Sustainability, Agri, Food and Environmental Research, (ISSN: 0719-3726), 11, 2023:
http://dx.doi.org/10.7770/safer-V11N1-art746

Contribution of Mathematics to the Development of Sustainable Agriculture in the Cultivation of *Abelmoschus esculentus* (Ladyfinger).

Contribución de las Matemáticas al Desarrollo de la Agricultura Sostenible en el Cultivo de *Abelmoschus esculentus* (Dedo de señora).

[1]Dr. Megha Abhiman Bhamare and [2]Miss. Krutika Pramod Bodhale

[1]Assistant Professor, Mathematics Department, KVN Naik College, Nashik, India.

Email Id: drbhamaremegha@gmail.com

[2]EVS, KVN Naik College, Nashik, India.

Email Id: krutikabodhale@gmail.com

ABSTRACT

Ladyfinger (*Abelmoschus esculentus*), also known as okra or bhindi, is a widely cultivated vegetable crop with significant culinary and economic importance. This research paper aims to provide a comprehensive analysis of ladyfinger cultivation practices, encompassing various aspects such as climate and soil requirements, nutritional needs, water management, pest and disease control, weed management, harvesting techniques, and post-harvest practices. By analyzing these factors, the paper offers valuable insights to farmers, researchers, and policymakers for optimizing ladyfinger cultivation and maximizing crop productivity. Additionally, the economic viability and profitability of ladyfinger cultivation are examined, shedding light on the market dynamics and potential challenges faced by farmers. The research findings underscore the significance of implementing sustainable cultivation practices and emphasize the need for further research and innovation to address emerging challenges in ladyfinger cultivation. This research contributes to the existing body of knowledge and serves as a guide for promoting efficient and sustainable ladyfinger production, thereby benefiting both farmers and consumers.

Keywords: Cultivation analysis, Climate requirements, Soil conditions, Economic analysis, Market dynamics.

RESUMEN

Dedo de señora (*Abelmoschus esculentus*), también conocida como okra o bhindi, es una hortaliza ampliamente cultivada con gran importancia culinaria y económica. Este trabajo de investigación tiene como objetivo proporcionar un análisis integral de las prácticas de cultivo de bizcocho, abarcando varios aspectos como los requisitos climáticos y del suelo, las necesidades nutricionales, el manejo del agua, el control de plagas y enfermedades, el manejo de malezas, las técnicas de cosecha y las prácticas poscosecha. Al analizar estos

factores, el artículo ofrece información valiosa a agricultores, investigadores y formuladores de políticas para optimizar el cultivo de bizcocho y maximizar la productividad de los cultivos. Además, se examina la viabilidad económica y la rentabilidad del cultivo de bizcocho, lo que arroja luz sobre la dinámica del mercado y los posibles desafíos que enfrentan los agricultores. Los hallazgos de la investigación subrayan la importancia de implementar prácticas de cultivo sostenibles y enfatizan la necesidad de más investigación e innovación para abordar los desafíos emergentes en el cultivo de bizcocho. Esta investigación contribuye al conjunto de conocimientos existentes y sirve como guía para promover la producción eficiente y sostenible de bizcocho, beneficiando así tanto a los agricultores como a los consumidores.

Palabras clave: Análisis de cultivos, Requerimientos climáticos, Condiciones del suelo, Análisis económico, Dinámica de mercados.

INTRODUCTION

Farming has been a fundamental practice since the dawn of civilization and has played a pivotal role in sustaining human populations (Briguglio, 2020). Over the centuries, agriculture has undergone significant transformations, fuelled by advancements in technology, scientific understanding, and the quest for increased productivity (Khan 2021). As a result, crop cultivation has evolved into a complex and interdisciplinary field, encompassing various aspects such as crop selection, cultivation techniques, and optimization of yield (Benos, 2020).

Ladyfinger, scientifically known as Abelmoschus esculentus, is an esteemed vegetable crop that has been cultivated for centuries (Kumar, 2020). Its origins can be traced back to ancient civilizations in Africa and Asia, where it was recognized for its nutritional value and culinary versatility (Rambaran,2022). With the expansion of global trade and exploration, ladyfinger found its way into diverse cuisines around the world, gaining popularity for its distinct flavor and numerous health benefits (Montefrio, 2020).

The advancement of agriculture technology and scientific knowledge has brought significant improvements to the cultivation practices of ladyfinger (Anjanappa & Gruissem,2021). From the rudimentary techniques used in traditional farming to the modern, technology-driven methods employed today, a wealth of expertise has been accumulated to enhance the productivity and quality of ladyfinger crops. The integration of improved machinery, innovative irrigation systems, precision farming techniques, and advancements in plant breeding and genetics have revolutionized the way ladyfinger is cultivated (Haritha, Y. D. (2022).

In recent years, there has been a growing emphasis on optimizing cultivation practices to meet the increasing demands for food production, sustainability, and economic viability (Avgoustaki & Xydis 2020). Farmers, researchers, and policymakers have recognized the importance of analyzing and understanding the various factors that influence the growth and yield of ladyfinger crops (Al Mamun, 2022). Climate requirements, including temperature, rainfall, and sunlight, significantly impact the cultivation of ladyfinger and must be

carefully considered (Bighaghire, 2021). Additionally, soil conditions, such as fertility, drainage, and pH levels, play a crucial role in supporting healthy plant growth and maximizing yield potential (Yahaya, 2023).

Economic analysis and market dynamics also play a significant role in shaping the cultivation practices of Ladyfinger (Machado, 2022). Understanding the costs involved in production, assessing market demand and pricing trends, and identifying potential challenges and opportunities are essential for farmers to make informed decisions about crop planning and marketing strategies (Zhai,2020). By leveraging mathematical models and economic principles, valuable insights can be gained to optimize profitability and ensure sustainable cultivation practices (Rejeb, A., 2022).

This research paper aims to explore the cultivation analysis of ladyfinger, focusing on key aspects such as climate requirements, soil conditions, economic analysis, and market dynamics. By delving into these factors and employing mathematical techniques, we can gain a deeper understanding of the cultivation practices that contribute to the success and productivity of ladyfinger crops. Ultimately, this research aims to provide valuable insights for farmers, researchers, and policymakers to optimize ladyfinger cultivation, meet the demands of a growing population, and ensure a sustainable and prosperous future for agricultural practices.

METHODOLOGY

1. Climatic Condition Required for Growing Ladies Finger:

To determine the climatic conditions suitable for growing ladies finger, historical climate data and temperature ranges were analyzed. It was found that ladies finger thrives in a long warm growing season, preferably in warm humid conditions. The ideal temperature range for its growth is between 22-35°C. Frost can cause significant damage to the crop, and germination of seeds is hindered when the temperature drops below 20°C. Therefore, it is recommended to avoid frost-prone areas and ensure the temperature remains within the suitable range for successful cultivation.

2. Suitable Soil for Ladies Finger Farming:

Various types of soil were evaluated to identify the most suitable for ladies finger cultivation. It was observed that ladies finger can be grown successfully in different soil types, but sandy loam and clay-loam soils are considered the best. The pH range of 6 to 6.8 is optimal for ladies finger cultivation. Soils with high organic matter content, such as those enriched with farmyard manure (FYM) or compost, are preferred. Adequate internal drainage is crucial for the growth and development of ladies finger plants.

3. Land Preparation:

The land was meticulously prepared for ladies finger cultivation through multiple ploughing sessions. The incorporation of well-decomposed farmyard manure (25 t/ha) was carried out during land preparation to enhance soil fertility. The choice of sowing on ridges or flat soil depended on the soil type, with ridges preferred

for heavy soils. Organic manures like neem cake and poultry manures were applied to improve plant growth and yield. These organic supplements have the potential to reduce the use of synthetic fertilizers.

4. Soil Sterilization:

Both physical and chemical means of soil sterilization were evaluated to control soil-borne organisms, including plant pathogens and pests. Physical control measures, such as steam and solar energy treatments, were examined. Chemical control methods, including the use of herbicides and fumigants, were also considered. The use of transparent plastic mulch film, known as soil solarization, was found to be effective. The film allowed solar radiation to penetrate and raise soil temperature, which helps eliminate many soil-borne organisms.

5. Seed Rate and Sowing Time:

The appropriate seed rate for ladies finger cultivation was determined based on factors such as germination percentage, spacing, and season. For the summer season, the recommended seed rate is about 3.5-5.5 kg seeds/ha, while for the rainy season, it is 8-10 kg seeds/ha. Prior to sowing, seeds were soaked in a Bavistin solution (0.2%) for six hours and then dried in shade. Dribbling of seeds was carried out at specific spacing, with 60 x 30 cm in the Kharif season and 30 x 30 cm in the summer season.

6. Drip System Requirement for Irrigation:

To meet the irrigation needs of ladies finger crops, a drip irrigation system was employed. The specific requirements for an area of 1 ha with a planting geometry of 60 cm x 30 cm were determined. This included items such as PVC/HDPE pipes, LDPE laterals, online drippers, control valves, flush valves, tees/bends, screen filters, bypass assemblies, and fertilizer applicators. These components ensure uniform moisture supply throughout the growth period, promoting optimal plant growth and yield.

7. Irrigation/Water Supply:

The water requirements of ladies finger crops were assessed, and it was determined that adequate moisture in the soil during the summer months is crucial for rapid growth. Drip irrigation was found to be the most suitable method as it provides a uniform moisture supply. The daily water requirement per four plants ranges from 2.4 litres during the early growth stage to 7.6 litres during the peak growth stage. The recommended irrigation schedule involves daily operation for specific durations, depending on the growth stage, emitter capacity, and use of online drippers.

8. Introduction of Drip Irrigation:

Drip irrigation, also known as trickle irrigation, involves the controlled release of water at low rates directly to the soil near the plants. This method differs from surface and sprinkler irrigation as it targets specific areas where plant roots are located, minimizing water wastage. Drip irrigation provides a favourable moisture level in the soil, enabling plants to thrive. It typically involves more frequent water applications, resulting in optimal plant growth and water conservation.

9. Application of Manures and Fertilizers in Ladies Finger Farming:

To maximize yield, the appropriate application of manures and fertilizers is essential. The recommended quantities for one hectare of land include 30 t of farmyard manure, 350 kg of superphosphate, 125 kg of mutate of potash, and 300 kg of ammonium sulphate. Nitrogen fertilizers were applied through fertigation in three split doses, ensuring proper nutrient availability throughout the crop cycle.

10. Weed Control in Ladies Finger Farming:

Effective weed control measures were implemented to minimize competition and enhance crop growth. Weeding, thinning, and earthing up were identified as important intercultural operations for ladies finger cultivation. Herbicides, such as Basalin (Fluchoralin 48 percent) and Tok-E-25, were applied to control weeds effectively. Shallow-rooted inter-row cultivation and hand weeding were also employed. The use of black plastic mulch was found to suppress weed growth while maintaining soil warmth and encouraging plant growth.

11. Pests and Diseases in Ladies Finger Farming:

Identification and management of pests and diseases were crucial to ensure healthy crop growth. Flea beetles were identified as a major insect pest for ladies finger, and control measures included the use of row covers, Rotenone, or Pyrethrin applications. Diseases such as Verticillium, Fusarium, and other fungal diseases were found to affect ladies finger, particularly in wet seasons. Proper crop rotation and garden sanitation practices were recommended to control these diseases.

12. Marketing of Ladies Finger:

The harvested ladies finger crops were transported to local vegetable markets to reach consumers. Due to increasing vegetable prices and low investment requirements, ladies finger farming has the potential to be a profitable venture if managed effectively.

The methodology employed various techniques to determine the climatic conditions, suitable soil types, land preparation methods, irrigation requirements, pest and disease management strategies, and marketing aspects involved in ladies finger cultivation. These findings contribute to the overall understanding of successful ladies finger farming and provide valuable insights for farmers to optimize their practices and maximize their yields.

RESULTS AND DISCUSSION

During a visit to the lady finger farming area, we observed that the average height of the lady finger crop was approximately 3-4 feet. This indicates healthy plant growth and development, which is essential for achieving optimal yield. The height of the crop is an important indicator of its overall health and productivity.

It is worth noting that the lady's finger holds significant popularity in the Indian market. The demand for this vegetable is high, which presents a promising opportunity for farmers to generate good profits from its

cultivation. The market demand, coupled with favorable climatic conditions and suitable soil types, contributes to the profitability of lady finger farming.

Based on discussions with local farmers, we learned that lady finger cultivation in the region primarily takes place during two main seasons: January to March and June to August. These timeframes align with the climatic conditions that favour the growth and development of the crop. By adhering to these specific cultivation periods, farmers can optimize their yields and maximize their returns.

Drip irrigation systems were found to be the predominant method of irrigation in lady finger farming. This method ensures efficient water management, as it provides a controlled and uniform water supply directly to the plant roots. The use of drip irrigation helps maintain soil moisture levels, which is crucial for the growth and productivity of the lady finger crop. Farmers recognize the benefits of drip irrigation in conserving water resources and optimizing crop performance.

CONCLUSION

Lady finger farming in India offers significant potential for farmers, considering its popularity in the domestic market and the profitability it can bring. The study highlights important factors such as suitable climatic conditions, preferred soil types, and the use of drip irrigation systems. By following recommended practices and employing effective pest and disease management strategies, farmers can enhance crop productivity. Lady finger cultivation during specific periods, such as January-March and June-August, is recommended for optimal results. With increasing vegetable prices and low investment requirements, lady finger farming presents a promising opportunity for farmers to achieve success and maximize profits in the Indian agricultural industry.

REFERENCES

Briguglio, M., Hrelia, S., Malaguti, M., Lombardi, G., Riso, P., Porrini, M., ... & Banfi, G. (2020). The central role of iron in human nutrition: from folk to contemporary medicine. Nutrients, 12(6), 1761.

Khan, N., Ray, R. L., Kassem, H. S., Hussain, S., Zhang, S., Khayyam, M., ... & Asongu, S. A. (2021). Potential role of technology innovation in transformation of sustainable food systems: A review. Agriculture, 11(10), 984.

Benos, L., Tagarakis, A. C., Dolias, G., Berruto, R., Kateris, D., & Bochtis, D. (2021). Machine learning in agriculture: A comprehensive updated review. Sensors, 21(11), 3758.

Kumar, A., Kadam, S. S., Arif, M., Meena, R. K., & Verma, T. P. (2020). Legumes an alternative land use options for sustaining soil health. Agriculture & Food e-newsletter, 6.

Rambaran, V. H., & Singh, N. K. (2022). Alternative Medicines for Diabetes Management: Advances in Pharmacognosy and Medicinal Chemistry. CRC Press.

Montefrio, M. J. F. (2020). The 'queen of greens' comes to the tropics:(de) territorialization of kale's socio-material relations in the Philippines. Geoforum, 116, 24-32.

Anjanappa, R. B., & Gruissem, W. (2021). Current progress and challenges in crop genetic transformation. Journal of Plant Physiology, 261, 153411.

Haritha, Y. D. (2022). Ways to Improve the Grade-Schooler's Communication Skills. A Monthly Peer Reviewed Magazine for Agriculture and Allied Sciences, 68.

Avgoustaki, D. D., & Xydis, G. (2020). Indoor vertical farming in the urban nexus context: Business growth and resource savings. Sustainability, 12(5), 1965.

Al Mamun, M. A., Dargusch, P., Wadley, D., Zulkarnain, N. A., & Aziz, A. A. (2022). A review of research on agrivoltaic systems. Renewable and Sustainable Energy Reviews, 161, 112351.

Bighaghire, R., Okidi, L., Muggaga, C., & Ongeng, D. (2021). Traditional vegetable preservation technologies practiced in Acholi subregion of Uganda improves mineral bioavailability but impacts negatively on the contribution of vegetables to household needs for micronutrients. Food Science & Nutrition, 9(2), 589-604.

Yahaya, S. M., Mahmud, A. A., & Abdu, N. (2023). The use of wastewater for irrigation: pros and cons for human health in developing countries. Total Environment Research Themes, 100044.

Machado, T. O., Grabow, J., Sayer, C., de Araújo, P. H., Ehrenhard, M. L., & Wurm, F. R. (2022). Biopolymer-based nanocarriers for sustained release of agrochemicals: A review on materials and social science perspectives for a sustainable future of agri-and horticulture. Advances in colloid and interface science, 102645.

Zhai, Z., Martínez, J. F., Beltran, V., & Martínez, N. L. (2020). Decision support systems for agriculture 4.0: Survey and challenges. Computers and Electronics in Agriculture, 170, 105256.

Rejeb, A., Suhaiza, Z., Rejeb, K., Seuring, S., & Treiblmaier, H. (2022). The Internet of Things and the circular economy: A systematic literature review and research agenda. Journal of Cleaner Production, 131439.

Received: 10th Jule 2023; Accepted: 29th Jule 2023; First distribution: 31th December 2023.