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ORIGINAL RESEARCH ARTICLE

Introduction of sweet basil (*Ocimum basilicum* L.) as a short-duration annual aromatic crop in Assam for enhancing the income of farmers of the North-East Region

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ABSTRACT

Sweet basil (Ocimum basilicum L.) is widely cultivated by the farmers of North Indian plains after harvesting the menthol mint or maize crop. Large area under cultivation of this annual crop by marginal farmers in North India is pre-dominantly occupied by the variety "CIM-Saumya," developed by CSIR-Central Institute of Medicinal and Aromatic Plants. In the present study, an effort has been made for the first time to introduce CIM-Saumya cultivation as a short-duration crop in three northeastern districts of Assam, namely, Goalpara, Kokrajhar and Dhubri. The work was carried out under the aegis of CSIR-Aroma Mission and World Bank-funded APART (Assam Agribusiness and Rural Transformation Project) in May 2022. The first-year data of a May-September cropping cycle has suggested that CIM-Saumya could adapt and perform very well in all three new habitats of Assam. The crop recorded an average herb yield, i.e., 25–27 ton $ha^{-1,}$ that resulted in the recovery of 100-110 Kg ha^{-1}oil upon hydro-distillation of the whole herb. Based on its excellent chemical fingerprint, the farmers could sell their oil to the buyer companies in the Barabanki district of Uttar Pradesh @ Rs 1400 Kg^{-1}. Thus, per this high market rate of O. basilicum, the Assam farmers could realize a net profit of 1.0-1.03 lakh per hectare within 100-120 days. Details on cultivation practices followed, and the cost economics realized in this study are discussed here.

INTRODUCTION

Ocimum basilicum, or Indian sweet basil belonging to the family Lamiaceae, is an important essential oil-yielding crop of North, Central and a few Southern states of India. Like other congeners of the genus *Ocimum* such as *O. sanctum,* sweet basil also possesses many medicinal, flavoring and culinary attributes due to several bioactive terpenoids in its aerial herbage. The essential oil extracted via hydro-distillation of this herb, therefore, finds wide application in the preparation of several decoctions and teas for treating the common cold, fever, cough, fatigue, indigestion, skin infections and immunological deficiencies (Gupta 1971; Dwivedi *et al*., 2000; Srivastava *et al*., 2009, 2018, Yadav *et al*., 2021). More than 150 species of *Ocimum* are known to grow in the world today. They are commercially cultivated in the USA, France, Turkey, Iran, Bulgaria, China, and Japan. South Africa and India. In India, *O. sanctum* and *O. basilicum* are the two major species that are commercially cultivated in the states of Uttar Pradesh, Uttarakhand, West Bengal, Jharkhand, Chhattisgarh, Madya Pradesh, Rajasthan and Andhra Pradesh (Balakrishnan *et al*., 2018)

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Looking at the high industrial demand of *O. basilicum* oil in domestic as well as international herbal markets for medicinal, flavouring, and cosmetic applications, CSIR-Central Institute of Medicinal and Aromatic Plants (Lucknow) has been extensively working on the genetic improvement, chemotype selection and agrotechnology development of *Ocimum* species for different agro-climatic zones of the country. The institute developed a high-yielding variety, "CIM-Saumya," of *O. basilicum* in 2003. With an average oil content of 0.5-0.7% in the green herb and high yields of methyl chavicol (60-65%) and linalool (21-25%), CIM-Saumya is a prevalent variety among farmers of all north and central states of the country. This communication summarizes our first-time effort to check the feasibility of introducing and monitoring the field performance of *O. basilicum* in the North-Eastern states of Assam. The results obtained during the first year of this testing are presented and discussed here.

MATERIALS AND METHODS

The plant: *Ocimum basilicum* is an erect, aromatic, herbaceous, annual or short-duration perennial herb that can grow up to a height of 0.80-1.00 meters (Kumar *et al*., 2018). The glabrous and deeply hairy stem is branched from the base with four angular, rounded or round-quadrangular edges. Leaves are ovulated, dark green, 3-6 cm long and 1.50-3.50 cm broad in size. Flowers are born in the long terminal, racemose inflorescence. Petioles are 20 mm long and pubescent; pedicles are 1-2 mm long and also pubescent. Calyces are campanulate 4-5 mm long at anthesis and 6-8 mm long in fruits; corolla is 7-8 mm long, white with purple margin. Stamens have tufted and are often hairy near the base (Suddee *et al*., 2005).

The climatic condition of experimental sites

The present study was conducted in the farmers' fields of Goalpara, Dhubri and Kokrajhar districts of Assam. These three districts' climatic conditions are sub-tropical monsoon type; temperatures range from 25-35 °C in summer to 8-12 °C during winter, with heavy rainfall and humidity (Singh, 1993). The Spring (March–April) and autumn (September–October) seasons are usually pleasant, with moderate rainfall and temperature. The southwest monsoon generally influences the agriculture pattern in Assam state. The rainy season with high humidity was most suited for basil cultivation to conduct in this study. A total of 15 farmers, five farmers in each district, were selected for this study.

Cultivation practices followed

Soil and land preparation: The soil at all three experimental sites was well-drained, fertile sandy loam to loamy with good water holding capacity. The pH ranged from 5.5 to 6.5, ideal for *O. basilicum* cultivation (Srivastava *et al*., 2009). The experimental fields were on upper land, so water lodging was not a problem during cropping. 2-3 deep plowing (up to 5-8 cm) was found necessary before transplantation. The field was plowed one time and harrowed two times. 10-15 tons per hectare of farm yard manure (FYM) was applied during plowing and mixed well. The land was kept ready for transplantation from April to mid-May.

Propagation: *Ocimum basilicum* can be propagated by nursery or direct broadcasting/sowing methods. In the broadcasting method, the seed rate should be high (2.00-2.50 $Kgha^{-1}$). Though the direct sowing technique was not frequently followed in the present study but can be employed in the Assam region. The field was first cleaned of weeds and stubbles and then enriched with 15 tons per hectare with FYM. About 1.50 kg basil seed was mixed with 15kg vermicompost and broadcasted in a one-hectare area. The thinning was done after 25-35 days of sowing; after thinning, a proper population density was maintained, as suggested for cultivation in northern Indian plains by (Srivastava *et al*., 2018 and Bahl *et al*., 2018).

Raising of Nursery and transplantation: The nursery method generally suggests the cultivation of sweet basil. The nursery beds are prepared in a well-leveled field so the water can run efficiently on every corner. Beds were kept free from weeds, stubbles and soil nematodes. About 500 m^2area of the nursery are required to cover a one-hectare area plantation. Before sowing, 1.50 tons of farm yard manure (FYM), 15 Kg Nitrogen (N), 20 Kg Phosphorus (P) and 10 Kg Potash (K) were applied to the nursery soil. Basil seeds are tiny and light in weight, so they were mixed with 8-10 times vermicompost or sand or well-dried fine soil. Approximately 1.00-1.50 kg seeds of CIM-Saumya were sown in a nursery bed(20m × 25m) to generate seedlings to cover the one-hectare area of the plantation. In north India, a suitable time for nursery raising is the last week of May to the first week of June, but in North Eastern

districts of Assam, it was done in the second week to the end of April. Seeds were shown 5-10 cm apart at a shallow depth because of their tiny size. As in north and central India, the nursery of basil crops in the Assam region was also ready for transplantation within 25-30 days (Srivastava *et al*., 2009).

Transplantation of basil: One-month-old basil seedlings were transplanted in rows at a plant-to-plant and plant-to-row spacing of 30x45 cm. The transplanting was done either in the early morning or late evening to avoid wilting, as suggested by (Bahl *et al*., 2018). Light irrigation was given just after transplantation.

Irrigation: In Assam, the monsoon comes early, so the moisture was well maintained during the cultivation period of basil. During the whole cropping period, only 3-4 irrigations were found to be needed. The farmers selected for this study were project beneficiaries and spent the minimum cost on irrigation.

Weeding and Hoeing: Initially, plant growth was slow due to the dominance of weeds. After 30-40 days of the plantation, the first weeding was done, followed by hoeing to accelerate the plant growth. After one month of the first weeding/hoeing, the second cycle of weeding was followed. After the second weeding, plants became bushy and lower weeds were suppressed. In the case of broadcasting, the first weeding was done after 25-35 days of sowing during thinning to maintain the desired population density of the basil crop. The second weeding was carried out after a gap of 30 days. (Srivastava *et al*., 2018).

Manure and Fertilizers: In Assam condition, about 60 kg Nitrogen, 40 kg phosphorus and 40 kg potash were applied for one hectare of area for the whole season. Out of this, one-third of the total applied nitrogen and the whole phosphorus and potash fertilizer doses were given while planting. The remaining nitrogen was given in two splits at a gap of 25-30 days because it is a short-duration crop. The quantity and quality of the essential oil depend upon the time of nitrogen application for the plants (Srivastava *et al*., 2018).

Pest and Diseases: Basil crops are generally less affected by pests and diseases (Smitha *et al*., 2014). In the case of the present experimental sites in Assam, no major or significant incident of any pest or disease was encountered or reported by the beneficiary farmers of this study.

Harvesting: Basil crop was harvested when lower leaves started turning light yellow during full bloom. The harvesting was done on sunny days after 80-90 days of the plantation, as suggested earlier by Srivastava *et al*., (2018) and Dwivedi *et al*. (2000) for northern plains. Some farmers tried to take two harvests, but it took a long time for the second crop to grow and hence not found suitable for the Assam region.

Distillation: Essential oil from the harvested herb was hydro-distilled using a field distillation unit (FDU) designed by CSIR-Central Institute of Medicinal and Aromatic Plants. Fresh herbage of basil was left in the field for drying for one day and then filled into the distillation tank. Moisture and impurities in essential oil, were removed using anhydrous sodium sulphate overnight, as has been a practice for most other essential oils (Srivastava *et al*., 2018).

Storage: The distilled basil oil was stored in Galvanized Iron (GI) or stainless-steel containers away from sunlight at a cool place. Essential oils are highly volatile, so they react with plastic and sunlight. Hence, it is not stored in a plastic container and direct exposure to sunlight (Srivastava *et al*., 2009).

RESULTS AND DISCUSSION

This study's initial first-year data indicates that *Ocimum basilicum* can be successfully introduced and feasibly cultivated as a short-duration essential oil-yielding crop in the Assam climate. An average of 105 kg of essential oil was obtained from the one-hectare area (Table 1). Agro-economics of the field trial cultivation of the CIM-Saumya variety of *O. basilicum* conducted at the three experimental sites suggested that with an average oil content of 0.40-0.50% and net oil yield of 105 Kg, the farmers could realize a net profit of Rs 1,03,050 against an expenditure of Rs 43,950 from a field of 1.00 ha size (Table 1).

In this case study of Assam, all the parameters for the above calculation were based on the market rates, human resources and other materials costs that were employed during the cultivation of basil. Therefore, a word of caution is that the price of produce (essential oil) is not fixed and may vary according to domestic and international market

Table 1: Agro-economics of *O. basilicum* (cv. CIM-Saumya) cultivation in Assam region

S. No.	Activities for cultivation	Average Expenditure (Rs. /ha/year)
1.	Cost of seed 1.5 Kg (@Rs 2500/kg)	3,750/-
2.	Nursery Preparation	1,200/-
3.	Field Preparation	3,000/-
4.	Planting @ Rs 300/Person/Day	6,000/-
5.	Irrigation	2,500/-
6.	Weed management(Manually)	5,000/-
7.	Nutrient management	3,500/-
9.	Harvesting @ Rs 300/Person/Day	9,000/-
10.	Distillation @ Rs 500/Batch	10,000/-
11.	**Total Expenditure**	43,950/-
12.	Average oil yield (Kg/ha.)	105
13.	Present Market Rate	Rs. 1400/kg
14.	Gross return	1,47,000/-
15.	**Net returns (Profit)**	1,03,050/-

demand and supply ratio in a particular year. Hence, the calculated economics can also deviate according to market pressures. However, the overall scenario of basil cultivation in the Northeast environment is a feasible and profitable venture.

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