BOHR Journal of Pharmaceutical Studies
2023, Vol. 1, No. 2, pp. 40–46
DOI: 10.54646/bjops.2023.06
www.bohrpub.com

REVIEW

Modern Developments in the Growing of Medicinal Plants

Manish Ahire*, Aakash Indrekar, Komal Kate, Jyoti bhande and Dattaprasad Vikhe

Pravara Rural College of Pharmacy, Loni, India

***Correspondence:**
Manish Ahire,
manish.ahire125@gmail.com

Received: 15 June 2023; **Accepted:** 26 June 2023; **Published:** 17 July 2023

Nature has provided us with improved settings throughout thousands of years to promote the growth of medicinal plants. Plants have been used as medicines since ancient times because people thought they were safe and beneficial to human health. For their main healthcare requirements, 80% of the world's population still mostly uses alternative medicine systems. Several kinds of secondary metabolites, also known as bioactive plant elements, are found in plants and give them their medical value in nature. Scientific agriculture uses technological features to generate secondary metabolites from medicinal plants, but simple methods must be used for their growth, collection, and preservation. The phytochemicals that play a significant part in the pharmacological activities of medicinal and aromatic plants include alkaloids, glycosides, tannins, resins, volatile oils, and other bioactive phytochemicals. The physical environment, which includes sunlight, temperature, rainfall, and soil type, significantly affects how medicinal plants grow and develop as well as the secondary metabolites that emerge from those processes. Biotechnological approaches are being used to improve output and potency of medicinal plants, such as tissue culture, micropropagation, synthetic seed technologies, and methods based on molecular markers. This article also provides a description of the many advanced technologies currently being used in agriculture.

Keywords: medicinal plants, grafting, budding, micropropagation, cultivation, monoculture, hydroponics, agricultural technology, harvesting

Introduction

Most people's main healthcare is based on medicinal plants, which are also a substantial source of income for many rural residents, especially those who live close to woods. For more than 80% of the populace in underdeveloped nations that rely on conventional medical practices, they provide primary healthcare. In recent years, herbal medications have also grown in popularity due to their rising acceptance in both developed and developing nations. The awareness of the negative side effects of many contemporary pharmaceuticals is the fundamental reason for the return of herbal medicines. Large-scale commercial harvest from the wild increased as a result of the continuously rising demand for herbal medicines (1).

The supply chain is negatively impacted by the steadily rising demand for medicinal plants, which results in destructive harvesting and adulteration for real medications. During the past 20 years, both industrialized and developing nations have seen a marked surge in interest in traditional medical practices, particularly herbal remedies. Significant economic advantages are being obtained as the markets for therapeutic plants expand quickly on a national and international scale. Many studies reveal that the quality of the consumer-accessible herbal products varies, despite their widespread use. This variation in herbal preparation quality might be connected to the intricacy of their manufacture. The safety and quality of a range of medicinal plants and the products derived from them have recently been shown to be significantly influenced by excellent farming and collection/harvesting procedures (2).

Compared to a few decades ago, modern farms and agricultural operations operate quite differently, mostly as a result of technological breakthroughs in the form of sensors, machinery, and information technology.

Importance of agricultural technology

It's no longer necessary for farmers to apply water, fertilizer, and pesticides uniformly throughout whole fields. Instead, they may employ the very minimum essential, concentrate on extremely specific areas, or even handle each plant individually. The advantages of such approach are:

- Higher productivity and reduced costs.
- Safer growing environments and meals.
- Lessening of ecological and environmental effect.

Cultivation of medicinal plants

Growing medicinal plants involves rigorous supervision and attention.

We need to take greater care of medical and mechanical management since the market demand for medicinal and aromatic plants has risen owing to their improved medicinal worth and pharmacological activity. Ancient agricultural techniques should be used if there is no scientific approach available. If not, scientific research must be done to design a method of cultivation (3). The fundamentals of agricultural operations, including the right rotation step and an environment that is conducive for plant production, are adapted to meet source requirements. If appropriate, conservation agriculture (CA) competence should be adopted, particularly when it comes to the development of fertile matter and soil moisture.

Techniques employed for plant reproduction

Plants can be reproduced through cutting, layering, grafting, and micropropagation techniques. Although layering entails coaxing roots to develop there, cutting entails chopping off the parent plant's stem. To develop a new variety, parts of two different plants are fused during grafting. Growing tiny fragments of plant organs or tissues in a container with the right nutrient media is known as micro propagation. The tissue becomes a callus, which is a collection of immature cells, before differentiating into plantlets. After that, these plants are put in nursery beds or pots to develop into mature plants.

Modern farming methods in India

There are more agricultural practices used in various parts of India than those that were previously listed. Several of these are not using Indian conventional agricultural techniques.

FIGURE 1 | Process, advantage, disadvantage of horticulture (5).

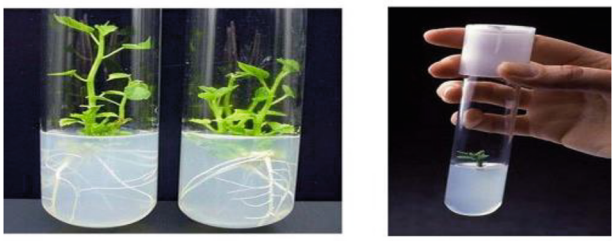

FIGURE 2 | Plant Tissue Culture (6).

FIGURE 3 | Grafting and Budding (7).

This comprises:

Aeroponics system: Plants are cultivated in an atmosphere of mist or air without the need of soil in a method called aeroponics. The plant root is suspended in the air for the duration of the process, which is a subset of hydroponics. Farmers will have more control over how much water they consume if they utilize this strategy.

Aquaponics: Aquaponics is a closed-loop system that primarily depends on the mutually beneficial interaction of aquaculture and agriculture for fertilizing. Hydroponics and traditional aquaculture are combined in this growing technique.

Hydroponics: The hydroponics method of farming uses no soil at all and requires less dirt than other agricultural techniques. By employing nutrients, such as mineral-rich water solution, healthy plants are grown without the use of solid media. The practice of hydroponic farming is a subset of hydroculture, and the sources of the nutrients employed in these systems vary.

FIGURE 4 | Internet of Things (8).

FIGURE 5 | Agricultural Robotics (6).

Monoculture: This technique involves cultivating a single crop in a particular farming region. Unfortunately, the monoculture farming method is not commonly used in a nation like India. Monoculture includes activities like cultivating therapeutic herbs inside. Monoculture, simply said, is a method of contemporary agriculture where just one type of plant or product is produced.

Shifting cultivation

With this kind of farming, the land is only cultivated for a couple or three seasons. The land was then allowed to organically grow crops. Farmers then move to a different area. They leave as the soil loses their fertility or the region is taken over by weeds. The duration needed for cultivation is frequently shorter when the ground is allowed to regain fertility (4).

FIGURE 6 | Artificial Intelligence (10).

Characteristics of shifting cultivation

(1) If enough land is restored for a long time (10 to 20 years), it is environmentally feasible.
(2) There shouldn't be an excessive amount of food demand or requirement.
(3) This method is appropriate for the hard climatic conditions and delicate tropical ecosystems.
(4) As a result, we have had only sporadic success in identifying workable substitutes for shifting agriculture in India.

FIGURE 7 | Drones (11).

FIGURE 8 | Harvesting (12).

Protected cultivation in horticulture crops

Crops are grown under protected cultivation conditions, which is a regulated setting. The techniques can be used singly or in combination to create a hospitable environment to protect plants from adverse weather and lengthen cultivation or off-season agricultural production. By minimizing evaporation losses, drip irrigation is used under raised beds coated in mulch films to not only get rid of weeds but also keep the soil moist for a long time.

Advancements in cultivation

A number of advancements in plant propagation and cultivation have been linked to the increasing domestication of food crops from the dawn of agriculture. Aiming to produce more is a goal shared by the scientific and agricultural communities, even if economic profitability is a major motivator of advancement.

1- High density planting

The term "high density planting," or HDP, refers to planting at a density higher than that which would provide the greatest crop yield at maturity if each plant had developed to its full natural size. The number of plants in a particular area may be used to calculate planting density. In simple words, better HDP application can lead to higher productivity yields per land area.

Using dwarfing, bio regulators, pruning, and other sophisticated cultivation techniques to limit vegetative growth is essential for the effective application of HDP. HDP is a very labor, capital-, and research expensive technology even if it has the potential to deliver large productivity benefits. In an HDP context, only a few certain plant cultivars or kinds may be used successfully.

HDP requires advanced management strategies that are both professional and scientific, yet these strategies are not readily available worldwide.

2- Plant tissue culture

The development of tissues or cells takes place in a synthetic Media that is distinct from the organism in tissue culture, a novel method of plant propagation. Depending on the circumstances, a single cell can regrow a whole plant. Above conventional techniques that are often used in agriculture, tissue culture application offers significant advantages. Tissue culture has seen a lot of practical use recently, notably for the quick clonal or *in vitro* production of many commercially significant plant species. A few of these are rice, palm oil, rubber trees, sugarcane, bananas, sweet potatoes, and tomatoes.

3- Grafting and budding

Grafting is a well-established procedure that has had a significant influence on agricultural output and continues to have repercussions for modern technologies.

In contrast to grafting, which involves inserting a portion of the stem into another related plant, budding involves inserting a bud from one plant into another related plant. Grafting is not a novel method, even though budding is. Grafting dates back 4,000 years to Mesopotamia and ancient China.

Modern agricultural technologies for sustainable and flexible farming

Today's enabling Agri technology platforms operate as a crucial link between farmers and other agroecosystem stakeholders, helping them to achieve enhanced agricultural output. With greater pre-season access to seeds, tools, and money as well as support in the form of information, services, and agri-inputs as well as direct access to a variety of markets, warehouses, and cold storage after harvest, tech-enabled agriculture helps to ensure the farmers' success. The cultivation of plants is made considerably easier by the use of digital farming technologies, including drones and artificial intelligence.

Internet of things

The Internet of Things (IoT) is the utilization of synchronized data across several platforms to share vital information in real time.

Crop monitoring in conventional farming takes a lot of time and labor. Due to the use of technology, the Internet of things alters this entire scenario and makes it real time.

Sensors, such as those used for tracking plants, animals, and soil temperature and humidity, among other things, capture a lot of data.

Via their mobile devices, these sensors give farmers real-time information. As a result, India's agriculture is currently following this latest technology (9).

Agricultural robotics

In the Indian agricultural sector, agricultural robots is taking shape. Yet, the idea has been around for a while. Technology-related companies are now working hard. This newest technological trend is used for many different tasks, including planting, harvesting, collecting fruit, and sowing seeds.

Artificial intelligence

Farmers may get real-time data by using artificial intelligence in farming. This technology has provided farmers with the crucial real-time information they require, such as weather information, crop output, and pricing information, which enable farmers with more knowledge for decision making. Additionally, this technology makes it feasible for prompt rectification and remedial action.

Drones

Drones or unmanned aerial vehicles are mostly used to monitor crops, apply pesticides and fertilizers, and so on.

By lowering the amount of labor needed to cultivate a crop, this most recent development in agriculture is revolutionizing farming technology.

Advantages of cultivation

From a variety of perspectives, including the following, growing medicinal plants is advantageous:

(1) It guarantees that the medicine comes from the right natural source.
(2) Under cultivation, the gathering and harvesting of the medications can be efficiently managed, meaning they can be gathered at the appropriate time and in the right way.
(3) Drying and storage of medications from agricultural sources should be regulated to ensure high-quality medicines.
(4) During cultivation, the completed product's purity is ensured since weeds and other pollutants may be eradicated by meticulous weeding throughout the crop's growth.
(5) The following practices can help with drug quality and production during cultivation:
(6) The choice of disease-resistant and high-yielding seeds and cultivars.
(7) The use of organic and inorganic fertilizers that boost plant productivity and the amount of their active ingredients, such as nitrogenous fertilizers that boost the alkaloid levels in solanaceous plants.
(8) The creation of disease-resistant, high-yielding hybrid plants.
(9) The cultivation of pharmaceuticals guarantees a steady and regular supply of real medications.
(10) Cultivation can be used to regulate and minimize the monopolies on the manufacture of crude pharmaceuticals as well as their prices.
(11) Controlled production of such drugs can help limit the illicit traffic in harmful substances like cannabis and opium.

The aforementioned factors make it clear that it is better to receive crude medications from sources that have been grown or, to put it another way, sources that have been placed under cultivation in order to produce crude pharmaceuticals of high quality. However, there are several significant disadvantages to growing therapeutic plants.

Disadvantages of cultivation

The main drawbacks of growing medical or pharmacological plants may be summed up as follows:

(1) The increasing expense of production.
(2) A certain medicinal plant cannot be grown because of the absence of the necessary environmental conditions. For instance, Indian hemp needs a typical tropical temperature to produce the drug-like resin.

These difficulties, which apply to other grown crops as well, should not deter people from growing drug plants, though, since the rewards far exceed the disadvantages.

Harvesting

To ensure the finest quality medical plant components and completed herbal products, it is important to harvest medicinal plants at the right time of year or season. Depending on the plant component that will be utilized, the harvest time may vary. Official monographs, published standards, national pharmacopoeias, key reference works, and published standards typically contain thorough information on the best time for harvesting (9). It is important to take precautions during harvesting to avoid contaminating the materials with weeds, poisonous plants, or strange objects (13).

WHO guidelines

(1) Harvest medicinal plants and herbal remedies at their best for their intended purpose.
(2) It is necessary to exclude damaged or incomplete plants.
(3) Medicinal plants/herbal drugs should be harvested under the best possible conditions avoiding wet soil, dew, rain or exceptionally high air humidity. It's important to take precautions against any harmful impact that elevated moisture levels from harvesting in rainy weather may have on medicinal plants or herbal medicines.
(4) Harvesting equipment or cutting tools must be modified to minimize soil contamination.
(5) The gathered medicinal plant or herbal medicine shouldn't come into touch with the ground. It needs to be quickly gathered and transferred in dry, clean circumstances.
(6) Caution should be exercised during harvesting to prevent the mixing of collected medicinal plants/herbal medicines with harmful weeds.
(7) Cleanliness and the absence of contamination from past harvests are requirements for harvesting

containers. While not in use, containers must be kept dry, clear of pests, and out of the path of domestic animals, livestock, and rodents.

(8) To avoid unfavourable quality changes, harvested medicinal plants and herbal medicines must be safeguarded against mechanical damage and compacting. To avoid (a) overfilling the sacks and (b) heaping the sacks, caution must be exercised in this respect.

(9) Medicinal plants and herbal remedies must be processed quickly to prevent thermal degradation.

(10) The harvested crop must be kept free of pests, mice, rats, domestic animals, and cattle. Recordings of all pest control techniques should be made (14).

Future prospects

Advances in medical plant fermentation and tissue culture have created new pathways for this type of manufacturing, while genetic engineering has made it feasible to produce desired bioactive compounds on a large scale. It may be possible to produce uncommon and highly prized secondary metabolites that are necessary for medicine through cell culture. Increased rates of regeneration can be encouraged by micropropagation by tissue encapsulation of propagules, which also makes storage and transit easier.

Discussion

The supporting case for the preservation of variety may be made using the cultural value placed on therapeutic plants. The cultural features pertaining to the employment of the plants and the cultural values pertaining to their cultivation must be distinguished from one another since these cultural values are not fundamentally the same for wild and domesticated plants. For the creation of many types of traditional medicinal formulations, traditional and Ayurveda practitioners employ medicinal plants and their components as raw materials. In contrast to contemporary medicine, historically validated methods of preparing medicinal and aromatic plants have not progressed enough.

At the herbal production and processing facility, conventional methods are still mostly employed, and very little has been updated. In order to acquaint part of the medicinal medicine crop, which is in high demand from the cosmetic neutraceutical, food, and pharmaceutical industries, a unique project may be undertaken. Such initiatives would significantly encourage farmers to take up the professional growing of aromatic and medicinal crops. The modern herbal medicine industry's key necessity for restarting the production of effective and genuine standard medications for humanity is the scientific growing, development, harvesting, and processing of medicinal plants.

Conclusion

Recent years have seen an increase in the value of medicinal plants due to their usage as food supplements and other pharmaceutical goods. The existence of the many important plant species and their habitats in the wild is being threatened by an over-reliance on forests for these high-volume raw pharmacological commodities. Many species, especially those that are endangered in the wild, can be cultivated as a viable alternative. With the genetic variety of these species preserved in their native environments, this would assist to assure a steady supply of them for human needs. The sustainable preservation of natural stocks requires a variety of strategies, including cultivation.

A situation that is extremely distinct from growing horticulture and other commercial crops is presented by the domestication or cultivation of the species. Domestication activities should be conducted in tandem with planned research to develop efficient species-specific POPs and coordinated efforts to create supportive regulatory and economic frameworks. It is also important to look at the best institutional setup for industry farmer benefit sharing. These metrics have to be modified to account for unique socioeconomic and cultural conditions in the area. For instance, the choice of cultivating species, adoption of technology, and institutional setup may differ from a region where these factors are different in states where agroforestry practices are common, in localities where size of land holdings is smaller and labor costs are higher, and in locales where these factors are not.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

Acknowledgments

I am thankful to all my co-workers and my respected guide.

References

1. The Food and Agriculture Organization (FAO). *Small Family Farmers Produce a Third of the World's Food*. Rome: FAO (2022).
2. Stitt M, Müller C, Matt P, Gibon Y, Carillo P, Morcuende R, et al. Steps towards an integrated view of nitrogen metabolism. *J Exp Bot.* (2002) 53:959–70.
3. Ng J, Han M, Beatty P, Good A. Genes, meet gases: the role of plant nutrition and genomics in addressing greenhouse gas emissions. In: Edwards D, Batley J editors. *Plant Genomics and Climate Change*. New York, NY: Springer (2016). p. 149–72.

4. Shen J, Li C, Mi G, Li L, Yuan L, Jiang R, et al. Maximizing root/rhizosphere efficiency to improve crop productivity and nutrient use efficiency in intensive agriculture of China. *J Exp Bot.* (2013) 64:1181–92.
5. Wuebbles DJ. Nitrous oxide: no laughing matter. *Science.* (2009) 326:56–7.
6. Han M, Wong J, Su T, Beatty PH, Good AG. Identification of nitrogen use efficiency genes in Barley: searching for QTLs controlling complex physiological traits. *Front Plant Sci.* (2016) 7:1587–1587.
7. Ray DK, Ramankutty N, Mueller ND, West PC, Foley JA. Recent patterns of crop yield growth and stagnation. *Nat Commun.* (2012) 3:1293.
8. McAllister CH, Beatty PH, Good AG. . Engineering nitrogen use efficient crop plants: the current status. *Plant Biotechnol J.* (2012) 10:1011–25.
9. Eathington SR, Crosbie TM, Edwards MD, Reiter RD, Bull JK. Molecular markers in a commercial breeding program. *Crop Sci.* (2007) 47:S154–63.
10. Chamara N, Islam MD, Bai G, Shi Y, Ge Y. Ag-IoT for crop and environment monitoring: past, present, and future. *Agric. Syst.* (2022) 203:103497. doi: 10.1016/J.AGSY.2022.103497
11. Duong LNK, Al-Fadhli M, Jagtap S, Bader F, Martindale W, Swainson M, et al. review of robotics and autonomous systems in the food industry: from the supply chains perspective. *Trends Food Sci. Technol.* (2020) 106:355–64.
12. Duvick DN. Biotechnology in the 1930s: the development of hybrid maize. *Nat Rev Genet.* (2001) 2:69–74.
13. Edwards MD, Stuber CW, Wendel JF. Molecular marker-facilitated investigations of quantitative-trait loci in maize. I. Numbers, genomic distribution and types of gene action. *Genetics.* (1987) 116:113–25.
14. Everson RE, Golin D. Assessing the impact of the Green Revolution, 1960 to 2000. *Science.* (2003) 300:758–62.
15. The Food and Agriculture Organization (FAO). *The Future of Food and Agriculture: Alternative Pathways to 2050*. Rome: FAO (2018). p. 1–60.