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Effect of foliar application of macro and micronutrients on fruit drop, growth, yield, and quality of Kinnow Mandarin (*Citrus Reticulata*) on five-year-old plants

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Introduction

Menthol mint (*Mentha arvensis*) is a most popular essential oil bearing, short duration cash crop, well fitted in traditional cropping system like paddy-wheat-mint, paddy-mustard-mint, paddy-potato-mint, maize-wheat-mint without affecting the existing cropping system. It can be cultivated in well-drained, deep, fertile, organically rich soils with good moisture retaining capacity, neutral in pH and texture ranging from sandy-loam to clay-loam. In North India, majority of marginal and small land-holding farmers start sowing of mint from January and continue till March for its essential oil derived aroma compounds obtained through distillation of shoots biomass are traded globally.

Yield and Profit

The yield and profit from menthol mint depends on various factors like planting material, method of cultivation, management practices, frequency of harvesting in a year, climatic factors, market price etc. Generally, mint has planted by two different methods i.e. direct planting of suckers/roots in the fields during the months of Dec.-January and through nursery raising, transplanting during February and March. If farmers cultivated mint through direct method, it will be ready for harvesting in 110-120 days, whereas transplanting method will take 80-90 days for harvesting. In North India, maximum two subsequent harvests are taken by farmers at 40-45 days intervals and obtain about 25-30t/ha, green herbs (250kg oil/ha.). The total cost of cultivation incurred approximately Rs. 50k-60k/ha and net profit Rs.1.70-1.80 lakh/ha.

Major mint producing belts

In India, Uttar Pradesh is the leading mint producing state accounts for 80-85% of Indian mint production and remaining 15-20% comes from Punjab, Bihar, M.P., Haryana, Himachal Pradesh etc. In Uttar Pradesh, it is mainly cultivated by marginal and small land-holding farmers on a large scale and commercial basis in Barabanki, Muradabad, Sambhal, Badaun, Chandausi, Ambedkar Nagar, Sitapur, Pratapgarh, Bareilly, Rampur, Lakhimpur districts etc. Recently the crop has been extended to some other districts viz., Rai Bareli and Lucknow etc.

Production and export

India is a major producer and exporter of menthol mint. During a last decade, (2000-01 to 2017-18) India has been produced around 80% of global mint oil and exported about 75%. The production and export varied between 14.50Mt to 29.50Mt and 4.19Mt-25.75Mt during the decade (DGCI&S, 2018). The reason for continuous increase in its cultivation is due to growing internal consumption demand and its export potential to other countries (Chand et al. 2002).

Major export destination

The major export destinations of Indian mint oil are China, USA, Singapore, Germany, Japan, Netherlands, *United Kingdom*, Paraguay, Hong Kong, Argentina, Brazil and France etc. Apart from India; China, Brazil and United States are also increasingly stepping up in the global market of menthol mint oil.

Commercial uses of menthol mint

The menthol crystals are widely used and having large commercial value. The several commercial uses of Menthol crystals are as fallow:

Pharmaceuticals industry: Menthol mint oil is an essential ingredient of the ointments, pain relevant balms, cream/gel, coughs syrup and lozenges etc. It is also help in digestion/stomach disorders, asthma patients, depression and fatigue, contributes in weight loss.

Personal care: Menthol crystals is used as a denaturant, flavoring agent and fragrance ingredient in the formulation of a wide variety of perfumery, cosmetics and personal care

products such as in soap, bath, aqueous cream etc

Oral preparations and flavoring agent: Menthol itself used as flavoring agent in preparations of tooth pastes, chewing gums, dental creams, mouth washes and beverages etc.

Food and beverage: Menthol crystals can be used as a flavor and fragrance agent in food such as in chewing gums, candy, confectionery and beverage.

In other industries: Chewing Tobacco, Cigarettes and Pan Masala.

Role of CSIR-CIMAP in Menthol industry

CSIR-CIMAP has played a major role in developing menthol industry in India from menthol importing country to the largest global producer and exporter of menthol mint oil by spreading its cultivation in more than 0.3 million hectares, developing short- duration and high yielding varieties and also superior agro-production and processing technologies, which enhanced the income of nearly 0.6 million farming families. It has played an important role in research and development of improved varieties of mint and is a major source of quality planting material followed by demonstration and dissemination of improved plant varieties (short-duration and diseases resistant menthol-rich) and agro-technologies among the growers and entrepreneurs all over the India.

Development of a novel agro-system "Early Mint Technology (EMT)" which potentially reduces harvesting time by 20-30 days, increases the productivity by 15-20%, and minimizes expenditure on land, labour, water and fuel of about 20-25%.

- Developed and disseminated the low cost, efficient boiler operated steam distillation units to farmers and entrepreneurs for large-scale operations and directly fired-type field distillation units for small-scale production of essential oils from mints and other aromatic crops.

- Designed and developed many implements like Mentha-harvester, Solar Powered Distillation Unit and Tractor-Trolley Mounted Directly-Fired Type Mobile Distillation Unit, etc for harvesting and post-harvest processing of mints. The units can attached to any tractor and transported directly to the farmer's field for

distillation of mentha and other aromatic crops.

- Organizes the several awareness programmes, demonstrations, training programs, conferences, workshops and seminars/webinars to promote mint cultivation from farmer's field to national-level. It provides opportunities for farmers, farm women and entrepreneur to raise their incomes by adopting new technologies.

- From 2004, CSIR-CIMAP continuously organized the Kisan Mela every year in the end of January month for dissemination, demonstration of new varieties and technologies and for distribution of planting material (suckers) among the farmers. In occasion of 16th Kisan Mela, CSIR-CIMAP released a high yielding variety of menthol mint 'CIM- Unnati', which can produce about 180-190 kg essential oil per hectare. It has 20% higher essential oil and has the potential of doubling the menthol mint farmer's income.

Opportunities

Sustainable production of menthol mint is a big issue. It is a practice involving the management of resources that meets the present needs without compromising the ability of future generations to meet their own needs from its production. The following factors play a key role in sustainable cultivation of mint.

- Mentha cultivation in India has proved quit remunerative to the growers, particularly to small landholders and fitted will in the existing cropping systems in mint growing areas of the country.

- Mint growers consider it as short duration cash crop or bonus crop as it does not disturb or replace the cultivation of any major winter (Rabi) or rainy season (Kharif) crops.

- Mentha being labor-intensive crop, it provides various employment opportunities for more than a million of households in cultivation, distillation, processing and marketing particularly in rural areas.

- Mint growers can easily sell the oil to spot market because of large numbers of buyers are available in the markets.
- The mint oils used in a wide variety of consumer goods such as detergents, soaps, toilet products, cosmetics, pharmaceuticals, perfumes, confectionery food products and beverages (soft and hard drinks) therefore the demand from consumption sector is growing continuously.
- Growing the global demand of processed products of mint oil create the employment opportunities.
- By promoting the optimal utilization of farm resources during lean period with little animals grazing and weather risk, it promotes the additional farm income as cash or bonus crop to become a farmer self-reliant.
- As cash or commercial crop, the marketable surpluses are nearly 100 per cent for all farms size categories of farmers viz. marginal, small, semi-medium and large.
- Introduction of future trading in marketing of menthol mint, the hedgers (farmers or producer) eliminating the price risk and speculators (Investors and traders) gains financial reward from capitalizing on pricing volatility.
- Mentha cultivation may lead to intensive cropping and maximizing the annual returns of farmer's from a particular piece of land. Mentha are being widely cultivated in Indo-Gangetic Plains enabling India to emerge as the largest producer of mint oil in the world.

Challenges

Use of natural resources and environmental problem

Menthol mint is a high water-demanding crop as water is one of the most crucial inputs for its growth, for herb and oil yield. It requires on average of 10-12 irrigations to attain the maturity stage. Its active growth period coincides with the pre-monsoon hot summer months, when soil moisture is inadequate, soil and air temperature are high leading to high evapo- transpiration (Shormin *et al*., 2009). The ground water availability is non-

uniform in space and time. Irrigation sector is major consumer of ground water, accounting for 92% of its annual withdrawal and the remaining 8 percent for domestic and industrial uses. It is being projected that water demand in India is going to be as high as 24 percent by 2025 and 74 percent by 2050 (Central Ground Water Board, 2007). Most of the farmers believe that more number and heavy irrigation will lead to higher crop production (herbage and oil yields). Whereas, both excess as well as sub-optimal soil moisture decrease the growth, herbage and oil yields.

Shrinking farms and scattering farmer's landholding

Increasing in the scattering farmer's land holding and decreasing the average size of holding. From last 40 years our acreage has remained at 140 million hectares but the number of farmers has increased from 7 to 14 crore. With smaller land at disposal, there is a decrease in farmer's capacity to invest in land. With average land holding halved, the cost of getting inputs and time consumed has doubled. If these are not tackled now, it will be difficult to maintain agriculture as a feasible profession (Himanshu Darji and Keyur Dhandeo). In these situations the cultivation of mint will become a greater challenge for its growers.

Local and inefficient distillation units

The method of distillation affects essential oil quality by way of pressure and temperatures applied. As compare to improved distillation unit, local or inefficient distillation units needed more time and a high amount of heat to extract oils from herbs of mentha. As we know that the burning of deadwood provides an excellent source of heat but there are numerous disadvantages from this activity like deforestation and including release of relative amount of poisonous gases to the environment, which causes air pollution.

Introduction of synthetic menthol mint oil

Menthol mint provided over time smart income to farmers and created million of employment opportunity through its production and marketing without change in the cropping system. Despite of this, natural mint products are increasingly facing a threat

from synthetic substances, which could hit their production and farmers livelihood security in the coming years.

Cost and Returns Competition

Due to increasing price and consumption level of inorganic fertilizers, labour wage rate, the cost of production menthol mint increased continuously. The production cost of synthetic menthol mint oil is lower than the natural menthol mint oil. On the other hand, synthetic mint oil market price is lower than the natural menthol oil, due to which major toothpaste and other companies are going to purchase synthetic mint products resulting in the fall of demand for natural menthol mint production.

Global competition

In spite of India being the largest producer and exporter of mentha oil in the world having a share of 80- 85%, it faces challenges from main competitor countries like China, Brazil, the US, and Japan to keep and secure its position in the global market.

Quality and longevity issues

Indiscriminate use of chemical fertilizer, irrigation and inadequate harvesting and post harvest management practices affects the shelf-life quality mint oil.

Risk and Uncertainties

The risk and uncertainties are inherent in weather, climate, yields, prices, government policies, global markets, and production factors that affect mint farming, farm income and sustainability in future.

Conclusions

India is the largest producer of menthol mint oil in the world with over 29.50 million tones of production and 25.75 million tones of export. The remarkable growth in production and export of mint oil in recent years and this trend is almost certain to continue in future. The existing of wide range of natural endowment, favorable climatic condition and support of CSIR-CIMAP in development and dissemination of improved plant varieties, agro-production and processing technologies offers vast potential for cultivation

of natural mentha oil and employment generation for millions of farming families throughout the country. However, there is a need to tape this potential so that production and household employment will expanded and mentha growers will be benefitted more.