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Hurdles In Summer Cucumber Cultivation In Polyhouses Located In Hot-Humid Coastal Regions

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ABSTRACT

This article addresses the composite challenges associated with cucumber cultivation within protected structures during the summer season in coastal regions like *Konkan*, Maharashtra, emphasizing the critical role of agro-climatic conditions, control of polyhouse temperature, disinfection and buffering of media, control of insect pest attacks, and various other miscellaneous factors in maximizing crop productivity. It highlights the significance of factors such as light availability, humidity, temperature, CO_2 concentration, fertigation, and selection of cucumber variety in shaping cucumber yields. The importance of maintaining optimal microclimatic conditions, such as temperature control inside the polyhouse and canopy leaf area index, should be underscored for energy-efficient polyhouse cultivation. Additionally, the article discusses the control of fungal and insect pests and suggests measures to prevent the spread of diseases. Various strategies are presented, including the use of guard traps to deter fruit flies and the importance of disinfection and insect-proof netting. These measures collectively aim to enhance crop production within the constraints of specific climatic conditions, providing a comprehensive analysis of cultivation challenges and their appropriate solutions, particularly in hot and humid coastal regions. The article highlights the pivotal role of crop yield in improving the benefit-cost ratio for marginal farmers.

***keywords*:** Sterilization, Elevated water temperature, Nutrient solution, Frequent fogging

INTRODUCTION

Cucumber (Cucumis sativus) is a widely cultivated vegetable known for its crisp texture, mild flavor, and high water content. It is a popular choice for both culinary purposes and nutritional benefits. However, the successful cultivation of cucumbers during the summer season in coastal regions presents several challenges and hurdles. The unique combination of environmental conditions, including high temperatures, humidity, and potential salt stress, poses significant

obstacles to cucumber farmers in the regions. This article explores the various challenges in cultivating cucumbers in the coastal region (*Konkan*) during summer time, highlighting the impact of these hurdles on crop growth, yield, and quality. Additionally, the article discusses potential strategies and techniques that can be employed to mitigate these challenges and enhance the likelihood of successful cucumber cultivation in this challenging environment. By understanding and addressing these hurdles, farmers can optimize their cucumber cultivation practices, ensuring a more sustainable and productive agricultural system in the coastal regions during the summer months.

Cultivating crops in coastal regions presents a unique set of challenges, especially during the scorching summer months. Maharashtra's coastal region, known for its diverse agricultural practices, experiences distinct hurdles when it comes to cultivating crops like cucumber. Cucumber, a popular and versatile vegetable, requires careful consideration and strategic approaches to thrive in this environment. Cucumber cultivation in Maharashtra's coastal regions during the summer months demands a proactive and adaptive approach. Overcoming challenges related to climate, water management, media conditioning, pests, and heat stress requires careful planning, implementation of best practices, and perhaps the incorporation of advanced agricultural technologies. This article delves into the specific challenges in cucumber cultivation in polyhouses during summer time in coastal regions and explores potential solutions thereon.

The research field of the AICRP-PEASEM (All India Coordinated Research Project on Plastic Engineering in Agricultural Structures and Environment Management), DBSKKV, Dapoli Center comprises two distinct polyhouses. These polyhouses consist of a Galvanized Iron (GI), spanning an area of 644 sq. m., and a Bamboo polyhouse (as shown in Fig. 3) of 740 sq.m. During the summer season, it was decided to cultivate the cucumber inside the high-rise bamboo polyhouse. This endeavor aimed to cultivate the cucumber crop in the off-season. However, despite the strategic planning and execution, numerous challenges were encountered in the course of cucumber cultivation. These challenges significantly impacted crop yield, resulting in suboptimal output. The lesser yield can be attributed to a variety of cultivation challenges and underlying causes. In this article, we have presented a succinct overview of the key factors that contributed to the lesser yield of the cucumber.

CULTIVATION CHALLENGES AND MITIGATION STRATEGIES

1. Algae growth in water

We observed considerable algae growth in a small water pond constructed on the research field of AICRP-PEASEM, DBSKKV, Dapoli Center to store the irrigation water as shown in Fig.1.

Fig. 1: Considerable algae growth (increased EC & pH) observed in a small water pond constructed at the research field of AICRP-PEASEM, DBSKKV, Dapoli Center.
(**Source**: *AICRP-PEASEM, Dapoli*)

Algal growth in irrigation water can have several disadvantages, particularly about pH (acidity or alkalinity) and Electrical Conductivity (EC). Algal growth can raise the pH levels of the water. This is because algae photosynthesize, which consumes carbon dioxide, leading to an increase in pH. Also, algal growth can lead to an increase in the EC levels of the water. This is because algae release organic compounds into the water during their metabolic processes, which can increase the conductivity. Hence, the control of algae is important before we use such water for fertigation. Copper-based algaecides, such as Copper Sulphate, Quaternary Ammonium Compounds (Quats), Hydrogen Peroxide, Potassium Permanganate, etc. are the major chemicals used to control algal growth in irrigation water.

2. Media conditioning

Before cultivating any crop entities within the growing medium, the conditioning of the respective medium stands as a paramount factor influencing both growth and yield parameters. In our specific scenario, cocopeat was selected as the medium for soilless cucumber cultivation. To enhance the availability of fertilizers to the crop, it became essential to address the buffering capacities of the cocopeat while using it as fresh or reused media for the next crop, particularly in terms of Calcium (Ca) and Magnesium (Mg). It is recommended to utilize completely soluble Calcium Nitrate for buffering purposes of cocopeat. In the cases where Field grade Calcium Nitrate is employed, it is essential to ensure thorough agitation to facilitate the dissolution of particles within the mixture. Furthermore, a meticulous adjustment of pH and Electrical Conductivity (EC) levels is indispensable to counterbalance the presence of salts within the medium. Such adjustments are pivotal in ensuring a conducive environment for the cultivation process.

3. Sterilization of media

Sterilization involves eradicating microorganisms through exposure to elevated temperatures via specific treatment methods. It is essential to ensure that the substrate you are utilizing undergoes thorough sterilization to eliminate entire potentially harmful microorganisms. It is crucial to exercise caution during the sterilization process to avoid the inadvertent destruction of beneficial microorganisms. In general, temperatures ranging from 70°C to 80°C are effective in exterminating various microorganisms, such as fungi, bacteria, insects, nematodes, and weed seeds. Steam sterilization typically involves exposing cocopeat to temperatures between 80°C and 100°C for common durations ranging from 15 minutes to 1 hour based on the equipment and desired level of sterilization. Once sterilization is accomplished, the cocopeat becomes completely ready to use after rapid drying. Likewise, chemical sterilization is another technique that involves the use of chemicals to eliminate all forms of microbial life, including bacteria, viruses, and spores, from a surface or object. The most common chemicals used for sterilization include Ethylene Oxide (ETO), Hydrogen Peroxide, Peracetic Acid, Formaldehyde, Glutaraldehyde, Sodium Hypochlorite (Bleach), Ozone, etc.

Among various techniques, steam sterilization stands out as the most effective approach for eradicating unnecessary microorganisms that could potentially cause harm to a crop.

4. Selection of the variety of crop

The choice of crop variety significantly influences crop yield in greenhouse cultivation. It is important to select an appropriate variety based on the specific location and its climate. The majority of cucumber varieties are suited to moderate climates. Therefore, their yield decreases if the weather gets hot. Matching the variety to the region ensures optimal production, it is always better to select heat-tolerant variety. In cases of protected cultivation or greenhouse environments, opting for parthenocarpic varieties can be advantageous, as they don't require pollination for ovule fertilization. This is crucial because the absence of pollination, which is often facilitated by honeybees, can reduce production.

5. Control of high temperature inside the polyhouse

During the summer season, the primary issue encountered is the elevated water temperature in the original water source. It is imperative to ensure that the water source is positioned in a shaded area. If achieving direct shading is unfeasible, an alternative approach involves transferring water from the primary source to a secondary source in the shade, such as a tank or another reservoir as shown in Fig. 2.

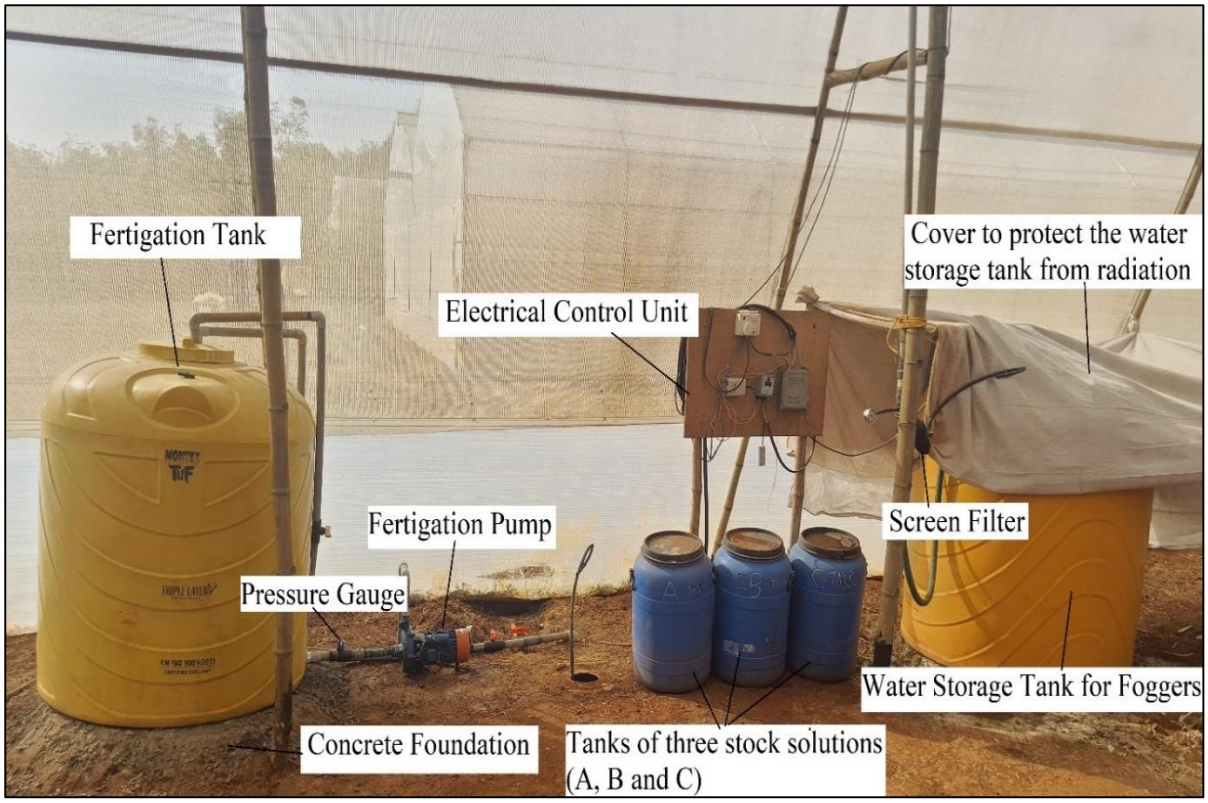

Fig. 2: A view of a high-rise bamboo polyhouse with both the systems installed i.e., fertigation system and fogging system (**Source:** *AICRP-PEASEM, Dapoli*)

Frequent fogging procedures are essential to regulate inside temperature and uphold the desired relative humidity (RH) levels inside the polyhouse. However, it is advised to exercise caution with fogging frequency to avoid the potential spread of fungal diseases like powdery mildew. This highlights the necessity for a judicious fogging method to sustain an optimal internal environment within the greenhouse. In the context of cultivating cucumber crops, maintaining the temperature within the range of 26º to 29º Celsius and ensuring a relative humidity ranging from 60% to 70% (*Extension, Alabama A&M & Auburn Universities*) are critical. The excess temperature leads to the scorching of cucumber apical buds, the burning of pre-matured fruits, and damage to upper foliage. Therefore, it is optimal not to grow cucumber vines above 50% to 70% of the gutter height of a polyhouse as the temperature rises suddenly above that height. Furthermore, an excess of relative humidity can contribute to challenges associated with ventilation as it reduces the thermal gradient in a polyhouse.

6. Control of the elevated temperature of the water tank and laterals

Similarly, the summer season gives rise to challenges within the polyhouse environment that could potentially interfere with crop production. This problem becomes particularly pronounced during the summer season due to the heating up of the water tank, pipes, and laterals. To mitigate this concern, it is advisable to position the tank in a shaded area and provide adequate covering to maintain its temperature throughout daylight hours or pre-cool the water using mechanical chillers, but this is a costly measure.

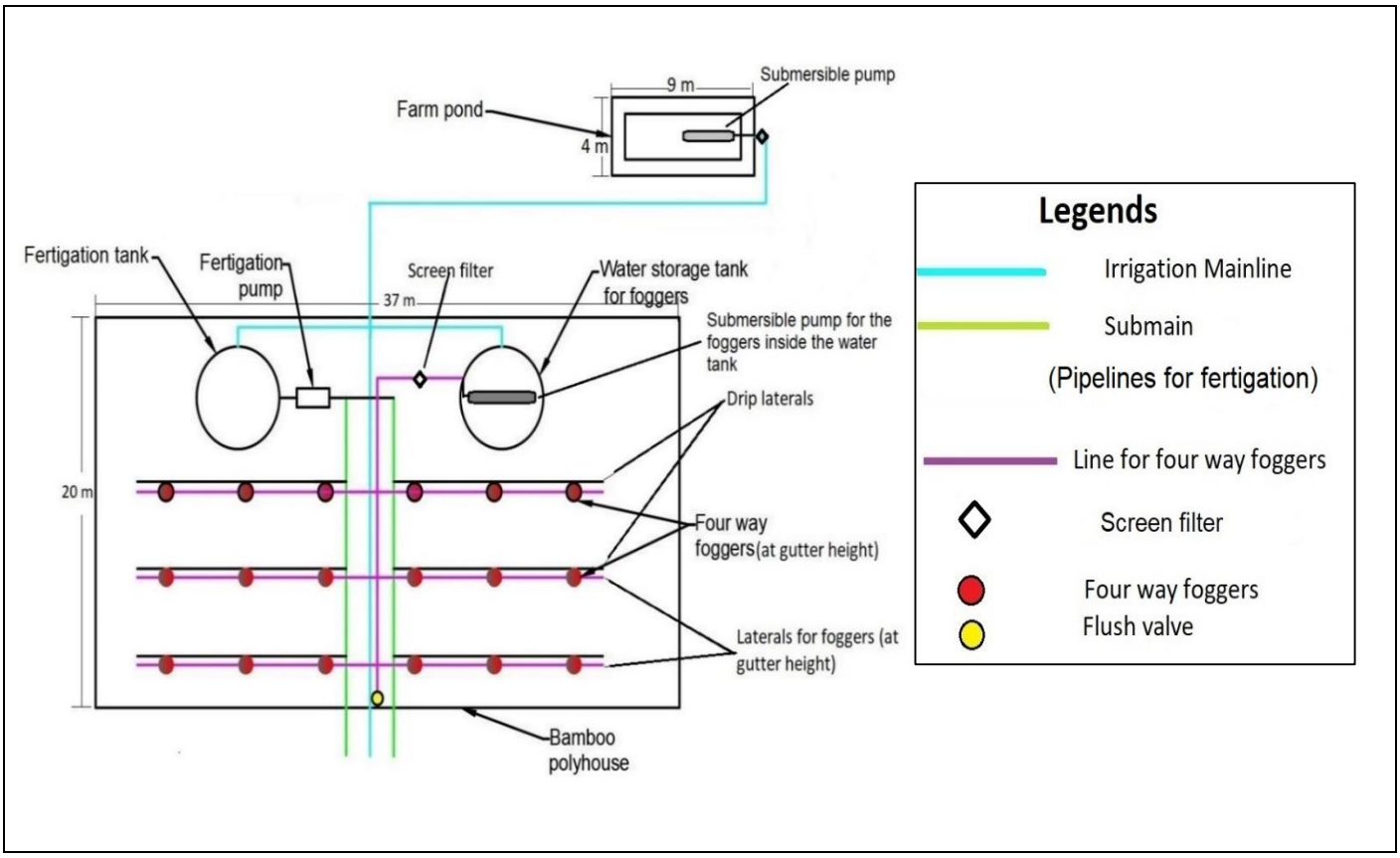

Fig. 3: Schematic presentation of the fertigation and fogging systems in the experimental bamboo polyhouse (**Source**: *AICRP-PEASEM, Dapoli*)

The layout depicting the arrangement of the fertigation and fogging systems within the high-rise bamboo polyhouse located at the research field of the AICRP-PEASEM, DBSKKV, Dapoli center is shown in Fig. 3. The diagram provides a comprehensive presentation of all the components used for both systems. The four-way foggers were installed at the gutter height of the bamboo polyhouse (Fig. 4). Submersible pump of 1.5 hp was installed inside the water tank of 1500 liters capacity to supply the water for the four-way foggers.

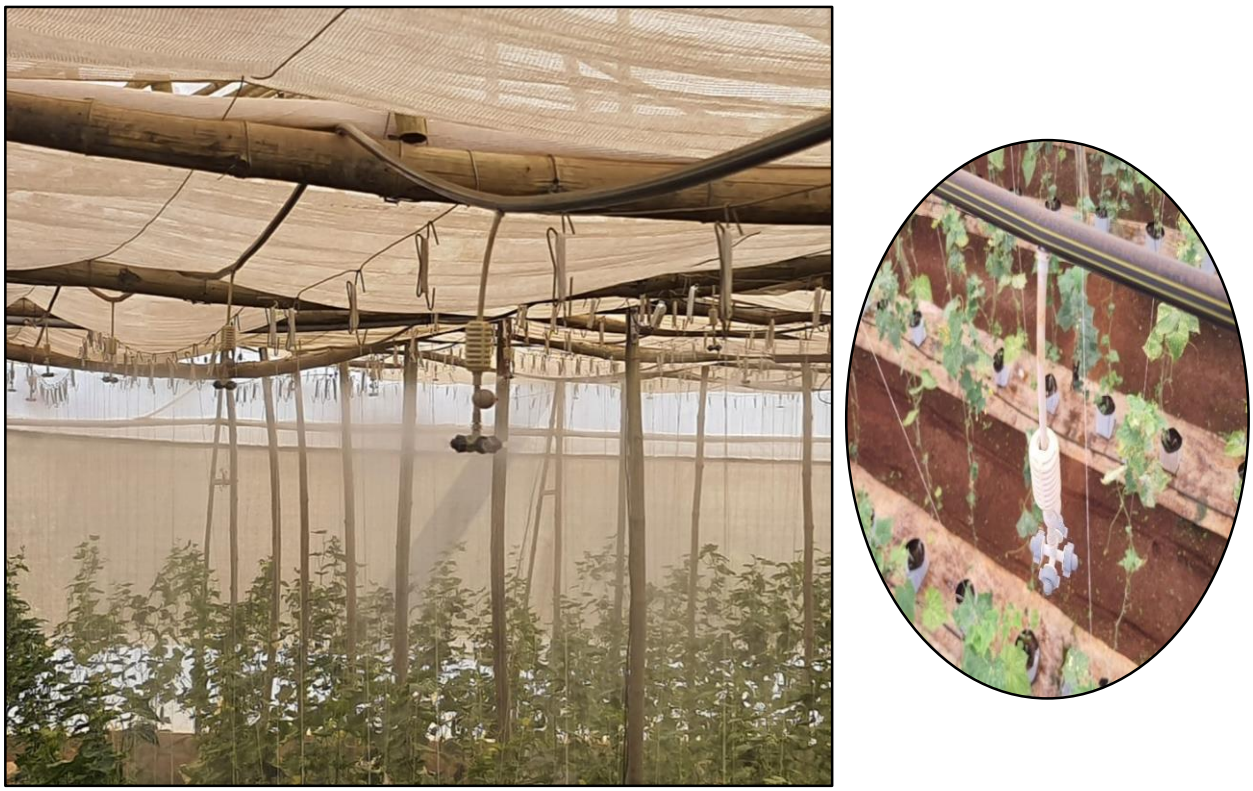

Fig. 4: Foggers installed at the gutter height inside the high-rise bamboo polyhouse of AICRP-PEASEM, DBSKKV, Dapoli Center (**Source:** *AICRP-PEASEM, Dapoli*)

7. Agro-climatic conditions

The productivity of cucumbers cultivated within protective structures is significantly reliant upon factors such as light availability (600-1000 µmol/m²/s of photosynthetically active radiation), humidity levels (60-70%), temperature variations (18°C to 24°C), CO_2 concentration (as high as 1000-1200 ppm), fertigation, cultivation methodology, and the specific cultivars used. Furthermore, the electrical conductivity (EC) of leachate (exit point) should be higher than or at least equal to the EC of the fertilizer solution applied to the plants (entry point). The crop's overall productivity is profoundly influenced by how the plants respond to the prevailing environmental circumstances. As highlighted by Marcelis *et al.* (2005), a mere 0.8-1.0 percent reduction in solar radiation reaching the plant canopy leads to as high as one percent decrease in vegetable crop yield. From both a biomass production and energy conservation perspective, maintaining daytime and nighttime air temperatures at 19.0°C and 15.0°C respectively (recommendations are for cold climate countries), coupled with achieving a canopy leaf area index (LAI) within the range of 2.0-3.0, emerges as the optimal approach for energy-efficient winter greenhouse cucumber cultivation, as reported by Luo *et al.* (2005). Consequently, the cultivation of cucumbers within protective structures warrants meticulous attention to optimal microclimatic conditions, ensuring enhanced yield and fruit quality in a limited space.

8. Management of irrigation and nutrients

Managing irrigation and nutrients in cocopeat is essential for successful plant growth. Cocopeat is a popular growing medium due to its water-holding capacity and ability to retain nutrients. Irrigation scheduling, moisture monitoring, pH control, EC measurement, leachate management, nutrient formulation, microbial activities, regular monitoring, etc. help in preventing nutrient deficiencies, over-fertilization, irrigation, and nutrients-related issues. Cucumbers can be cultivated within greenhouses utilizing soilless media, including Perlite, Rockwool, Peat, and similar substrates. In the context of cucumber cultivation on soilless media, meticulous attention is imperative in monitoring nutrient levels supplied to the crop. This is crucial due to the absence of soil, which would otherwise serve as a natural compensatory mechanism for depleted nutrients. The optimal pH range for the nutrient solution is 5.5–6.5, adjustable using acids. pH modulation involves subtle adjustments in the nitrate/ammonium ratio. Maintain EC levels below 2.2 dS/m for the nutrient solution and 3.0 dS/m in the root zone. Drain water nitrate levels should be 200–300 ppm, varying with growth stages. Maintain a nitrate/ammonium ratio not lower than 5:1 (*https://www.haifa-group.com/files/Guides/Cucumber.pdf*). Ensure zero nitrite presence to avoid impairing root function. Elevated ammonia or ammonium levels hinder potassium absorption by roots. Hence, it is imperative to manage irrigation and nutrients to get the expected yield.

9. Control of insect-pests attacks

The foremost hazardous and predominant challenge for diminished yield pertains to the attack of fungal and insect pests. Disruptions in the equilibrium of the greenhouse environment give rise to the spread of fungal infections and other diseases. Among the fungal diseases encountered in the cultivation of cucumbers, fusarium wilt appears in the early stages due to excessive moisture in the vicinity of the root zone, whereas powdery mildew emerges during the later stages. Prevalent among these challenges, downy mildew is the most comprehensive affliction in cucumber cultivation. Alongside, leaf necrosis and cup-shaped leaves stand out as other prevailing disorders within the orbit of cucumber cultivation. To prevent fruit damage caused by fruit flies, installing guard traps is recommended.

10. Other miscellaneous challenges

In the context of every fertigation cycle, the liquid chemical fertilizer within the fertigation tank must be thoroughly agitated to prevent the accumulation of residues at the tank's bottom. The implementation of appropriate training and pruning techniques is imperative for better growth of plants and also for yield. Also, it is crucial to prevent direct contact between the grow bag and the soil to mitigate the risk of soil-borne diseases. Furthermore, measures must be taken to restrict the ingress of pathogens through various avenues, such as human interference or wind, etc. The fundamental determinant for disease management is thorough disinfection of the intended cultivation area. When considering polyhouse environments, meticulous disinfection procedures employing highly effective disinfectants are imperative. Employing insect-proof netting of 40 mesh UV stabilized is an optimal strategy to prevent the ingress of insects into the confines of the polyhouse (*https://nhb.gov.in/bulletin_files/Technical_Standard.pdf*). This measure involves the

incorporation of dual entry points equipped with a strict system to obstruct the infiltration of harmful agents. Furthermore, the provisioning of double doors and sanitization facilities at the entry door of the polyhouse assumes significance, thereby serving as a preventive against pest intrusion.

By employing the provided solutions, optimal production can be achieved within constrained climatic parameters. The above-discussed points have provided a succinct analysis of cultivation deficiencies encountered during the summer season, alongside corresponding remedial measures. Given the geographical context of the coastal region within the nation characterized by a hot and humid climate, the susceptibility to crop diseases increases. Thus, the imperative is the meticulous regulation of the internal environment of polyhouses, thereby multiplying crop yields beyond expectations. The paramount factor influencing the computation of the benefit-cost ratio for marginal farmers is the yield. The ease of achieving an optimal benefit-cost ratio for marginal farmers is notably facilitated by the highlighted points outlined in the discussion. These key points serve as critical components in the overarching strategy to enhance agricultural productivity and economic viability.