULTURAL TECHNOLOGIES ON WORLD HUNGER

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Abstract

With the global population expected to reach 9.7 billion by 2050, innovative agriculture solutions are essential to meet the accelerating demand for food. The ongoing challenge of global hunger has led to the exploration and implementation of new agricultural technologies to improve food production and distribution. This article examines the impact of these innovations, including urban agriculture, vertical farming, hybrid seed technology, protected cultivation, etc. The finding suggests that new agricultural technologies have the potential to significantly reduce world hunger.

Keywords: Poverty, Hunger, Agricultural Science, Climate change, Sustainability.

Introduction

For the hungry and malnourished people of the world, climate change is an increasingly relevant threat multiplier. With the increasing rate of world population and the continuing decrease in agricultural land, it seems difficult to produce food for such a huge population. To tackle this big problem, we need to work more on agricultural techniques to improve the production from a unit of farm. For example, the El Niño weather event of 2015–16, which was exacerbated by higher sea surface temperatures, among other factors, led to widespread food insecurity and hunger in multiple countries. Since the early 1990s, the number of extreme weather-related disasters has doubled, affecting the productivity of major crops and causing food price hikes and income losses (FAO et al., 2018). Thus, it disproportionately negative impact on people living in poverty & their access to food.

Key Aspects of Global Hunger

In developing countries, the human population is increasing continuously, specifically in African countries, where it has reached an alarming situation in terms of sustaining a healthy life on Earth. To reduce poverty and hunger, there is a need for sustainable development in every sector, particularly in agriculture and rural development. Hunger and poverty, along with many other factors, dominate the underprivileged people of society and create differences among them. The FAO finds that poverty could increase more in the world by 2030. This situation will automatically lead to hunger for poor people because they will not have any income source to buy food materials, so we must promote agricultural production in a sustainable way that will help solve this big problem. New agricultural techniques have the potential to increase production and improve the nutritional values of the food items. Higher production ultimately gives rise to more supply, which will lead to a decrease in food prices and affect the market chain.

New agricultural innovations

To eliminate world hunger and poverty, there is an urgent need for sustainable and environmentally viable solutions. The number of people forced to live in poverty could increase significantly, by 122 million, by 2030 due to climate change. Developing countries are particularly vulnerable, facing frequent floods, prolonged droughts, and other extreme weather events. Several conservation practices, such as zero tillage, crop rotation, crop diversification, and efficient irrigation management through drip and sprinkler methods, are crucial. These practices help combat the devastating effects of climate change and address the global hunger crisis in sustainable and innovative ways.

Ranking of the India in Global Hunger Index 2023

Of the total 125 countries of the world, India ranks 111th with a score of 28.7, which was serious hunger, while the global score is 18.3, which was moderate.

The Hunger Index measures countries' performance on four elements.

1. Undernourishment
2. Child wasting
3. Child stunting
4. Child mortality

Undernourishment: It represents bad health because of not getting enough food; Child wasting: indicate to a child who is too thin in height; Child stunting: A child who is too short for their age; Child mortality: Death of children under the age of five years.

Nine fields of study to solve world hunger

1. Agricultural science
2. Public policy
3. Nutrition
4. Water management
5. Reduce food waste
6. Climate change and sustainability
7. Microfinance
8. Agricultural mechanization & infrastructure
9. Biodiversity

Agricultural science: It plays an important role in reducing world hunger worldwide. During the COVID pandemic, only this sector helped the rural community of India to support their life in this crucial phase. Every day, one out of nine people in the world goes hungry.

Public policy: Global hunger comes down when we adopt the necessary steps to fight against hunger through sustainability and food security.

The policies must be in favour of small land-holding farmers and landless farmers. The government must provide loans to these beneficiaries on a subsidy basis.

Nutrition: The neonatal period is very crucial and vulnerable for a child's survival. It decreased significantly, where in 1990, there were 37 deaths per 1000 lives, which was reduced to 17 in 2022. The solution lies in education and awareness, where we are aware that people should get a healthy diet during pregnancy for the mother and child. Overall, malnutrition makes people poorer.

Water management: Water is a finite resource. All social and economic development revolved around the water. It was mentioned under sustainable development goal 6, which is the "water action agenda". In these areas, people suffer from basic needs like food, clothing, and shelter for their survival. Education and sanitation are necessary required for the upliftment of these countries. The World Bank and IMF provided funds to these countries from time to time. Without water, it is very hard to get food. Due to frequent droughts, people are compelled to malnutrition, especially children. Currently, Namibia plans to butcher elephants in the country in a bid to solve their hunger crisis that has affected around half their population, nearly 1.4 million people.

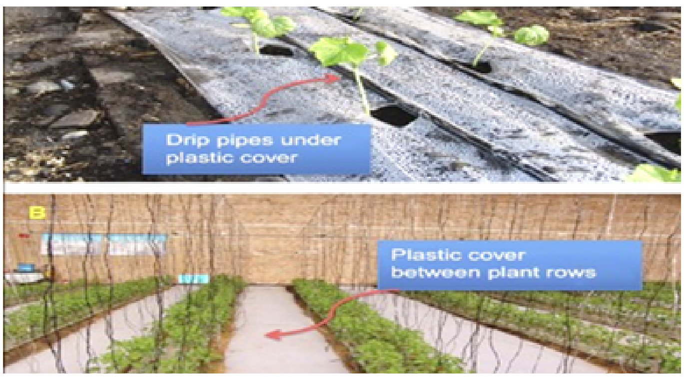

Fig. 1 Drip irrigation

Reduce food waste: Food waste is a major problem in the world. Over 30% of the food is lost each year. This waste food is a huge source of potent greenhouse gas emissions and wastes other natural resources. It is a big challenge to motivate people not to waste food. Reducing food waste while storing food to feed hungry people could help to reduce global greenhouse gas emissions and prevent environmental impacts while establishing food security.

Effect of climate change and sustainability: Anthropogenic activities play a major role in disrupting the ecological balance of nature, leading to climate change. It significantly increases the temperature to 1°C above preindustrial levels. Agriculture, also dependent on temperature and rainfall, affects the food security of common people, decreasing the yield of major cereal crops and fruit crops such as mangoes, which have decreased across Africa, widening food insecurity gaps. For every 1 0C of average warming globally, there will be:

- A 6% decrease in wheat yields
- A 3.2% decrease in rice yields

A 7.4% decrease in maize yields (The IPCC's Special Report on Climate Change and Land).

Microfinance: It is the process of providing financial assistance to those people who cannot afford food in the form of loans, starting to educate them about health and sanitation.

Fig. 2 Sprinkler irrigation

Fig. 3 Urban agriculture

Fig. 4. Vertical farming (Yuan et al., 2022)

The World Bank and IMF provide funds to African countries from time to time because they are suffering from climate change. Agriculture is the main occupation of these countries, and it is used to earn their livelihood.

Agricultural mechanization and infrastructure: Agricultural mechanization is the use of machinery in place of human labor to foster agricultural production and productivity to feed the increasing population worldwide. The arable land area is shrinking due to building infrastructure, and soil and water erosion is due to climate change activities. The ninth goal of sustainable development is to build resilient infrastructure, promote sustainable industrialization, and foster innovation.

Biodiversity: It means living, and diversity means variation, i.e., variation in the living ecosystem. biodiversity helps in many ways to create a favorable environment for our living on Earth, maintaining healthy soil It is very useful for our ecosystem to maintain and sustain the living forms on earth. It maintains a healthy soil structure, pollinates plants, and provides habitat for wildlife. Thus, biomes decrease soil erosion and provide aesthetic value.

New technologies in agriculture

The new technology in agriculture has made many changes in the system of food production, and these technologies increased the productivity

- Urban agriculture and vertical farming
- Hybrid seed technology
- Protected agriculture
- Precision farming
- Animal breeding
- Agriculture robotics
- Hydroponics
- Aeroponics

Urban agriculture and vertical farming: Urban agriculture is the activity related to agricultural commodities like growing fruits, vegetables, and flowers in the area of the cities to refresh our minds.

Hybrid seed technology: The technology of hybrid seed came in 1966-77. Hybrid seeds had a significant role in the Green Revolution. At that time, wheat and rice hybrid seeds fulfilled the country's requirements, and we also had surplus production at that time.

Protected cultivation: Growing crops under controlled conditions is called protected cultivation.

Fig. 5 Protected cultivation

In the offseason, we grow vegetable crops like cabbage, cauliflower, cucumber, tomatoes, etc. to get maximum return. Under protected cultivation, we maintain the temperature, humidity, light, and other factors that can be regulated as per the requirements of crops.

Precision farming: Precision farming is a management approach to farming through modern technology that applies various inputs to the field economically and soundly. Precision farming, in conjunction with other agricultural approaches (i.e., weed control through herbicide spray only on that area where weed emerges), reduces overall pesticide use and prevents the soil from degradation. Nutrient application with the use of variable rate technology and sensors by checking the soil capacity.

Animal breeding: In animal breeding, we successfully grade up-mating purebred males of an established breed with non-descript females over several generations (6-8 generations). For example, the Godavari breed of buffalo was developed by crossing non-descript buffalo of the coastal area of Andhra Pradesh with the male Murrah breed. From livestock, our focus is to-produce desirable traits for growth and yield, like high quantities of milk, eggs, and meat.

Agricultural robotics: A robot that was deployed for agricultural purposes. Robots are a new technology in the agriculture sector that helps in planting seeds, herbicide spray, harvesting crops, monitoring the environment, and performing soil analysis. These robots will help in proper field management and reduce working expenditure costs.

Hydroponics: It is a technique of growing small-rooted leafy vegetables in a nutrient medium without soil. In nutrient medium, we artificially provide minerals in water to crops.

Aeroponics: It is the growing of vegetable crops instead of soil, and we supply nutrient water through a mist into their roots in the air. It conserves water and controls bugs and many diseases. The water used in aeroponics is reusable. In recent times, zero-budget natural farming (ZBNF) has popularized among farming enthusiasts in India. ZBNF needs to be tested for large-scale adoptability and profitability.

Conclusion

These are the alarming situations for human existence due to climate change. According to the United Nations Food and Agriculture Organization (FAO), global hunger has been reduced from 18.6% of the world's population in 2000 to around 9.2% in 2022 due in part to advances in agricultural technologies. The FAO reported that without adapting to new climatic changes, the number of people struggling with food insecurity could increase to 115 million by 2030. So, it is necessary to adopt new agricultural techniques because they are eco-friendly and will reduce unwanted climate change.

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HEAVY RAINS AND CROP MANAGEMENT: BEST PRACTICES FOR RESILIENT FARMING

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Abstract

Heavy rains pose substantial challenges to agricultural productivity, imposing effective crop management strategies for resilience. Here are few best practices to mitigate the ill effects of heavy rainfall on crop farming. The key strategies include selecting drought-resistant and flood-tolerant crop varieties that can withstand variable moisture regimes. It is quite important to implement sustainable soil management techniques viz., cover cropping and reduced tillage, enhances soil structure and improves water retention meanwhile preventing erosion. In addition, proper drainage systems and contour farming can help manage water flow and reduce waterlogging. Timely weather forecasting and monitoring are crucial for making right decisions for scheduling planting and harvesting. Farmers are encouraged to adopt integrated pest management practices to protect crops from pests that thrive in wet conditions. Furthermore, education and community engagement in best practices foster a collaborative approach to resilience. By embracing these strategies, farmers can enhance their adaptive capacity, ensuring sustainable productivity inspite of heavy rainfall thereby resulting in food security and economic stability under climate vagaries.

Keywords: Drainage, Heavy rains, Pesticides, Water stagnation

Introduction

Climate change is the main concern for farmers due to the gambling of monsoon rains. For the past few years, abnormal rainfall has been observed in Telangana state. These rains may have a significant impact on agriculture, especially in the cotton, maize and rice-growing regions. Effective-management strategies are essential to ensure healthy yields even under extreme weather conditions. Here are a few practices for managing the effects of heavy rains on various crops in the best way.

Cotton

Cotton is predominantly grown in heavy clay soils, the yield of cotton is adversely affected with heavy rains due to lack of proper drainage (Fig 1).

Fig.1. Cotton field affected by heavy rains

In Telangana, cotton undergoes lot of stress during the critical stages viz., boll `late September to early October. Unfortunately, heavy rains during this period can cause physiological disorders, leading to crop death. To mitigate this, farmers can:

- Drain excess water from the fields.
- Dry drenched cotton seeds.
- Follow medium range weather forecasts to schedule their cotton picking.

In case of disease occurrence such as wilt, drenching of the soil of the affected plants with Copper-Oxy-Chloride @ 3g and in case of bacterial leaf blight/boll rot spraying of Copper-Oxy-Chloride @ 3g + Pushamycin or Plantomycin @ 0.1/0.2 g or streptocyclin @ 0.1 g can be done after cessation of rains. If leaf reddening occurs due to heavy rains, foliar spray of 19-19-19 @ 10 g/l can be recommended to recover the crop.

To control insect pests such as spodoptera, measures such as collection and destruction of egg masses/larvae or spray of 5% NSKE solution can be done. To promote growth after cessation of the rain, top dressing of the second dose of nitrogen and potassic fertilizers at 40 DAS and the third dose at 60 DAS is recommended.

Maize

Maize crops are highly susceptible to heavy rains and moisture stress, particularly vulnerable during the first three weeks of June, which can lead to germinating seedling or the young seedling to decay and die. Preventive measures include:

·Draining excess water and re-sowing if necessary.

·Planting using the ridge and furrow method for better water management.

During the later periods of the last week of June to the first week of August and also during the stages of vegetative to silking and tasselling, the crop may show yellowing of plants, phosphorous deficiency and pollen washout. Application of urea @20 kg and MOP@10 kg per acre after draining out excess water and foliar spray 19-19-19 @ 5 g/l or DAP @ 20g/l of water can recover the crop.

Fig.2. Maize field affected by heavy rains

For disease management, soil drenching with a chlorine solution or copper oxychloride can help. Diseases like Erwinia root stock, leaf blight, bacterial stem/ stalk rot may occur which can be controlled by soil drench with 35% Chlorine (Bleaching Powder) @ 2 g/l of water or copper oxy chloride @ 3 g/l of water along with Plantamycin @ 0.3g/ Agromycin @ 0.3g per litre of water. Also, intercultivation improves soil condition for drainage and controls weeds. During early august to early September, the cob formation takes place and the crop reaches maturity and rains cause lodging, breakage of stalk and rotting of calyx. This loss can be prevented by harvesting of cobs and drying of the calyx by exposing it to sun (Fig 2).

Long duration rice

During the period of early June to July the nursery is raised and seedlings are transplanted. Later from early to mid-July the crop gets established. From mid-July to early august the tillering phase continues.


Fig.3. Paddy field affected by heavy rains

During the 1st to 3rd week of August, the crop remains in the vegetative lag phase where the rains cause lodging, submergence, yellow stem borer, gal midge, BLB and sheath blight. The panicle emergence to booting stage continued from the last week of August to the 3rd week of September. The crop reaches harvesting stage by the end of October. The management measures and the influence of rain on crops are similar to those of short- and medium-duration rice (Fig.3).

Conclusion

Every crop reacts differently to heavy rains depending on the stage of growth. The most consistent management practice is ensuring fields are properly drained. Sowing in ridges or furrows, resowing seedlings, and using appropriate pest and disease control measures are essential to minimizing crop losses. With these practices, farmers can build resilience against the challenges posed by heavy rains and continue producing healthy crops.

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NATURE'S HELPERS: HOW BIRDS' ACOUSTIC SIGNALS INFLUENCE STOMATAL OPENING?

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Abstract

Stomata are minute epidermal openings on leaf surfaces regulating the vital process of photosynthesis and transpiration in plants. The opening and closing of stomatal apertures are regulated by many factors including turgor pressure changes, influenced by environmental and hormonal signals. Recently, birds are known to stimulate stomatal opening, by sending bird calls as "acoustic signals". Bird calls are perceived by plants via mechano-sensitive ion channels, influencing ionic changes, turgor changes, and facilitating stomatal opening. This article presents one of the interesting stories as to how birds can help plants to open stomata. It may seem to be as an unusual relation, but these feathered friends have an interesting relation with plants other than pollination, that supports healthy ecosystems. Understanding these associations offers new avenues in sustainable agriculture.

What are Stomata?

The stomata are minute openings on the leaf surfaces that regulate photosynthesis and transpiration, crucial for overall plant health. Stomata consist of a pair of specialized guard cells present in aerial surface of leaves covering mesophyll cells (Sarwat and Tuteja, 2017). Increase in guard cell turgor pressure led to a greater stomatal pore aperture, which enhances the rates of CO_2 uptake for photosynthesis and water loss, via a process termed stomatal conductance (Hetherington and Woodward, 2003).

What triggers stomata to open?

The opening of stomata is triggered by various external factors including availability of water, CO_2 levels in the atmosphere, humidity, temperature and internal factors like hormone levels mainly abscisic acid.

Recent research has revealed several signals that regulate stomatal openings in plants, encompassing a combination of environmental, hormonal, and molecular factors (Fig.1). Below are some key signals:

1. Environmental Signals: Light, CO2 concentration and humidity levels mainly influence stomatal opening. Blue light triggers stomatal opening via phototropins, activating H^+-ATPase in guard cells, which leads to ion influx and osmotic changes. Red light can also influence stomatal behavior indirectly through photosynthetic carbon assimilation. While low CO_2 levels promote stomatal opening, and high CO_2 levels typically cause stomatal closure the high vapor pressure deficit (low humidity) reduces stomatal aperture to prevent water loss (Driesen et al., 2020). Along with these factors higher temperatures can also enhance transpiration, influencing the dynamics of stomata (Hetherington and Woodward, 2003). The reactive oxygen species (ROS) generated by ozone exposure also triggers closure of stomata.

2. Hormonal Signals: Although abscisic acid (ABA) is the primary regulator of stomatal closure during drought stress, the cross-talk with other hormone regulate stomatal opening. The ABA activates ion efflux channels, leading to guard cell turgor loss, but auxin promote stomatal opening by enhancing proton pump activity and facilitating ion transport. The cytokinins, which are often antagonistic to ABA, promote stomatal opening under favorable conditions. Recently, strigolactones are also considered has emerging signals with potential roles in modulating stomatal responses under stress along with jasmonates, which facilitates stomatal closure in response to pathogen attack or abiotic stress (Sarwat and Tuteja, 2017).

3. Molecular and Intracellular Signals: Cytosolic calcium (Ca2+) changes act as a second messenger in guard cell signaling, mediating ABA, ROS, and other responses. The nitric oxide (NO) works with ABA to promote stomatal closure.

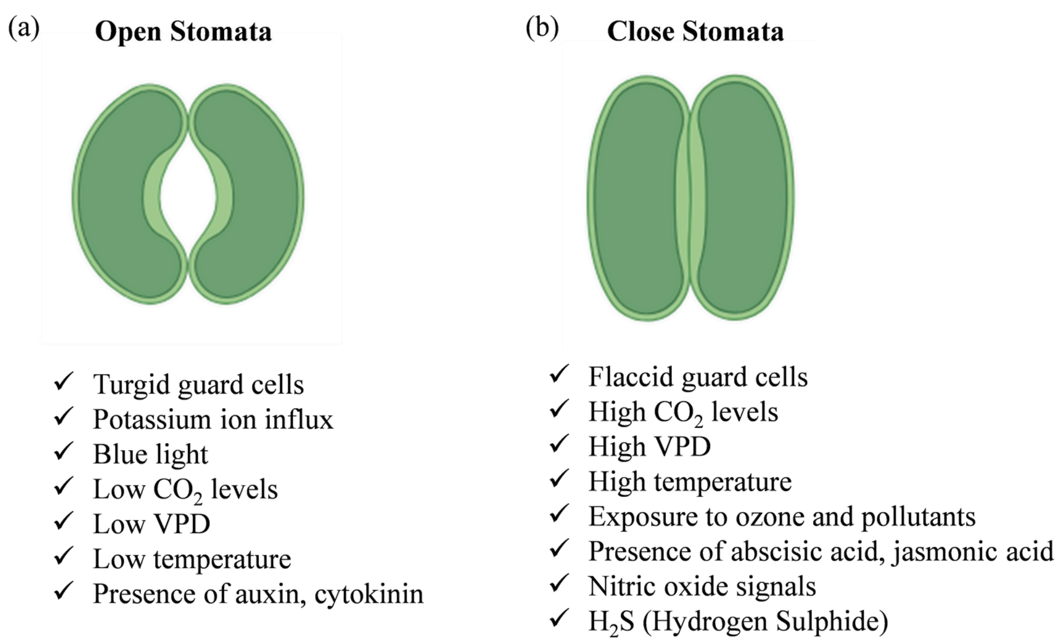

Fig.1: Factors influencing opening (a) and closing (b) of stomata. Illustration created using biorender.com

The K^+ and Cl^- ion channels are key players in regulating guard cell osmotic pressure during stomatal movements (Hetherington and Woodward, 2003). Also, sucrose and other sugars act as signaling molecules influencing stomatal aperture based on energy demands.

4. Novel Signals and Crosstalk: Recently hydrogen sulfide (H_2S) identified as a modulator of stomatal closure via interaction with ROS and NO. Theguard cell-specific peptides like RALF (Rapid Alkalinization Factor) can alter stomatal dynamics. Secondary messengers like phosphatidic acid and inositol phosphates are known to regulate guard cell signaling pathways (Driesen et al., 2020). Along with these signals, the circadian rhythm tightly controls diurnal patterns of stomatal opening and closure in plants. These signals interact in a complex network to optimize gas exchange and water use efficiency while responding to environmental and physiological changes.

The bird- plant connection

Interactions between birds and plants are diverse and play crucial roles in maintaining ecosystems. Beyond the well-known roles of pollination and seed dispersal, birds engage in surprising interactions with plants that support ecological balance. Most known relation is that the birds use plants as nesting sites or shelter. Some other common interactions include seed dispersal (Ornithochory) and pollination (Ornithophily) by birds. Certain insectivorous birds feed on plant pests, reducing herbivory and supporting plant health. For example, blue tits eat aphids and caterpillars on plants. Birds and plants often form mutualistic interactions, where birds get food (nectar or fruit), while plants get pollinated or their seeds dispersed. In some cases, birds can compete with plants for resources or cause harm, such as when some birds steal nectar without-aiding pollination (nectar robbing) (Anderson et al., 2016). These interactions are vital for maintaining ecological balance, plant biodiversity, and healthy ecosystems. The response of plants to their surrounding atmosphere particularly to sound signals (bioacoustics) was first document during 1960s by T. C. Singh, at Annamalai University in India. He experimented by playing classical music for plants. He noticed significant increase in the crops' height as well as their overall biomass. In another study, Dan Carlson patented his research on auditory fertilizer called "Sonic Bloom," in 1985. He made a statement that "Every cell wall or cell membrane maybe functions as an eardrum." These studies showed the importance of sound signals in plant development, thus opening the new field of bioacoustics (Petrescu et al., 2017). Plant detect the vibrations from the chewing of their shoots by herbivores, this triggers defense response by producing toxins (Kollasch et al., 2020). Another such example of sound perception by plants is when vibrations are induced by buzzing bees in flower petals, triggering nector production (Pujiwati et al., 2018; Raguso et al., 2020). However, further studies are required to confirm whether plants respond to sounds directly or to the vibrations induced by sounds.

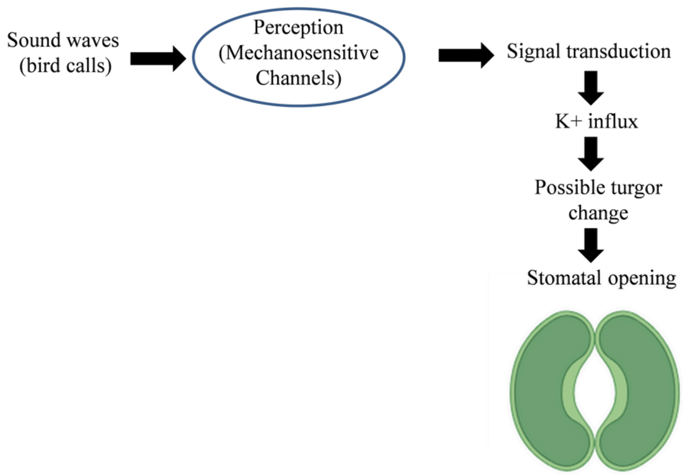

Fig. 2. Possible mechanism of stomatal opening in response to sound waves.

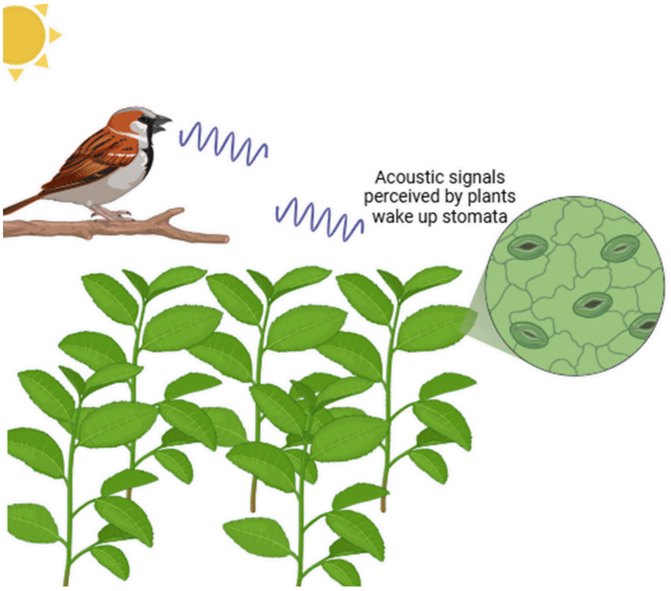

Fig. 3. Graphical representation showing influence of bird's acoustic signals on stomatal opening. Illustration created using biorender.com

The bird- stomata connection

Since plants can perceive natural sounds in the form of bird calls form their surroundings, the present article has tried to uncover the interaction between bird-stomata. Studies have documented that when bird move around the plants, they stimulate or create microclimates by stirring up the air. This creates small changes in humidity and temperature triggering stomatal opening. This is beneficial for plants during warmer conditions (Appel et al., 2014). The bird chippings can serve as bioacoustic (sound) signals that influence stomatal opening (Mishra et al., 2016). The calls can be potentially perceived by plants through mechanoreceptors (sensitive to sound waves or vibrations) present on the membrane (Pujiwati et al., 2018). These signals perceived by the cuticle regulate epidermal patterning, also influencing stomatal development (Bird and Gray, 2003). Plants generally perceive sounds through mechano-sensitive ion channels. These vibrations trigger alterations in the extracellular matrix, regulating stomatal opening, (Shih et al., 2014) but the potential mechanism behind is yet to be confirmed.

Bird calls during daytime act as sound signals to wake up stomata

Studies have shown that sound waves act as stimuli (Pagano and Del Prete, 2024). The vibrations created by bird chippings can stimulate plant's sensory systems (Mishra et al., 2016). The plants have the ability to respond to various frequencies and certain sound waves (Hussain et al., 2023) which enhance the activity of stomatal guard cells (Pujiwati et al., 2018). The sound waves are perceived by mechano-transmitters present on the cell surface, these signals triggers influx of $K+$ ions bringing changes in the turgor pressure of the guard cells causing stomata to open (Fig. 2.). The plants have internal biological clocks called circadian rhythms which regulate all the physiological processes throughout the life cycle of plant (Creux and Harmer, 2019). Bird calls, particularly in the morning, act as acoustic cues that signal the start of daylight, promoting stomatal opening to facilitate photosynthesis. When stomata open in response to these acoustic signals, plants can take in more CO_2 (Pujiwati et al., 2018), thereby enhancing photosynthesis, which is crucial process for plant growth (Fig. 3). The bird droppings showcase a healthy ecology. And also, the sound from bird chippings encourages plants to open their stomata thus affecting plants growth and development (Appel et al., 2014).

Conclusion

The use of sound signals by birds and plants to communicate exemplifies the remarkable interdependence found in nature. Delving deeper into these processes unveils fascinating mechanisms by which the organisms interact and exchange information. This not only broadens our understanding of plant physiology but also highlights the sensory capabilities of plants. Plants have the ability to hear music, further research is needed to check whether stomata act has analogous structure to ears in plants. Understanding the intricate relationship between birds and plants opens avenues for innovative practices in sustainable farming, enhancing ecosystem resilience and productivity.

A tiny step in the direction of farmer-bird-friendly methods

To foster and protect valuable relationship between birds and plants, the following bird-friendly measures can be adopted:

1. Planting Native Vegetation: Grow native plant species to create essential habitats that attract and support local bird populations.
2. Proving Water Resources: Establish small ponds or birdbaths to encourage birds and improving local biodiversity.
3. Minimize Pesticide Usage: Reduce the pesticides usage to promote healthier bird populations and preserve their natural habitats.

Happy Bird Watching!

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ALTERNATIVE CROPPING SYSTEMS TO FCV TOBACCO CULTIVATION IN INDIA

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Introduction

In the sixteenth century, tobacco was introduced to India by the Portuguese. With the advent of British colonial rule, tobacco cultivation began to be grown on a larger scale, particularly for export. Flue cured tobacco (FCV) tobacco has become one of the most well-known variety of tobacco farmed in India. Virginia, the state in which this method of curing tobacco was first created, is the name of the tobacco product commonly referred to as FCV tobacco or Virginia tobacco. The tobacco leaves are dried in a controlled environment with heat from flue pipes during the flue-curing process. FCV tobacco is very sought-after for use in cigarette manufacture since this process keeps the leaves' vibrant color and improves the flavor. India grew to become one of the world's top producers and exporters of this type, as FCV tobacco became a significant cash crop there over time.

In India, Tobacco crop is grown in an area of 0.45 M ha (0.27% of the net cultivated area) producing ~ 750 M kg of tobacco leaf. India is the 2nd largest producer and exporter after China and Brazil respectively. The production of flue-cured Virginia (FCV) tobacco is about 300 million kg from an area of 0.20 M ha while 450 M kg non-FCV tobacco is produced from an area of 0.25 M ha. In the global scenario, Indian tobacco accounts for 10% of the area and 9% of the total production (CTRI., 2023). Tobacco is one of the important commercial crops grown in India. It provides employment directly and indirectly to 45.7 million people and Rs. 6,529.30 crore in terms of foreign exchange to the national exchequer. A large share of the tobacco produced worldwide is FCV tobacco. The cultivation of FCV tobacco is primarily concentrated in the states of Andhra Pradesh, Karnataka, and parts of Telangana, with smaller areas under cultivation in Tamil Nadu, Maharashtra, and Odisha. With clearly defined wet and dry seasons, these areas have favorable climates that made them perfect for growing this crop. India has long been a major producer of tobacco, especially Flue-Cured Virginia (FCV) tobacco, which boosts employment and exports while also being a major agricultural activity. However, there are growing calls for diversifying away from tobacco cultivation due to the negative health effects of tobacco usage as well as environmental and socioeconomic issues. World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) suggested promoting economically viable alternatives other than tobacco production in order to cut down on the supply of tobacco.

Challenges associated with FCV Tobacco Cultivation

Numerous health issues, including different forms of cancer, respiratory illness and cardiovascular disorders are associated with tobacco consumption. Moreover, tobacco cultivation itself associated with environmental impact. Cultivation of tobacco is resource-exhaustive as it is labour and energy-intensive and requires huge amount of water, fertilizer and pesticides. In addition, continuous cultivation of tobacco leads to soil and soil-microbe degradation. Growing FCV tobacco undoubtedly provides financial support for many farmers. But, handling and processing of tobacco leaves forces farmers to expose indirectly to nicotine consumption. In this regard, it is necessary that feasible alternative cropping methods be adopted to reduce the health and environmental risks associated with tobacco cultivation.

Alternative Cropping Systems to FCV Tobacco Cultivation

The move away from FCV tobacco growing requires the identification and promotion of alternative cropping methods. These substitutes need to be socially and economically acceptable to the farming communities in question, as well as environmentally sound. Several potential alternatives discussed here, with a focus on their adaptability to the regions currently engaged in tobacco cultivation.

•According to research, farmers find it challenging to switch from growing tobacco to other crops since tobacco is seen as a financially advantageous crop (Hiremath, 2000; and CTRI, 2007). In rainfed conditions, it is always safer to use intercropping systems rather than relying solely on crop failures. It was noted that a good substitution approach for tobacco growing would be mixed non-tobacco cropping patterns (Panchamukhi, 2000).

•Similar studies on bidi tobacco in Karnataka showed that sugarcane in irrigated regions and soybean and sorghum in rainfed areas can be effective tobacco substitutes. The benefit-cost ratio of tobacco and other crops, when briefly analyzed, firmly indicates that the returns on tobacco is higher than those of other crops when compared to FCV tobacco. According to preliminary research, there is no economically feasible alternative to FCV tobacco, although net returns from intercropping different crops, such as groundnut, red gram, soybean, and chilli, have been positive (WHO, 1997 and www.thehindu.co.in). According to Kaur (2002), farmers in Gujarat who transitioned from tobacco to multiple planting or intercropping with cotton had an increase in net return per hectare.

Similarly, in 2000 drought conditions forced the tobacco Andhra Pradesh farmers to plant other crops (like pulses, gingelly, maize, and soybean), which they discovered were not only cheaper to cultivate than tobacco but also viable substitutes (Sharma, 2000).

•Study conducted at Karnataka revealed that, hybrid cotton+chilli+groundnut and hybrid cotton+chilli+French bean can be economically viable alternatives to FCV tobacco for the farmers. None of the alternative sole crops tried were comparable to sole crop of FCV tobacco in terms of net returns. However, chilli was the next best remunerative crop (Dinesh Kumar et al., 2010).

•Das and Bhattacharya, (2016) shown that cultivating potato (Rs. 22429/acre), maize (Rs. 16315/acre), boro paddy (Rs. 15722/acre), gave higher gross profit than motihari tobacco (Rs. 14006/acre) in Dinhata subdivision of Kuch Bihar, West Bengal. The average net profit was highest for potato (Rs. 16934/acre), followed by maize (Rs. 12916/acre), jati tobacco (Rs. 12877/acre), boro paddy (Rs. 12185/acre), motihari tobacco (Rs. 6057/acre), mustard (Rs. 2393/acre) and wheat (Rs. 1358/acre). The data indicated that average cost-benefit ratio in respect of operating cost was higher in boro paddy (1.5), maize (1.37) than jati tobacco (1.03) and motihari tobacco (0.92). Average return to total cost was also higher in boro paddy (0.87), maize (0.84), and potato (0.46) than jati tobacco (0.34) and motihari tobacco (0.25), and hence these can be economically viable alternative to tobacco.

•The regions currently under FCV tobacco cultivation, such as Andhra Pradesh and Karnataka, have favourable conditions for growing a variety of fruit crops. Mangoes, bananas, papayas, and citrus fruits are particularly well-suited to these regions. These crops have established domestic and export markets, which can provide substantial economic returns. For instance, the Banganapalli mango from Andhra Pradesh has already gained a Geographical Indication (GI) tag, enhancing its market potential.

•Millets have a high nutritional value and are increasingly being promoted as a solution to food security and nutrition challenges in India. With the Indian government designating 2023 as the "International Year of Millets," interest in and demand for these crops have increased. Urban consumers' increased health concern has also raised the demand for products made from millet, giving millet farmers ready markets to transition to.

•Agroforestry integrates trees and shrubs into agricultural systems, providing multiple benefits, including improved soil health, increased biodiversity, and additional income sources from timber, fruits, and non-timber forest products. Reliance on a single crop, such as tobacco, might carry economic risks that can ·be mitigated by having a diverse income stream through agroforestry.

Conclusion

The transition of FCV tobacco cultivation towards alternative crop or cropping systems in India is not just preferable but also constitutive in order to ameliorate the health, environmental and socio-economic problems associated with the tobacco industry. Despite FCV tobacco being at the core of agricultural economic activity within India, it is imminent to embrace the sustainable food production system due to the increasing awareness about adverse thereon. The effectiveness of other cropping systems has several determinants such as the existence of suitable technology, market opportunities, and government's politics. It is important however for the Indian government in partnership with research institutions and other Non-Government

Organizations to take to the front the provision of such support to the farmers during this change. This entails provision of technical assistance to farmers, ensuring availability of credit, creation of access to markets and the knowledge to the farmers on the alternative crops. In the last place, the changing from single FCV tobacco cultivation to other farming options is bound to engender a more stable and vigorous agricultural sector in India. Increasing the diversity of crops planted will help farmers decrease their dependence on a particular crop, increase the stability of their earnings and help advance sustainability in the agricultural environment.

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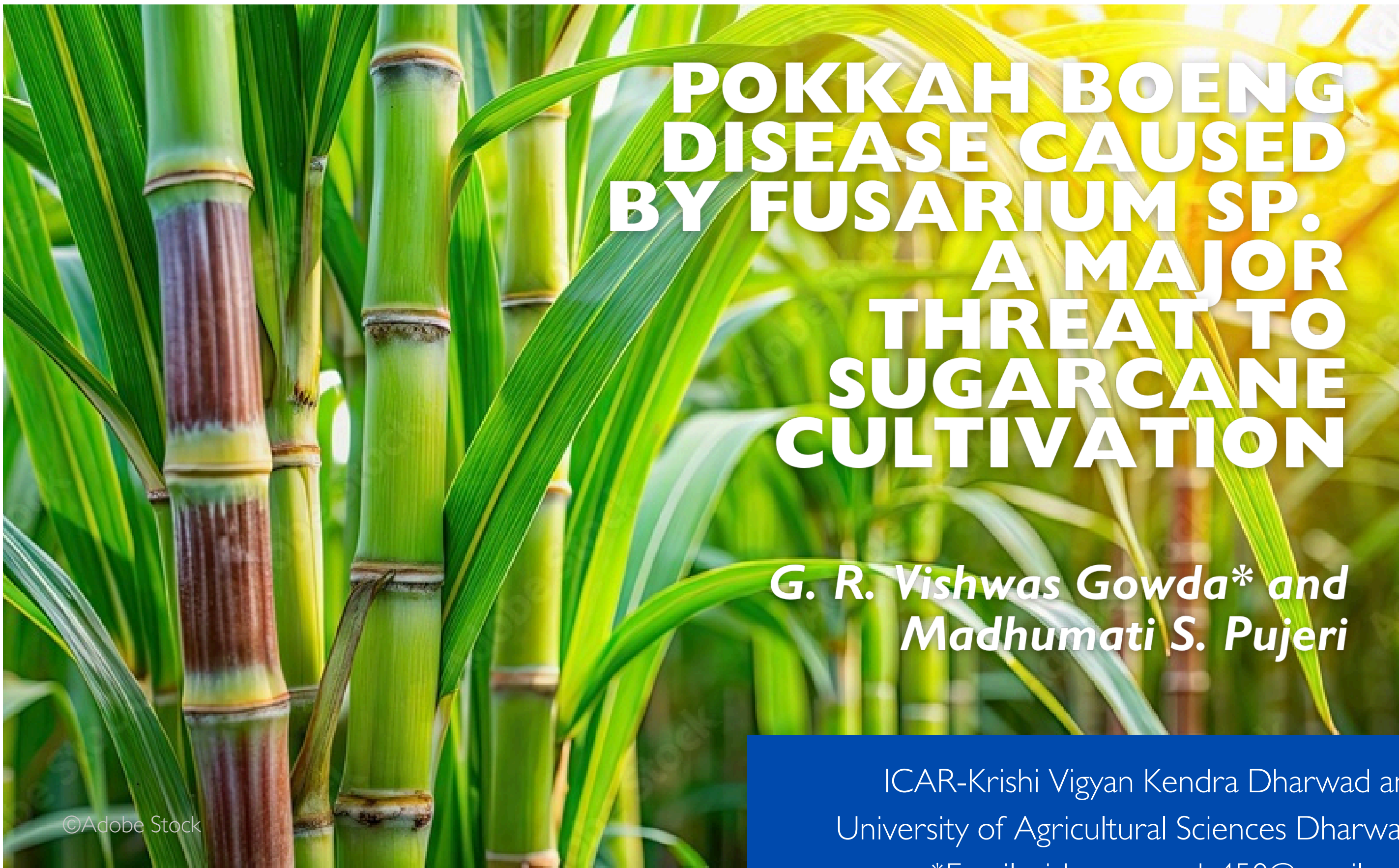

POKKAH BOENG DISEASE CAUSED BY FUSARIUM SP. A MAJOR THREAT TO SUGARCANE CULTIVATION

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Abstract

Sugarcane, cultivated over 4.2 million hectares in India, is a vital cash crop, ranking second globally in sugar production and first in consumption. However, its productivity is threatened by Pokkah Boeng (PB), a disease caused by *Fusarium spp.* first reported in India during 1983–1984. PB has become a significant challenge, particularly in susceptible varieties like Co 7219 and CoC 671, manifesting in chronic and acute phases of symptom development that lead to malformation, necrosis, top rot, and severe yield and quality losses. The disease spreads through airborne spores, rain splash, and insect injuries, thriving in conditions of high humidity, sandy clay loam soils, and temperatures between 20–32°C. Effective management involves using resistant varieties, sett treatments with fungicides and biocontrol agents like *P. fluorescens* and regular fungicidal sprays such as Bavistin and Dithane M-45. A deeper understanding of the pathogen's epidemiology, host range, and life cycle is essential for developing sustainable strategies to reduce the economic impact of PB on sugarcane cultivation.

Keywords: Fusarium, pokkah boeng, varieties, fungicides and bioagents

Introduction

Sugarcane, a vital cash or commercial crop cultivated across most Indian states, covering approximately 4.2 million hectares. India stands as the largest global consumer of sugar, with an annual demand of around 19 million metric tons, and ranks second in production, trailing only Brazil. During the 2009-10 sugar season, India's sugar output surpassed 28 million metric tons. The crop, however, faces challenges from over 200 diseases worldwide, with approximately 55 of these causing significant economic losses in India. Among these, wilt disease, commonly referred to as Pokkah Boeng, has posed a persistent threat. It has been a major concern in east coastal regions, parts of southern Gujarat, and the subtropical plains. In upland areas like Tamil Nadu, Karnataka, Maharashtra, and Andhra Pradesh, the disease has been reported sporadically, impacting crop health and productivity. Pokkah Boeng, a serious threat to sugarcane, is caused by the fungus Fusarium moniliforme, first identified by Sheldon. Its perfect stage is recognized as Gibberella fujikuroi (Sawada, 1919). Researchers across Asia have consistently confirmed Fusarium as the causal organism of Pokkah Boeng in sugarcane, emphasizing its role as a major pathogen in the region. The species Fusarium sacchari (E.J. Butler and Hafiz Khan and W. Gams 1971) and F. verticillioides are specifically associated with these respective diseases (Arie, 2019). Interestingly, fungi with slower growth rates often exhibit greater antagonism towards faster-growing fungi, potentially aiding their survival by competing effectively within specific ecological niches. Pokkah Boeng is a Javanese term denoting a malformation or distorted top was originally in Ja1va but in that time no causal agent was established and its incidence was recorded by Padwick, (1940). In India, Pokkah Boeng was first reported in Maharashtra between July and November of 1983–84, affecting the sugarcane varieties Co 7219 and CoC 671. Since then, it has evolved into a prominent disease impacting sugarcane cultivation. The pathogen spreads through wind-driven rain, infected planting material, and sugarcane stem borers, posing a persistent challenge to crop health and productivity (Patil and Hapase,1987). Fusarium is a destructive fungal pathogen classified under the phylum Ascomycota, class Sordariomycetes, order Hypocreales, and family Nectriaceae.

This diverse genus includes numerous species that act as plant pathogens, thriving in a wide range of environments and capable of persisting in soil for extended periods. These fungi often become aggressive following plant stress, leading to significant crop damage. In sugarcane, Fusarium is associated to two major diseases: one affecting the stalk and the other targeting the leaves or spindle. Fusarium verticillioides (Sacc.) Nirenberg, 1976 is the most frequently reported fungal species infecting sugarcane. This species, previously known as F.moniliforme, is capable of producing the chemical fusaric acid. Among the Fusarium species, F. verticillioides is particularly prominent. Fusarium proliferatum (Matsush.) Nirenberg ex Gerlach and Nirenberg, 1982, is another common pathogen that infects a variety of crop plants across different climatic zones. F. sacchari, F. verticillioides, F. proliferatum, and Fusarium subglutinans (Wollenw and Reinking) P.E. Nelson, Toussoun, and Marasas 1983 have all been isolated from sugarcane. F. sacchari thrives on decaying plant material and produces numerous conidia, which are dispersed by wind and rain.

Symptomology of Pokkah Boeng (PB) disease

Pokkah Boeng disease appears in sugarcane plants typically 5 to 6 months after planting, with symptoms appearing in both acute and chronic phases, depending on the severity of infection and the affected clone.

Chronic phase

In the chronic phase of Pokkah Boeng disease, sugarcane plants exhibit characteristic twisting of the top leaves accompanied by varying degrees of leaf deformities. In many cases, newly emerging spindle leaves show signs of recovery. Upon closer inspection, malformed leaves shows more lesions at the leaf base, resulting in white patches,

Twisted top symptom

Malformed leaves symptom

Internodal shortening symptom

blackened areas on the lamina, and pronounced black necrosis along the veins. In tolerant varieties, these symptoms tend to stabilize without causing significant damage. However, in susceptible varieties, the disease progresses, leading to severe leaf necrosis, paleness, yellowing, and eventual drying. Severe infections significantly hinder or reduce internodal elongation in the stalk, with up to five or six internodes often showing stunted growth depending on the disease intensity (Viswanathan et al., 2014).

Acute Phase

The acute phase of Pokkah Boeng disease leads to a severe condition known as the top rot phase, marked by the decay of the growing point or spindle leaves. While many affected canes recover from initial symptoms, those in the top rot phase rarely regain their growth, making it a critical stage in the epidemiology of Pokkah Boeng and wilt in sugarcane. In this phase, emerging leaves within the crown often die, resulting in a characteristic whip-like dried spindle. Partial blight symptoms may also be observed, including stunted growth, pale foliage, and withering or drying of affected canes, contrasting sharply with the surrounding healthy or resistant varieties. Specific varieties, such as Co 86002, Co 89003, and C79218, display pronounced wilt symptoms.

In varieties like Co 86002 and C79218, nearly 80% of the canes exhibit characteristic signs of wilt, including pale rinds, pith formation, and internal discoloration (Viswanathan et al., 2014).

Etiology of FFSC

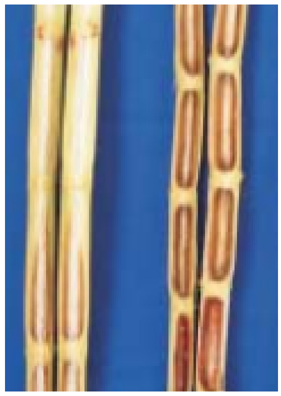
The morphological characteristics of the four Fusarium spp (F. andiyazi, F. proliferatum, F. verticillioides, and F. sacchari). were generally similar. The strains had abundant hyphae flocculation. Macroconidia usually had three to five sickle-shaped, slightly falcate, and thin-walled partitions. Microconidia were rod shaped or ovoid, with a flat base, and usually 0 to 1 septum. Fungal growth was initiated with abundant white or pink mycelium.

However, for F. sacchari, the microconidia on carnation leaf piece agar (CLA) did not have long chains produced in false heads from monopolyphialides and were oval shaped. Pseudochlamydospores were only observed in F. andiyazi and were similar to chlamydospores but had a smooth and thinner wall. The microconidia might occur in V-shaped pairs to give a "rabbit ear" appearance observed in F. verticillioides. In contrast, the microconidia in F. proliferatum were usually shorter than in F. verticillioides (Bao et al., 2023).


Whip-like spindle leaves symptom


Top rot symptom


Wilted clone

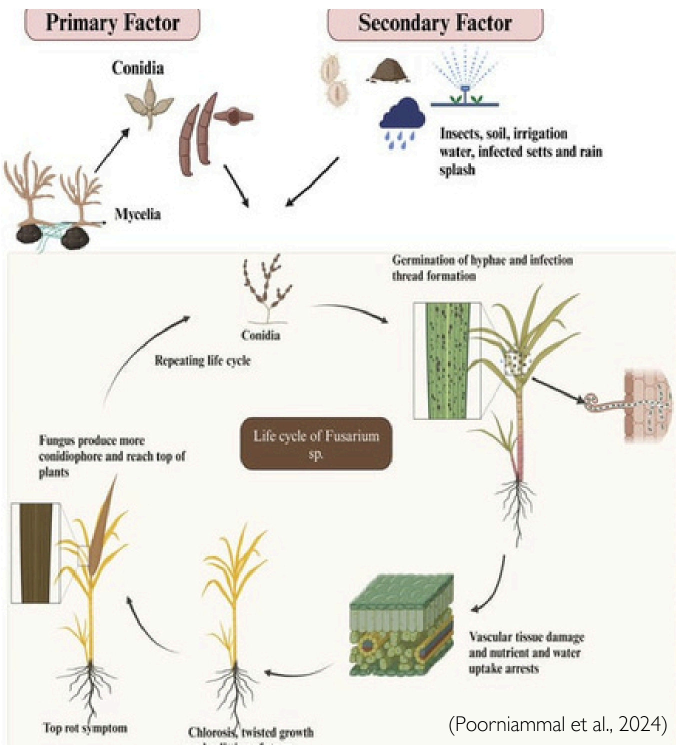

Tissue discoloration and cavity formation

Epidemiological factors for disease development

Pokkah Boeng disease thrives under specific environmental and agronomic conditions. Factors such as waterlogged soils, poor cultural practices that encourage weed growth, repeated cultivation of the same sugarcane variety in a field, and the presence of nearby susceptible varieties significantly contribute to its development and spread. Sandy clay loam soils with a pH of 6.5 to 7.5 have been observed to have the highest incidence of the disease compared to other soil types. Optimal soil temperatures for disease proliferation range from 24°C to 29°C, with the highest occurrence noted at 27.5°C. The disease becomes most severe under a broader temperature range of 20°C to 32°C, especially when accompanied by high humidity levels of 70–80% and overcast conditions during the rainy season, typically from July to September. These factors create an ideal environment for the pathogen to infect and spread, posing significant challenges to sugarcane cultivation (Poorniammal et al., 2024).

Life cycle of PB disease

Pokkah Boeng is a fungal disease primarily spread through the air via infected setts and splashes of rainwater. Secondary infections can occur when the plant sustains injuries caused by insects, borers, or natural cracks during growth. The pathogen's primary mode of reproduction and spread involves asexual spores known as conidia, which are of two types: microconidia and macroconidia. These spores germinate on the surface of plant tissues, initiating the infection process. After penetrating the plant, the pathogen forms infection threads, which develop into hyphae that infiltrate the host tissue. The fungus then establishes itself in the vascular system, disrupting the transport of water and nutrients.



Life cycle of Fusarium sp.

This interference results in distinctive symptoms, including yellowing of leaves (chlorosis), distorted growth patterns, and splitting of the stalks. As the disease progresses, the pathogen produces more conidiophores, aiding its spread and leading to "top rot," a condition where the upper part of the plant decays. While some Fusarium species undergo sexual reproduction to form ascospores, conidia remain the primary agents of disease spread (Poorniammal et al., 2024).

Host range

Fusarium moniliforme is a versatile pathogen capable of infecting a wide variety of hosts, including economically significant crops like banana, maize, cotton, mango, and sugarcane. This fungus is particularly notorious for causing diseases in crops such as maize, sorghum, rice, and sugarcane, while also producing harmful mycotoxins like fumonisins, moniliformin, and beauvericin. It has been documented to affect plant species in the Gramineae family and over 30 other plant families. Major prominent disease caused by F. moniliforme is Pokkah Boeng, which not only affects sugarcane but also affects sorghum. The sexual stage of the fungus, known as Gibberella fujikuroi. F. moniliforme infects both monocotyledonous and dicotyledonous plants, leading to a range of symptoms such as seedling blight, leaf scorch, stalk and root rot, abnormal stunting, and hypertrophy. Its broad host range and ability to cause multiple types of diseases make it a critical pathogen to monitor and manage in agriculture (Vishwakarma et al., 2013).

Management of pokkah boeng disease

Cultural methods

Ø Crop rotation should be practiced in fields affected by the disease to prevent its recurrence. Infected material, such as canes or setts showing symptoms of "top rot" or "knife cut", should be promptly removed along with the entire clump, including the root system, and destroyed by burning. Early harvesting of diseased crops can help mitigate the spread. Additionally, ensure that only healthy setts or seed material are used for planting to reduce the risk of infection.

Ø Use of resistant variety to PB disease - Co 356, Co 976, Co 1053, Co 7204, Co 7717, Co 7910, Co 8210, CoJ 82315, Co 8318, Co 8339, Co 8341, Co 8353, CoS 86218, Co 87267, Co 87268, Co 87269, Co 87270, and Co 87271 (Coimbatore), C 79113, C 84028, and C 84070 (Cuddalore), CoA 88081,CoA 89085 (AP), CoJ 46, CoJ 64, CoJ 72, CoJ 75, CoJ 76, CoJ 79, CoJ 82, CoJ 86, CoJ 89, CoJ 82191, CoJ 83536, CoJ 84191,CoJ 99192 (Punjab), CoH 1, CoH 12, and CoH 13 (Haryana) and CoJn 80141, CoJn 86141, and CoJn 86310 (MP).

Chemical methods

Ø As a preventive measure, soak the sugarcane setts in a solution of propiconazole 25% EC (1 mL/L) and imidacloprid 70 WS (1 mL/L) for 20 minutes before planting.

Ø To effectively manage Pokkah Boeng disease, apply fungicides such as Bavistin (1 g/L of water), Blitox (0.2%), Copper oxychloride, or Dithane M-45 (3 g/L of water). Two to three sprays at intervals of 15 days are recommended for optimal disease control.

Ø When no disease is present or early symptoms appear, a mixture of fluxapyroxad liquid, nano carbon liquid, and organosilicon is used. The fluxapyroxad concentration is 1.5–2.5 g/L, nano carbon concentration is 8–15 g/L, and organosilicon at 5–10 g/L are used to control Pokkah Boeng disease.

Biological methods

Ø Treating the setts with *Pseudomonas fluorescens* resulted in the lowest incidence of Pokkah Boeng disease, recorded at just 0.92%.

Ø A combination of phosphite (Phi) and Trichoderma (Taz-016) effectively controlled Fusarium in sugarcane, with 4000 µg/mL Phi and Trichoderma Taz-016, resulting in improved plant height, stem length, and leaf dry weight.

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APPLICATION OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN AGRICULTURE

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Introduction

Artificial intelligence and machine learning play a significant role in the development of agriculture. Artificial Intelligence generally called as the AI, is a kind of ideology designed to perform tasks just as how a human mind thinks and does whereas machine learning is something where the data are just applied for the machine to carry out its work just without programming it explicitly. Artificial intelligence is a branch of computer science that explains how it mimics human mind. The idea of modern artificial intelligence was designed by John McCarthy.

Artificial intelligence is distinguished into three types

Artificial Narrow Intelligence – relates to machine intelligence that exceeds human intelligence for a particular domain. Examples include playing games such as chess, self-driven cars.

Artificial General Intelligence – this system is just as smart as human brain and can perform the same intellectual activities like human.

Artificial Super Intelligence – this system refers to intelligence that greatly exceeds the cognitive performance of humans.

As we already know, India is an agricultural country and most of the people are engaged in agricultural activities for their pay. All farmers are always in the motive to get high quality and good yield crops. In this way artificial intelligence being a good planner just as human minds can help the farmers attain all they want. Factors such as temperature, light, humidity, soil fertility, soil porosity, water availability etc always affect the yield of the plants. For the accurate detection of these factors artificial intelligence so called AI can be used.

Where are AI and ML Used in Agriculture?

In present days with the developing technology and facilities, AI and ML are being used everywhere in every field especially in agriculture. Some of the main managing activities that AI performs are;

1. Soil and water management
2. Identifying and management of pest and diseases
3. General crop management
4. Agricultural produce monitoring and storage control
5. Weed management

Soil and Water Management: AI identifies and predicts the climate as well as weather to determine the amount of water that must be supplied in order to produce the maximum productivity. These AI systems optimize irrigation schedule based on the real time data and ensure that the water that is available can be used throughout the agricultural practices. These AI systems also have certain challenges such as data privacy, ethical considerations etc. By tackling these challenges and leveraging AI's full potential we can significantly improve water management in agriculture and enhance the global water security. On the other hand, for the management of the soil, AI provide the precise level of pesticides and fertilizers that can be used for the given type of soil. One of the examples of an AI driven radar developed by the Worcester polytechnic institute to provide the accurate measurements of soil moisture in the root level using which we can determine if the irrigation should be increased or decreased. Another example of AI being used in agriculture for the soil and water management is the Missouri partnership in which a public-private economic development organization has paired up with Climate FieldViewTM to provide the farmers with data that will help them make decisions related to irrigation and soil management to maximise the yield and quality of the crop. Few other examples include rule-based expert systems for evaluation of the design and performance of microirrigation systems and artificial neural systems for estimation of soil moisture.

Identifying and management of pest and diseases: The identification of pests by AI are performed using cameras, sensors and again these detections if early prevents the damage of the crops by the pests. Depending on the type of pests AI can again give us a precise and accurate treatment for the pests to vanish. It also provides more eco-friendly solutions which does not produce much harm to the people consuming the plant and prevents soil pollution. Cheeti et al in 2021 proposed an insect pest detection approach using advanced deep learning techniques for the four pests of crops. they used YOLO algorithm for the detection and the classification of pests' images. Liu and Wang applied the YOLO v3 object detector model for detecting the images of disease and pests of tomato crop and classifying it. Pests create a great impact in agriculture. If the pests are in abundant then the yield will obviously decrease, creating a great loss. SMARTSOY by Batchelor et al. and CORAC by Mozny et al. are few expert systems designed for the prevention of damages caused by the pests. Crops are highly prone to diseases that can reduce the yield of the plant. The productivity of the plant can be reduced from 10% to 95% depending upon the stage of the disease and its severity. AI can detect the diseases of plants by just using the images of the plants. Early detection of the disease is possible through AI and thus the risk of loss of yield and productivity of the plant can be prevented.

The AI classifies the entire part of the suspected plant into areas such as diseased area, non-diseased area, background etc. Few examples of AI detecting the diseases are c4.5 classifier, tree bagger, and linear support vector machines. Different artificial neural network-based model was designed to control the disease of the plant. Some hybrid systems are also used. Dr. Wheat is an expert system that was designed to diagnose diseases in wheat.

General crop management: In 1985, Mc Kinion and Lemmon created an idea of using AI techniques in crop management in the paper "expert systems of agriculture ". Boulanger in his doctoral thesis proposed a corn crop protection system. Roach et al proposed an apple plantation expert system known as POMME. Stone and Toman came up with an expert system called as COTFLEX for the cotton plantations. The accuracy of the best model so far obtained is 94%. AI provides an overall management of the crops and covers the aspects of the automated mechanisms of farming aspects.

Agricultural produce monitoring and storage control: Apart from protecting the crops from harmful agents such as pests, diseases, and harsh pesticides to prevent the loss of yield, it is also essential to ensure the proper storage of the harvested crops in the right appropriate location which has appropriate environment. Some of the systems that helps in these activities were developed by Chen and Yang, Capizzi et al, etc. Weed management: Some of the Weed's act as an endoparasite where it sucks all the nutrients, water and food of the main plant by growing near it, it can be harmful for the main plant to grow as the nutrients are being consumed by the weeds. For identifying and eliminating weed in crops like oats, barley, triticale etc, Pasqual designed a rule based expert system.

Application of drones in agriculture

Drones play a vital role in the expert systems. Some of the examples of drone operations are irrigation, monitoring, spraying, inspection of the crop, and soil analysis. It can have 3D cameras, multispectral and optical imaging. Drones are effective means for spraying fields, taking aerial photos and provide data that was not previously possible. They are also used for maping land, scout ways to improve the farm and give insights about obstacles on the farm. Despite having many benefits drones also have certain challenges. The drone can fly for very short time and is costly, especially those with better software and hardware tools. Drones require permits to be used in certain countries and also must not reach, more than 400 feet, and it is affected by the weather changes.

Conclusion

The appropriate application of AI and ML in agriculture would rectify problems related to soil health, plant health and the amount of irrigation requirements. AI helps the farmers detect environmental factors such as weather, humidity, temperature etc., in the crop field. By using AI and ML, will increase the yield and farm income. In the span of the next ten years, the influence and the impact of both AI and ML will increase and would reduce the workload and expense.

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Enlighten Agriculture E-Magazine

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Our journey of e- Magazine began with a shared vision to transform agriculture through knowledge-sharing, empowering the global farming community with cutting-edge insights, driving progress and environmental responsibility. Join us as we cultivate a brighter future for agriculture.

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At Enlighten Agriculture, our mission is to deliver timely, accurate, and unbiased information to advance the field of agriculture. We focus on providing cutting-edge, peer-reviewed content that informs grassroots organizations, industry stakeholders, and related institutions about the latest developments and innovations. Join us in exploring new frontiers and driving progress across agricultural sciences, horticulture, livestock, environmental science, and beyond.

Our Team

Our team is a diverse group of dedicated professionals committed to advancing agricultural science and practice. Together, our team combines deep expertise, a shared commitment to sustainability, and a drive for innovation to make Enlighten Agriculture a leading voice in modern agriculture.

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