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Ravi Prakash Verma
CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow, Uttar Pradesh, India

Prashant Tiwari
CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow, Uttar Pradesh, India

Ravi Kumar Shukla
CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow, Uttar Pradesh, India

Vipin Kumar
CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow, Uttar Pradesh, India

Ramesh Kumar Srivastava
CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow, Uttar Pradesh, India

Corresponding Author:
Ravi Prakash Verma
CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow, Uttar Pradesh, India

Menthol mint (*Mentha arvensis*): An annual aromatic crop for small and marginal farmers and MSMEs: A review

Ravi Prakash Verma, Prashant Tiwari, Ravi Kumar Shukla, Vipin Kumar and Ramesh Kumar Srivastava

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Abstract
Menthol mint, corn mint or Japanese mint (*Mentha arvensis)* belongs to the family Lamiaceae, which is well-known for its aromatic and medicinal properties in the world, is asserted to have certain capabilities and to use modern technology. Studies on the phytochemistry of *Mentha* spp. found that it contains glycosides, which are flavonoids. The main chemical constituent i.e. menthol is used in cosmetics, as well as an alternative or complementary treatment for conditions like nausea, vomiting, asthma, and gastrointestinal diseases. *Mentha arvensis* has polyphenols and antioxidants which are less harmful due to which it develops a keen interest in the food industry. Recently CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP) developed Early Mint Technology (EMT) which reduced inputs and increased yield in comparison to conventional cultivation practices. Presently, mint crop is cultivated during the summer season and it requires huge water for irrigation hence, it was felt to develop better agro-technologies and short duration high yielding varieties which require less irrigation and input cost. However, the features, traits and yield of mentha have received the majority of attention in past research studies. Therefore, the literature on the use of micro irrigation in mentha and on crops with lower water requirements is covered in this study. This review also describes the approaches that will be used to improve growth of mentha in the agricultural sector.

Keywords: Early mint technology, mentha arvensis, phytochemical properties, polyphenol, new varieties

Introduction
Mentha arvensis or Menthol mint or corn mint belongs to Lamiaceae family which is indigenous to temperate parts of Europe, western and central Asia, eastern Siberia, and North America having a circumboreal range. Some writers also put Mentha canadensis, a similar species, in *Mentha arvensis* as two varieties, *M. arvensis* var. *piperascens* Malinv. ex L. H. Bailey (eastern Asian plants like Japanese mint) and *M. arvensis* var. *glabrata* Fernald (North American plants like American Wild Mint) (Singh, 2004) [30]. In India, the story of mint cultivation is very dramatic & successful. From an importing country of mint oil in 1970s, now, India became the world's largest producer and exporter of mint oil today. Literature suggests that the Japanese mint was introduced in India by Dr LD Kapoor in 1952 courtesy of a Japanese botanist, who had sent him only six suckers that were planted at the Drug Research Laboratory, Jammu (Shah, 2009) [28]**.** Before, 1968, there was no production of menthol mint in India and all the demands for menthol mint oil were met through import. Col. R.N. Chopra and Dr I.N. Chopra of the Regional Research Laboratory in Jammu in 1968 [9], as well as Mr S.C. Bante, Managing Director of Hindustan Richardson Ltd., deserve credit for the introduction of this crop on a commercial scale. Japan dominated the menthol mint market in the first half of the 20th century, providing around 70% of the world's needs whereas China filled the remaining portion of the demand. In 1962-1963, Brazil had a manufacturing size of 5000 tonnes annually but between 1980-1994, China reentered the world market and served as the main provider. Though India entered in the global market only in the mid-1980s and increases its production up to 37000-40000 tonnes in 2020 (Sharma, *et al.*, 2019) [29]. India has retained its position as a global leader in the production and export of mint oil and related goods since taking over as the market's

preeminent provider in the middle of the 2000s. With a capacity of roughly 40000 Tonnes, India is currently the world's largest producer, exporter, and consumer of mint oil and related products related share of worldwide output is currently between 80 and 85%. The demand for natural menthol and its products will increase in the future Mentha word was originated from Greek legend nymph Minthe which stands for mint. *Mentha arvensis* was said to have been gathered for vegetation in Europe for the first time ever during the earliest era then, in the late 19th century, Japan began cultivating it for commercial use. China and Japan have gradually begun to be used in the medical industry and was brought to the subcontinent and is known as pudina, particularly in India and Pakistan (Okumu, 2016) [21]. Due to the high levels of natural invasion and global demand for its products, *M. arvensis* diversity is becoming more and more significant (Rastogi and Mehrotra, 1991) [26]. India, Pakistan, Iran, Japan, China, and Afghanistan are among the Asian nations that offer the greatest soil for optimum growth and they also are a major provider of mint to other countries (Bahl, *et al.,* 2000) [2]. Due to the rising demand for mint essential oil, wild mint is becoming more and more in demand every day. Three major mint producing countries are India, China and United States in comparison to other nations, India possesses top-notch mint variations and beats the U.S. economy in the field of mint production. America has been using a lot of its mint production in food and flavoring industry and China is the third-largest mint supplier in the world after America (Choudhury, *et al*., 2006) [10].

Fig 1: Nursery view of *Mentha arvensis* plant

Mentha arvensis is widely used as medicinal and ornamental plant in various parts of the world and its genus contains 25 to 30 different species worldwide. It is a tropical area native plant but *M. arvensis* taxa may also be found in temperate and subtropical parts of the world and may effectively cross with several Mentha species (Ishtiaq *et al.,* 2014) [16]. The novel hybridized Mentha plants' leaves' direct interactions with sunlight can alter their colour, length, age, and scent (Fatiha, *et al*., 2017). Mint plants can be grown in sandy loam to loam soil having pH value 6.5-8 and atmospheric humidity is about 60-70% (Heber, 2023). It can grow in partial shade, but the pace of growth will be slower compared to that in open farm cultivation (Mounira, *et al*., 2009). The nursery method is most commonly used in mint crop and is effective in various aspects of cultivation as sowing, irrigation and intercultural operations. Menthol crops may be grown in a variety of ecological contexts and show adaptability to a range of climatic situations, including drought, temperature swings and nutritional imbalance. Crops of mentha are climatically resilient due to morphological, Eco-physiological, and biochemical properties. (Stevovi and Calic-Dragosavac, 2010) [33]. *M. arvensis* grows rapidly under soggy circumstances, demonstrating its tolerance to abiotic stress. There was leaf fall and chlorosis as a result of climate stress **(**Johnson, *et al*., 2011). These findings demonstrate that *M. arvensis* is more tolerant of climatic stress and more adapted and it can readily alter its phenotypic characteristics in response to climatic circumstances. (Phukan, *et al*., 2013) [22]. The chemical makeup of essential oils exhibits significant variety as a result, various portions of mint create a variety of compounds and have varying biological effects (Borris,1996) [6].

Early mint technology vs traditional method

The term "Early Mint Technology" (Figure 3) refers to a improved method of mint cultivation that can boost oil yield by up to 15-20% while lowering the cultivation and irrigation costs by up to 20% in compare to traditional method of mentha planting (Figure 2). According to studies, the essential oil from wild mint leaves contains considerable amounts of menthol, menthone, iso-menthol, pulegone, and alpha-pinene. (De Sousa Guedes, *et al*., 2016) [12]. Mint oil also contains various Nutrients, minerals and vitamins (Figure 4,5,6). The yield of essential oil content expands its commercial uses. Menthol, the main chemical component in mint oil, is derived from the leaves and stems of mentha. Menthol is said to make up 93.7% of the chemical composition of mentha leaves oil, with tiny amounts of menthone, carvenone and iso-menthone totaling just 1.5%, 0.7% and 3.2%, respectively (Joshi, 2013). Different species of mentha have varying chemical compounds and yield (Table 1) (Balakrishnan, 2015) [4]. Direct interaction of sunlight with harvested green herbage changes the physio-chemical properties of essential oil (Gang, *et al*., 2001) [13]. The hydro-steam distillation technology is utilized in field distillation units for the large-scale extraction of essential oils in farmers' fields. At room temperature (25-30°C), a number of chemical substances, including water, condensed back into liquid form after entering the gaseous phase. To prevent essential oil from evaporating, remove the essential oil from the water and keep it in a dark bottle (Hussain, *et al*., 2015) [15]**.** A significant source of pesticides, insecticides, virioids and fungicides is the strong scent. Wasps, ants, hornets and cockroaches are just a few of the typical pests that mint oil effectively eradicates (Coutinho, *et al*., 2015) [11].

Fig 2: Traditional method of Mentha planting

Fig 3: EMT method of Mentha planting

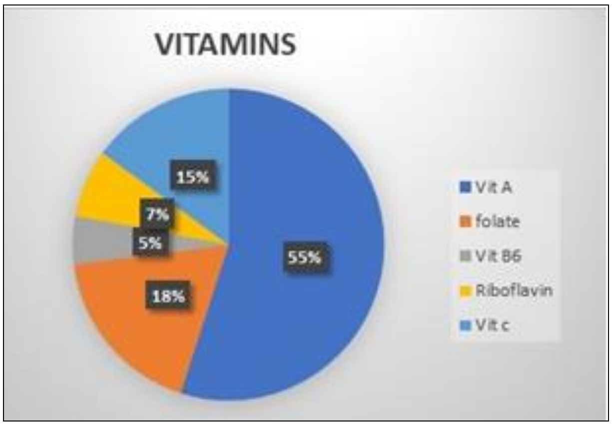

Fig 4: Vitamin value in mentha

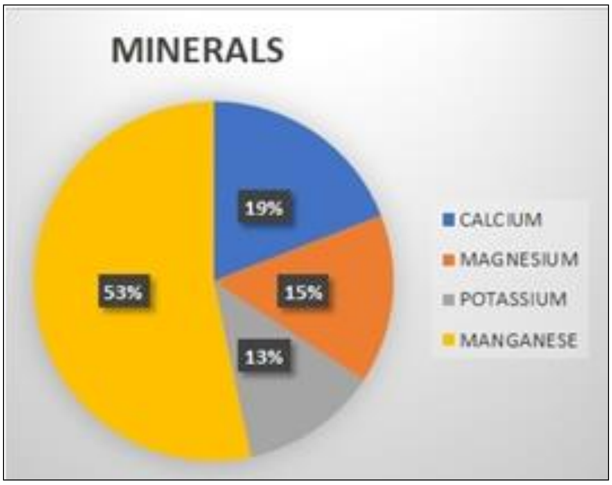

Fig 5: Minerals value in mentha

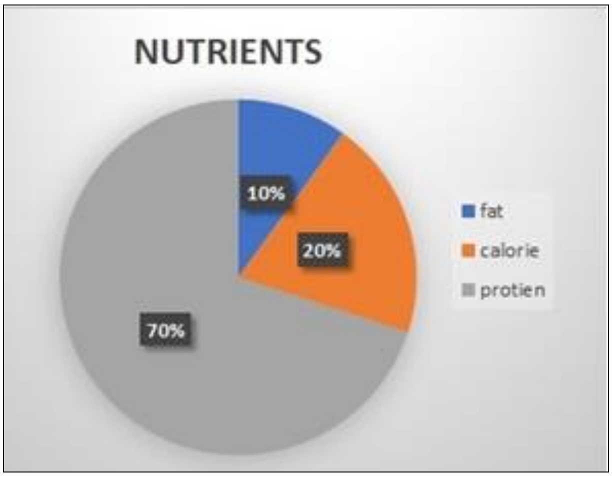

Figure 6: Nutritious value of mentha

Discussion

In tropical and subtropical regions of the world, Japanese mint (*M. arvensis* L.) is grown as a prominent source of natural menthol and dementholized oil. This crop is mostly produced in India, Brazil, China, Japan, Korea, Paraguay, Taiwan and Thailand having leaves that are 2 to 8 cm long and 1.5 to 4.0 cm broad, as well as hairy stems with an upright herbaceous perennial that grows to a height of 20 to 100 cm. It bears opposing leaves that are rhizomatous and are linked to the stem by extremely short stalks and the smell of mint is really strong. In 1998, around 80 thousand hectares are said to be the approximate amount of land in India that is used for growing Japanese mint, with an average yearly yield of 12 tonnes per ha. (Kumar, *et al*., 2020) [18]**.** Under an open agricultural approach, the mentha crop's growth and output were both at their highest from the varieties developed by CSIR-CIMAP which are Kosi and CIM-Kranti, respectively, produced higher oil and total fresh herbage. Under an open farming system, the Clevenger apparatus produced 1.21 and 1.27% oil recovery from the CIM-Kranti variety in the first and second harvests, respectively. The highest oil output per hectare was 186 kg/ha for open farming and 73 kg/ha for poplar-based agro-forestry (Singh, *et al*., 2022) [31].

As Mentha is a summer crop it requires more water. On sandy loam soil, field tests were done to examine how drip irrigation and fertilizer affected mint (*M. arvensis* L.) herbage and oil yields, water usage productivity and efficiency. A total of 777 mm of water were utilized by the crop, with a consumption efficiency of 0.338 kg $ha^{-}1cm^{-}1$ (Behera, *et al.*, 2014) [5]. UAN (1.9 g.m-3) had the highest water usage efficiency, followed by urea (1.4 g.m-3) and ammonium sulphate (1.3 g.m-3). In the first and second years, the maximum economic usage efficiency and water productivity were attained in 280 and 250 kg $Nha^{-}1$, respectively. The nitrogen utilization efficiency in the second year (0.34 g. $ha^{-}1$) was greater than in the first year (0.17 g. $ha^{-}1$) with rising nitrogen levels. UAN fertilizer application up to 170 kg $ha^{-}1$ boosted recovery efficiency whereas urea and ammonium sulphate recovery efficiency declined. Ammonium sulphate fertilizer's physiological nitrogen efficiency was comparable over the course of two years and appeared to be somewhat greater than that of urea and UAN fertilizers. According to the experiment's findings, peppermint in Khuzestan benefited more from the administration of higher rates of UAN fertilizer than it did from the lower rates of urea and ammonium sulphate (Poshtdar, *et al*., 2016) [23].

Herb and oil were significantly influenced due to the integrated supply of nutrients in both years, highest herb and oil yield was recorded at T_4 (N:P: K:133:40:40) and (FYM 67 ha^{-1}) in 1997. The extent of the increase in herb and oil yield was in the order of 27% to 118% and 34% to 119%, respectively (Chand, 1999) [7].

The extraction of essential oils is accomplished using modern hydro distillation (HD) techniques known as ohmic and microwave-assisted hydro distillation (OAHD and MAHD, respectively). The effects of OAHD and MAHD of peppermint essential oils from the aerial sections of the plant were investigated and the outcomes were contrasted with those of the conventional HD. According to the findings, HD needs over an hour for the extraction procedure whereas OAHD and MAHD techniques take less than 30 minutes (Mohsen, *et al*., 2015) [19].

Table 1: Species of Mentha their type, yield and its main chemical constituents reported by (Balakrishnan, 2015) [4]

Species/Type	Yield(oil)	Constituents
M. arvensis (Menthol mint mint)	134-163 kg/ha	Menthol (65-75%), menthone (7-10%), methyl acetate (12-15%), terpenes (pinene, limonene and comphene).
M. piperita (Pepper mint)	58-68 kg/ha	Menthol (35-50%), Methyl acetate (14-15%), menthone (92.5%) mentho-furan and terpenes like pinene and limonene.
M. citrata (Bergamot mint)	140-150 kg/ha	Linalool (45-50%) and linalyl acetate (45%)
M. spicata (Spearmint)	65-75 kg/ha	carvone (55-65%), limonene (30-35%) and cineole

Therapeutical uses

The mint oil and its allied products have various therapeutic utilization. Few are as under:

- Cures digestive issues
- Promotes the normal functioning of the body
- Acts as a natural antiseptic
- Cleanses the skin
- Relieves inflammation in pain balms and vapour rubs
- Used in mouth washes and toothpaste
- Used in antiseptic creams
- Used in skin moisturizing lotions and creams.

Mint as an opportunity for MSMEs

Mints have been popularly cultivated in India for more than 50 years. In the last few years, India has emerged as largest producer and an export hub for Mentha oil and its derivatives. The country contributes around 80% to the total global Mentha oil production followed by China (9%), Brazil (7%) and USA (4%) [7]. It exports different types of mint oil to China, the UK, France, the US, Netherlands, Germany, Brazil, Singapore, and Japan, among others. In similar ways, India (with 33% share in world exports) maintains its position as the world's largest exporter of menthol, despite the fluctuations over the years. India is closely followed by China (22%), Germany (22%) and Japan (9%) as the major exporters of menthol in the world. The area under mint cultivation in India is 0.3 M ha which produces nearly 30,000 MT of Mentha oil annually, 75% of which is exported by the country. (thedollarbusiness.com). It is primarily grown in Uttar Pradesh, Punjab, Haryana, Madhya Pradesh and Bihar. Uttar Pradesh is the largest producer of Mentha oil, accounting for 90% of the country's total Mentha production, followed by Punjab, Haryana, Bihar, and Madhya Pradesh Bihar and Madhya Pradesh. Therefore, in recent years, a sharp rise in Mentha oil prices has encouraged Farmers and entrepreneurs shifted towards Mentha cultivation and its processing, leading to its setting up small and medium industries to process oil and manufacture mint products. (Shaheeda *et al.*, 2024) [27].

Conclusion

M. arvensis produces essential oils that contain menthol above to 70%. The dementholized oil is used as a cheap, abrasive substitute of peppermint. The newly developed Early Mint Technology was a method that was introduced with a valiant effort. According to earlier research studies, mint growers have the greatest adoption gaps in terms of awareness and irrigation infrastructure with new techniques and technology. New varieties must be developed to with stand the summer season in order to increase oil output.

The oils of Mentha arvensis is known for its ability to treat colds, inflammation, nausea, vomiting and cramping also having anti-oxidant, anti-microbial, anti-viral, anti-inflammatory and anti-carcinogenic properties. Mint contains many phytochemicals and polyphenols, which are potent antioxidants that are less hazardous than synthetic antioxidants. *M. arvensis* oil has carminative qualities that aid in digestion, motion sickness, indigestion, food poisoning and dyspepsia. Menthol, a key element in the oil, soothes intestinal and stomach linings while also treating ulcers.

The technology of intercropping to attain maximum oil content with wheat also showed a non-significant result. New varieties of mint such as CIM-Kranti and Kosi the maximum fresh oil but the shortage of availability of such varieties and reach to farmers leads to reduce mint cultivation. For oil production, new technologies such as Ohmic and microwave-aided hydro distillation (OAHD and MAHD) have been established that are superior to traditional processes; because these solutions save time.

The study came to the conclusion that mints having lots of medicinal benefits which is verified through literatures. Despite having liver-damaging effects, it also has hepatoprotective properties and used to treat intestinal worms. A variety of medical conditions can be treated using *M. arvensis*, which has a wide spectrum of therapeutic characteristics. The fragrance, flavor and pharmaceutical industries require essential oil and its allied products in huge quality. The development and popularization of mentha production is hampered by the introduction of current technologies and the pace of acceptance of such technologies, which is declining owing to lack of knowledge and material availability.

Declaration: Authors do not have any conflict of interest.

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