Prospect and challenges of Litchi cultivation in northeast region of India

Abstract

The dynamics of pests affecting litchi crops have undergone changes over time, with litchi mites and bugs becoming less economically significant. However, insect pest infestations have emerged as a major constraint, causing substantial economic losses for growers. Litchi trees need to complete their post-harvest vegetative flush in a timely manner to produce a second flush in winter, which will then flower.Litchi fruit is highly perishable and temperature-sensitive, making it difficult to transport to distant markets without adequate cool chain infrastructure.The cumulative effect of biotic and abiotic factors compromises the agricultural value of this cash crop. Investigating natural defense mechanisms in litchi may uncover opportunities to enhance or induce antifungal compounds through defense elicitors.Further research could explore the applicability of these techniques in other countries, although registration issues may arise. Alternatively, other chemicals with similar benefits and lower health risks could be investigated. Additionally, the long-term effects of cincturing on fruit set and tree health warrant further investigation.

Keywords: litchi crops, insect pest, nutritional value, cultivation

Introduction

Litchi (*Litchi chinensis* Sonn, formerly Nephelium litchi Cambess) is a highly prized evergreen tree and fruit of the soapberry family, Sapindaceae. Renowned for its vibrant deep pink to red color and sweet, juicy aril, it's aptly called the "queen of fruits." This sub-tropical tree boasts high nutritional value, making it an excellent choice for individuals with geotropic weaknesses. Native to southern China, where it thrives along rivers and coastlines, litchi has a rich history dating back to 1059 AD, with numerous references in Chinese literature. Over time, its cultivation expanded to neighboring regions in south-eastern Asia and offshore islands. By the late 17th Century, litchi reached Eastern India (Tripura) via Burma (now Myanmar), and by the end of the 18th Century, it was introduced to Bengal. Today, major production centers include China, India, Vietnam, Taiwan, Thailand, Nepal, Australia, Africa, Israel, Mexico, Brazil, and the USA, with smaller production areas in Australia, South Africa, the USA, Mexico, Hawaii, New Caledonia, and Tahiti. In India, litchi has become a vital commercial fruit crop due to high demand and export potential, with widespread cultivation in eastern India, spanning approximately 100 km from the Himalayan foothills to Punjab, supporting millions of livelihoods. Bihar is the leading producer, followed by Uttar Pradesh, West Bengal, Punjab, Assam, Tripura, and Odisha.

Litchi Scenario in India:

Litchi cultivation is restricted to a select few countries globally, with India and China collectively accounting for 91% of worldwide production. In India, recent data indicates that approximately 720,000 metric tons of litchi are produced annually, cultivated across 98,000 hectares of land. The crop's specific climatic requirements limit its production to a few states, but despite this, India has made significant strides in increasing litchi acreage and production over the years. The majority of India's litchi production is concentrated in Bihar, West Bengal, Uttarakhand, Assam, and Jharkhand, with smaller contributions from Tripura, Punjab, and Odisha.

Table 1: Nutritive value of litchi fruit

Constituents	Fresh aril (per 100 gm)
Calories	63-64
Moisture	81-85 %
Protein	0.68-1.0 g
Fat	0.30-.58 g
Carbohydrate	13.31-16.40 g
Fibre	0.23-0.40 g
Ash	0.37-0.50 g
Calcium	8-10 mg
Phosphorus	30-42 mg
Iron	0.40 mg
Sodium	3 mg
Potassium	170 mg
Thiamine	28 mg

Nicotinic acid	0.40 mg
Riboflavin	0.05 mg
TSS (°Brix)	18-22
Ascorbic acid	24-60 mg

Major litchi growing States:

According to Sahani *et al.* (2020), Bihar spearheads litchi production, followed closely by West Bengal, Jharkhand, Assam, Chhattisgarh, Punjab, Odisha, Uttarakhand, and Tripura. Additionally, litchi cultivation has been observed in certain regions of Himachal Pradesh, and its popularity is growing in Kerala and Tamil Nadu. However, its expansion is hindered by specific climate requirements, restricting its growth compared to other fruit crops.

Popular cultivars grown in India: In India, the range of litchi varieties is limited, primarily derived from local seedling selection. Only a select few have garnered popularity or commercial significance. According to Wu *et al*. (2011), the varieties commonly cultivated in various states are:

Table 2. List of recommended cultivars

States	**Recommended cultivars**
Bihar	Shahi, China, Rose Scented, Bedana, Late seedless, late large red, purbi
Jharkhand	Shahi, China, Rose Scented, Bedana, Late seedless, Late large red, purbi
Orissa	Late large red
Assam	Shahi, China, Bombai, Deshi
Sikkim	Shahi
Manipur	Late large red
Meghalaya	Late large red
Nagaland	China, Shahi, Late large red
West Bengal	China, Ellaichi, Bedana, Bombai, Late large Red, Purbi
Chhattisgarh	Shahi, Late Large Red
Madhya Pradesh	Shahi, Late Large Red
Uttar Pradesh	Shahi, China, Rose Scented, Bedana, Dehradun, Calcuttia
Uttarakhand	Shahi, China, Bedana, Rose Scented, Dehradun, Late seedless
Punjab	Rose Scented, Dehradun, Late Seedless
Himachal Pradesh	Rose Scented, Dehradun Calcuttia
Jammu & Kashmir	Rose Scented, Dehradun, Calcuttia
Tamil Nadu	Rose Scented, Dehradun, Late Seedless, Late Large Red, Calcuttia

Challenge in litchi cultivation:

A. Climate Sensitivity

1. Impact of Unseasonal Weather: In the North East region, unseasonal weather conditions, such as untimely rainfall or unexpected temperature fluctuations, can adversely affect Litchi cultivation, disrupting the critical flowering and fruiting stages, resulting in reduced yields and poor fruit quality. Litchi requires a specific warm subtropics climate, characterized by short, dry, frost-free winters, and long, hot summers, with high rainfall and humidity (Mitra and Pathak, 2008). Commercial Litchi cultivation typically occurs between 17°-32° latitude, at low elevations in subtropics and 300-600 m in tropical locations, with cool or cold winters and warm to hot summers (Menzel, 1983; Menzel and Simpson, 1994). Research in controlled-temperature glasshouses, simulating field temperatures, revealed that optimal flowering occurred after ten weeks at 15°C, while periods exceeding 8 hours above 20°C were detrimental (Menzel and Simpson, 1995). Notably, smaller buds (a few millimeters long) were more likely to flower, whereas longer buds initiated leaf growth. These findings emphasize the importance of managing the orchard to promote new bud growth during winter.

2.**Frost and its effects on litchi trees:** In the North East region, where winter temperatures can drop significantly, litchi trees are highly susceptible to frost damage. However, frost and cold winter stress can induce dormancy, which can promote flowering. Nevertheless, if vegetative flushing occurs just before floral induction, it can lead to poor or no flowering, resulting in vegetative shoots. Consistent flowering is typically observed in areas where day temperatures drop below 20°C winter for a few weeks (Batten and McConchie, 1995). This is why the North coast frost-free region experiences more regular cropping. Furthermore, litchi trees need to complete their post-harvest vegetative flush in a timely manner to produce a second flush in winter, which will then flower.

B. Pests and Diseases

1. Common pests in litchi cultivation: The dynamics of pests affecting litchi crops have undergone changes over time, with litchi mites and bugs becoming less economically significant. However, insect pest infestations have emerged as a major constraint, causing substantial economic losses for growers. *Litchi chinensis*, originating from India, is susceptible to multiple pests, including mites like *Acerialitchii* Kiefer and the shoot borer *Chlumetia transversa* (Heather and Hallman, 2008). Additionally, other pests that attack litchi include the bark-eating weevil *Amblyrrhinusporicolis*, caterpillars (*Indarbelatetraonis, I. quadrinotata*), the fruit stone borer *Agyroplocecarpophaga*, and the butterfly *Viracholaisocrates* (Butani, 1977).

2. Disease infestation: In litchi production, two notable emerging disease issues are 'twig blight' and litchi sudden death disease, which exhibit similar symptoms. These symptoms include the death of leaves on new shoots, foliar blight, and tip dieback, making diagnosis challenging. Additionally, leaf blight causes tan spots on leaves, resembling sun scorch. Litchi fruit production faces various biotic and abiotic stressors, including susceptibility to algae, fungi, and insect pests that damage fruits and other vegetative parts, impacting yield and quality.

C. Limited varietal options

1. Identification of suitable varieties:The Northeast region of India presents a phenomenal opportunity for litchi cultivation, thanks to its diverse agro-climatic conditions. By recognizing and capitalizing on the potential of well-suited litchi varieties in this region, farmers can unleash maximum productivity, ensuring their orchards flourish and reach new heights of success!

2. **Research and development initiatives:**The currently cultivated litchi varieties in the Northeast region exhibit a limited genetic diversity, rendering them susceptible to disease and pest attacks, and constraining their adaptability to fluctuating climatic conditions. Moreover, the region's cold winter temperatures pose a significant threat to litchi flowering and fruiting. Furthermore, the limited adoption of modern agricultural technologies and practices in litchi cultivation in the Northeast region constrains productivity and efficiency. Additionally, the restricted dissemination of research findings and technologies to local farmers hinders the adoption of improved practices, thereby perpetuating suboptimal productivity.

D. High post harvest losses: Litchi fruit is highly perishable and prone to rapid deterioration after harvesting, primarily due to pericarp browning, which significantly reduces its market value (Singh and Yadav, 1988). However, frozen litchi fruits can preserve their quality and flavor if they are promptly cooled and stored at -25°C, remaining suitable for consumption for up to 1 year (Morevil, 1973). Furthermore, litchi pulp can be stored for an extended period by heat-treating it to 85°C, followed by SO_2 treatment (500 ppm) and mixing with 1% citric acid. This enables storage at room temperature (25-35°C) for 6 months or refrigerated temperatures (4-5°C) for up to 1 year (Sethi, 1985).

E. Market linkages and price fluctuations: Litchi fruit is highly perishable and temperature-sensitive, making it difficult to transport to distant markets without adequate cool chain infrastructure. To preserve its flavor and color, prompt transportation within 24-36 hours of harvesting to ambient temperature locations is essential. However, current supply chains often exceed this timeframe, highlighting the need for refrigerated transportation and cold storage facilities to access distant markets. Additionally, processing is necessary to extend the fruit's shelf life for export markets. The litchi market can be segmented into three categories: domestic, national, and export. Currently, farmers sell their produce to intermediaries, who then contract post-harvest services for harvesting, packing, and transportation to markets, where wholesalers or commission agents take over.

Prospects of litchi cultivation: The north east region boasts immense potential for litchi cultivation, thanks to its conducive climate, marked by distinct seasons and ample rainfall. The region's varied agro-climatic conditions offer opportunities for year-round production, enabling farmers to capitalize on this potential. However, to fully realize this potential, critical factors such as soil quality, effective pest management, and reliable water availability must be meticulously addressed. By collaborating with agricultural experts and leveraging local knowledge, farmers can significantly enhance the sustainability and productivity of litchi cultivation in the north east, unlocking its full potential and fostering a thriving agricultural sector.

Disease Management Strategy:

The cumulative effect of biotic and abiotic factors compromises the agricultural value of this cash crop. Investigating natural defense mechanisms in litchi may uncover opportunities to enhance or induce antifungal compounds through defense elicitors. Nutrition, particularly nitrogen and calcium levels in fruit tissue, plays a vital role in disease resistance, as observed in avocado (Willingham *et al.,* 2001). Developing more disease-resistant cultivars through conventional breeding or biotechnology is a viable option. Breeding strategies can significantly improve cultivars, addressing post-harvest issues. Advanced technologies like RAPD and AFLP can facilitate the evaluation of genetic diversity, enabling researchers to select and combine desirable traits. However, reliance on synthetic insecticides and pesticides has detrimental effects on the ecosystem and human health. Instead, Integrated Pest Management (IPM) strategies should be adopted to maintain ecologically and economically acceptable pesticide levels.

Genetic relationship studies on litchi

The investigation of genetic relationships and population structures within litchi germplasm is vital for informed breeding projects, enabling the selection of optimal parental combinations and effective management of germplasm to avoid genetic redundancy. Unlike traditional methods, UPGMA dendrogram analysis revealed four primary groups of litchi germplasm, correlated with fruit maturation time (Liu and Mei, 2006). This discovery led to the initiation of the Litchi Genome Sequencing and Resequencing Project in 2010, conducted by researchers from the China Litchi and Longan Industry Technology Research System. This project aims to provide high-throughput tools for standardizing and assessing genetic relationships within litchi collections. Furthermore, molecular genetic marker technologies offer the most direct means for cultivar identification and genetic relationship analysis, utilizing systems such as RAPD (Wang *et al.*, 2006), AFLP, SRAP, and SSR, which enable precise assessment and classification of litchi germplasm.

Tissue culture and future strategy:

In vitro propagation presents a promising alternative to traditional propagation and breeding methods in litchi, offering a rapid and efficient means of mass-producing elite genotypes. This review delves into the potential of tissue culture techniques in inducing somatic embryogenesis and organogenesis from litchi explants, highlighting the critical factors influencing regeneration success. The type of explants and plant growth regulators used significantly impact micropropagation outcomes. Auxins like 2,4-D and NAA are essential for callusing and somatic embryogenesis, while BAP and GA3 facilitate growth and multiple shoot formation. Research has primarily focused on developing somatic embryos and understanding their physiological and morphological aspects. However, enhancing the efficiency and reproducibility of micropropagation protocols is crucial for transmitting economically important traits through genetic engineering, inducing somaclonal variations, in vitro mutations, double haploids, and developing somatic hybrids in litchi.

Germplasm collection and conservation:

Historically, litchi cultivar breeding has relied on seedling selection, resulting in the preservation of over 300 cultivars in the National Litchi Germplasm repository in Guangzhou, China, the world's largest litchi gene bank (Wu *et al.,* 2007). Standardized protocols for cryopreservation and in vitro gene banks have been established for long-term conservation. Selection of improved cultivars has been practiced for thousands of years in Asia, with main cultivars like Fay Zee Siu and Wai Chee forming the basis of the litchi industry in many countries. Breeding efforts in the past 50-60 years have led to popular seedless or small-seeded cultivars like Dongguan Seedless and late-maturity cultivars like Maguili. Traditional breeding methods have great potential for improving productivity, rather than relying solely on biotechnology (Bose, 2001). Genomic DNA was isolated from young plant leaves using the method suggested by Dellaporta *et al.* (1983). The distinct features of the hybrids are listed in the Table.

Table 2 :

			Characteristics	
SI. No.	**Hybrids**	**Parental Lineage**	**Fruit-shape**	**Mature fruit colour**
1.	Hyb_CXS024	China X Sahi	Oblong	Dark red
2.	Hyb_CXS098	China X Sahi	Oblong	Reddish yellow
3.	Hyb_CXS106	China X Sahi	Cordate	Reddish yellow
4.	Hyb_BXC066	Bedana X China	Round	Crimson
5.	Hyb_BXC074	Bedana X China	Round	Dark red
6.	Hyb_GXB044	Gandaki Lalima X Bedana	Round	Reddish yellow
7.	Hyb_GXB049	Gandaki Lalima X Bedana	Oval	Red
8.	Hyb_GXB129	Gandaki Lalima X Bedana	Oval	Red
9.	Hyb_GXB153	Gandaki Lalima X Bedana	Round	Reddish yellow
10.	Hyb_SXC210	Sahi X China	Oval	Red
11.	Hyb_SXC069	Sahi X China	Oval	Dark red
12.	Hyb_DXC006	Dehrarose X China Gandaki Lalima X	Oblong	Purple red
13.	Hyb_GXC081	China	Round	Dark red
14.	Hyb_GXC128	Gandaki Lalima X China	Oval	Purple red

15.	Hyb_PXB001	Sahi X Bedana	Round	Red
16.	Hyb_PXB004	Sahi X Bedana	Round	Red

Management of canopy enhances litchi production:

Olesen *et al.* (1999) demonstrated the efficacy of pruning litchi orchards to regulate tree size, promote flowering, and enhance fruiting. They developed a predictive model that identifies the optimal pruning time based on radiation and temperature patterns along Australia's eastern coastline. This model was validated in commercial orchards, revealing regional variations in flushing rates, with slower rates observed in cooler, cloudier areas (e.g., Ballina, NSW) and faster rates in warmer, sunnier areas (e.g., Mareeba, QLD). In cases where a tree fails to flower in autumn, ethephon can be applied as a selective desiccant to remove young growth and induce a new flush. Pruning at the optimal time resulted in yields comparable to those of productive, non-pruned control trees, when normalized for canopy surface area.

Packing and Marketing:

Packaging plays a vital role in the supply chain of fruit crops, and the selection of packaging materials depends on market preferences and availability. Optimal packaging protects the fruit from damage and maintains its moisture content, ensuring optimal quality (Menzel, 2002). Sanitation levels must be meticulously maintained in packinghouses, encompassing cleanliness of collection points, drying tunnels, off-loading areas, and packing conveyer belts (De Jager *et al.*, 2000). The infrastructure of packing houses and processing plants is also crucial (De Roever, 1999; Brackett, 1999; Adams and Moss, 2000). Packing fruits in moisture- and contamination-free bags can significantly mitigate pericarp browning (Sivakumar *et al.*, 2011). Effective marketing strategies significantly impact growers' income and consumer satisfaction. Transportation of litchi can be accomplished via land, sea, or air, contingent upon market requirements. Workers involved in transportation must ensure proper temperature control to maintain fruit quality (Sivakumar *et al.*, 2011). Transportation facilities with adequate infrastructure, up-to-date market information, and supportive government policies are essential for successful litchi marketing.

Role of PGPRs in litchi production:

On the production side, the principal challenge hindering litchi from becoming a major crop in subtropical regions is low and irregular bearing (Pandey and Sharma, 1989). This issue is often attributed to failed flower initiation, leading to vegetative growth 1-2 months prior to panicle emergence and flowering, resulting in complete crop loss. However, growth regulators like synthetic auxin have demonstrated significant potential in enhancing fruit retention and yield in Israel (Stern and Gazit, 1997). Further research could explore the applicability of these techniques in other countries, although registration issues may arise. Alternatively, other chemicals with similar benefits and lower health risks could be investigated. Additionally, the long-term effects of cincturing on fruit set and tree health warrant further investigation.

Integration of plans (Vision 2050) to promote litchiproduction and cultivation by NRCL (National ResearchCentre on Litchi):

1. Priority objectives include enhancing litchi production by 33% and boosting exports of Indian litchi. Litchi's distinctive status as a premium fruit enables it to command a high price, presenting opportunities for domestic sales growth. Market research reveals that many consumers, particularly those from non-Asian backgrounds, are unfamiliar with or have not tried litchi, indicating significant potential for demand growth. Effective marketing strategies and addressing retail quality issues can help capitalize on this growth potential. Immediate actions include the introduction and selection of high-quality litchi varieties with early, mid, and late maturity to cater to diverse market demands.
2. Implement comprehensive training programs for farmers and extension agents on contemporary litchi cultivation and management techniques. This includes high-density orcharding practices and precise input application methods, enabling farmers to optimize yields and improve quality.
3. Production and distribution of quality planting materials.
4. Develop a comprehensive post-harvest management protocol to ensure optimal handling and storage of litchi fruits from harvest to wholesale markets, including distant locations, with a focus on inhibiting pericarp browning.
5. Provide expert advice on establishing market infrastructure and information systems tailored to the ethnic preferences of target markets.
6. Establish cooperative marketing units to promote fresh litchi produce and ensure fair prices for farmers.
7. Set up processing units in litchi production zones to add value and increase market opportunities.

8. Prioritize education and training for nursery workers and growers on tree care and adequate irrigation practices to ensure sustainable cultivation.
9. Implement organic farming practices to enhance nutrient cycling and promote eco-friendly cultivation.
10. Develop market-specific cultivars, packaging, and other requirements to cater to diverse customer preferences.

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