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Raju Kumar Sahu
Department of Plant
Physiology, CoA, Indira
Gandhi Krishi
Vishwavidyalaya Raipur,
Chhattisgarh, India

Kavita Sahu
Department of Plant
Physiology, CoA, Indira
Gandhi Krishi
Vishwavidyalaya Raipur,
Chhattisgarh, India

Dr. Vinita Zhodape
Department of Plant
Physiology, CoA, Indira
Gandhi Krishi
Vishwavidyalaya Raipur,
Chhattisgarh, India

Effect of micronutrients application on morpho-physiological, biochemical parameters and essential oil yield of mentha (*Mentha arvensis* L.)

Raju Kumar Sahu, Kavita Sahu and Vinita Zhodape

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Abstract

The experiment was conducted at Department of Plant Physiology, Agricultural Biochemistry, Medicinal and Aromatic Plants, IGKV, Raipur (C.G.) in *Mentha* during the 2020-21 *Rabi* season. Randomized block design was used to conduct the experiment with three replications. There was 10 treatments T₁ (Control, Water Spray), T₂ (FeSO₄ @ 300 ppm), T₃ (FeSO₄ @ 500 ppm), T₄ (FeSO₄ @ 700 ppm), T₅ (CuSO₄ @ 300 ppm), T₆ (CuSO₄ @ 500 ppm), T₇ (CuSO₄ @ 700 ppm), T₈ (ZnSO₄ @ 300 ppm), T₉ (ZnSO₄ @ 500 ppm), T₁₀ (ZnSO₄ @ 700 ppm). Herbage yield ranged from 16.06-20.18 t ha⁻¹. The maximum herbage yield was recorded in T₆ (20.18 ton ha⁻¹) herbage yield in T₉ (19.43 ton ha⁻¹) was statistically at par with T₆ and the minimum herbage yield was observed in T₁ (16.06 t ha⁻¹). Essential oil (%) ranged from 0.64-0.78%. The highest essential oil (%) was obtained in T₉ (0.78%) which was at par with T₆ (0.77%) and the lowest essential oil (%) was recorded in T₇ (0.64%).

Keywords: Mint, micronutrient, chlorophyll, herbage and oil

Introduction

Japanese mint a member of the Lamiaceae family, is a widely used aromatic plant in the food, sanitary and cosmetic industries. It is typically found in temperate and sub- temperate areas all around the globe. *Mentha* produce monoterpene-rich essential oils that are widely used in the food, flavour, cosmetics and pharmaceutical industries. It is a sterile natural hybrid of *M. aquatica* L. (2n=96) and *M. spicata* L. (2n=48) that is tetraploid (2n=4x=72). Pepper mint essential oil contains between 1 to 2.5% menthol (50%), menthone (10 to 30%), menthyl esters (up to 10%) and other monoterpene derivatives and is mostly made up of menthol (50%), menthone (10 to 30%), menthyl esters (up to 10%) and other monoterpene derivatives (Ali *et al.*, 2018) [1]. The state of Chhattisgarh, with its diverse geography and climate, serves as a storehouse for the region's unique medicinal and aromatic plant wealth. The "Herbal State" of Chhattisgarh is blessed with huge resources, including a rich and diversified flora of medicinal and aromatic plants, particularly on the Bastar Plateau and Northern Hills. Zn has been discovered to boost menthol content and current research efforts are focused not just on encouraging plant growth for increased herb harvest, but also on increasing oil yield (Johri *et al.*, 1991) [3]. Cu is required for a variety of metabolic activities in plants, including cell wall metabolism. Sulphur shortage on the other hand, produces a significant shift in the balance between soluble and insoluble nitrogen in favour of the soluble fraction (mainly glutamine and asparagine's as protein synthesis is halted, sulphur deprivation is characterised by arginine and amide build up (Patro *et al.*, 2010) [8]. Nitrogen, Phosphorus and Potash concentrations and their uptake of barley plants increase by increasing application of zinc. About 140 enzymes that catalyze specific biological reactions require iron (FeSO₄) as a cofactor (George *et al.*, 1994) [2].

Materials and Methods

The experiment was carried out during *Rabi* season 2020-21 at Instructional cum Herbal Garden and Department of Plant Physiology, Agricultural Biochemistry, Medicinal and Aromatic Plants, CoA, IGKV, Raipur (C.G.). The experiment were laid out in randomized block design with tenth treatments and three replication considered as FeSO₄ different ppm

Corresponding Author:
Raju Kumar Sahu
Department of Plant
Physiology, CoA, Indira
Gandhi Krishi
Vishwavidyalaya Raipur,
Chhattisgarh, India

levels as factor A and CuSO_4 as a factor B. ZnSO_4 is a factor C. The treatment such as T_1 (Control), T_2 300 ppm (FeSO_4), T_3 500 ppm (FeSO_4), T_4 700 ppm (FeSO_4), T_5 300 ppm (CuSO_4), T_6 500 ppm (CuSO_4), T_7 700 ppm (CuSO_4), T_8 300 ppm (ZnSO_4), T_9 500 ppm (ZnSO_4) and T_{10} 700 ppm (ZnSO_4). Nursery was raised in pro tray coco peat and FYM were used as media for growing menta cutting. Koshi variety of mint plant consists of shoot having stem and suckers. The transplanting was done on 25th February, 2021. Transplanting were done as per requirement, healthy seedlings were transplanted horizontally in furrows about 2.5 to 3 cm deep at the spacing of 15x45 cm distance and covered with thin layer of the soil.

Results and Discussion

Morphological parameters

The observations were recorded before the treatment and 15 days after the treatment. Recorded data was analyzed using the standard statistical tools. From the results it can be inferred that the plant height ranged from 29-38 cm. T_9 (ZnSO_4 @ 500 ppm) showed the maximum plant height 38 cm, while T_7 (CuSO_4 @ 700 ppm) showed the minimum plant height 29 cm. Similar result were obtained by Mehrab *et al.*, 2017.

Number of leaves plant⁻¹

Maximum number of leaves plant⁻¹ 87.08 was observed in T_6 (CuSO_4 @ 500 ppm). Similar observations were obtained by Zahra *et al.*, 2018 [10].

Number of branches plant⁻¹

Maximum number of branches plant⁻¹ 7.58 was observed in T_6 (CuSO_4 @ 500 ppm) which was followed by T_9 (ZnSO_4 @ 500 ppm) 7.54, Number of branches plant⁻¹ recorded in T_2 (FeSO_4 @ 300 ppm) 7.05 and T_5 (CuSO_4 @ 300 ppm) 6.76 was at par with the T_6 , while the minimum was recorded in T_1 Control 5.42. Similar observation was obtained by Zehtab *et al.*, 2008 [11].

Fresh weight

Maximum fresh weight 8.28 was observed in T_6 (CuSO_4 @ 500 ppm) which was followed by T_9 (ZnSO_4 @ 500 ppm) 8.15.

Number of branches plant

Number of branches plant⁻¹ recorded in T_2 (FeSO_4 @ 300 ppm) 8.08, T_5 (CuSO_4 @ 300 ppm) 8.05 and T_{10} (ZnSO_4 @ 700 ppm) 8 was at par with the T_6 , While the minimum was recorded in T_1 control 6.48.

Dry weight

Maximum dry weight 2.16 was observed in T_6 (CuSO_4 @ 500 ppm) which was followed by T_9 (ZnSO_4 @ 500 ppm) 2.14. Dry weight recorded in T_2 (FeSO_4 @ 300 ppm) 2.09, T_5 (CuSO_4 @ 300 ppm) 2 and T_{10} (ZnSO_4 @ 700 ppm) 1.95 was at par with the T_6 , While the minimum was recorded in T_1 Control 1.61. Similar results were obtained by Pandey *et al.*, 2015 [7].

Leaf area plant⁻¹

Maximum leaf area plant 622.65 was observed in T_6 (CuSO_4 @ 500 ppm) which was followed by T_9 (ZnSO_4 @ 500 ppm) 582.95, while the minimum was recorded in T_1 Control 429.50.

Leaf area index

Maximum leaf area index 10.90 was observed in T_6 (CuSO_4 @ 500 ppm), while the minimum was recorded in T_1 Control 7.79.

Specific leaf area

Maximum specific leaf area 522.67 was observed in T_6 (CuSO_4 @ 500 ppm), while the minimum was recorded in T_1 control 320.36.

Specific leaf weight

Maximum specific leaf weight 0.53 was observed in T_6 (CuSO_4 @ 500 ppm), while the minimum was recorded in T_1 Control 0.36.

Biochemical parameters

Data recorded for biochemical parameters before and after treatments as impacted by various concentrations of micronutrients.

Chlorophyll a

Maximum chlorophyll a 0.81 was observed in T_9 (ZnSO_4 @ 500 ppm) which was followed by T_2 (FeSO_4 @ 300 ppm) 0.80. Chlorophyll a recorded in T_1 control 0.79, T_{10} (ZnSO_4 @ 700 ppm) 0.78 and T_6 (CuSO_4 @ 500 ppm) 0.77 was at par with the T_9 . While the minimum was recorded in T_3 (FeSO_4 @ 300 ppm) 0.65.

Chlorophyll b

Maximum chlorophyll b T_9 0.32, was observed in (ZnSO_4 @ 500 ppm) which was followed by T_2 (FeSO_4 @ 300 ppm) 0.26, Chlorophyll b recorded in T_6 (CuSO_4 @ 500 ppm) 0.24 was at par with the T_9 . While the minimum was recorded in T_7 (CuSO_4 @ 700 ppm) 0.20.

Total chlorophyll

Maximum total chlorophyll T_9 (1.12) was observed in (ZnSO_4 @ 500 ppm) which was followed by T_2 (FeSO_4 300 ppm) (1.06), Total Chlorophyll recorded in T_1 control 1.02, T_6 (CuSO_4 @ 500 ppm) 1.01 and T_{10} (ZnSO_4 @ 700 ppm) 1.00 was at par with the T_9 . While the minimum was recorded in T_3 (FeSO_4 @ 500 ppm) 0.86. Similar result found by Pandey *et al.*, 2015 [7]. After treatment data revealed that all treatment was significantly differed to each other. Results indicate that the variation in total chlorophyll significant within treatments.

Yield parameters

The maximum herbage yield was recorded in T_6 (20.18 ton ha⁻¹) herbage yield in T_9 (19.43 ton ha⁻¹) was statistically at par with T_6 and the minimum herbage yield was observed in T_1 (16.06 t ha⁻¹). Similar result found by Pejman *et al.*, 2018 [9] essential oil (%) ranged from 0.64-0.78%. The highest essential oil (%) was obtained in T_9 (0.78%) which was at par with T_6 (0.77%) and the lowest essential oil (%) was recorded in T_7 (0.64%). Similar result found by Kumar *et al.*, 2010 [4].

Summary

The experiment was conducted at Department of Plant Physiology, Agricultural Biochemistry, Medicinal and Aromatic Plants, IGKV, Raipur (C.G.) in Mentha during the 2020-21 Rabi season. Randomized block design was used to conduct the experiment with three replications. There was

10 treatments T₁ (Control, Water Spray), T₂ (FeSO₄ @ 300 ppm), T₃ (FeSO₄ @ 500 ppm), T₄ (FeSO₄ @ 700 ppm), T₅ (CuSO₄ @ 300 ppm), T₆ (CuSO₄ @ 500 ppm), T₇ (CuSO₄ @ 700 ppm), T₈ (ZnSO₄ @ 300 ppm), T₉ (ZnSO₄ @ 500 ppm), T₁₀ (ZnSO₄ @ 700 ppm). Herbage yield ranged from 16.06-20.18 t ha⁻¹. The maximum herbage yield was recorded in T₆

(20.18 ton ha⁻¹) herbage yield in T₉ (19.43 ton ha⁻¹) was statistically at par with T₆ and the minimum herbage yield was observed in T₁ (16.06 t ha⁻¹). Essential oil (%) ranged from 0.64-0.78%. The highest essential oil (%) was obtained in T₉ (0.78%) which was at par with T₆ (0.77%) and the lowest essential oil (%) was recorded in T₇ (0.64%).

Table 1: Effect of micro nutrients on fresh herbage yield of Mentha

Treatments		Fresh herbage yield
	Kg plot ⁻¹	Ton ha ⁻¹
T ₁ control	2.89	16.06
T ₂ FeSO ₄ @ 300 ppm	3.47	19.28
T ₃ FeSO ₄ @ 500 ppm	3.13	17.36
T ₄ FeSO ₄ @ 700 ppm	3.07	17.05
T ₅ CuSO ₄ @ 300 ppm	3.42	19.00
T ₆ CuSO ₄ @ 500 ppm	3.63	20.18
T ₇ CuSO ₄ @ 700 ppm	3.23	17.96
T ₈ ZnSO ₄ @ 300 ppm	3.24	18.00
T ₉ ZnSO ₄ @ 500 ppm	3.50	19.43
T ₁₀ ZnSO ₄ @ 700 ppm	3.31	18.37
SE (m)	0.13	0.73
CD (0.05%)	0.39	2.15

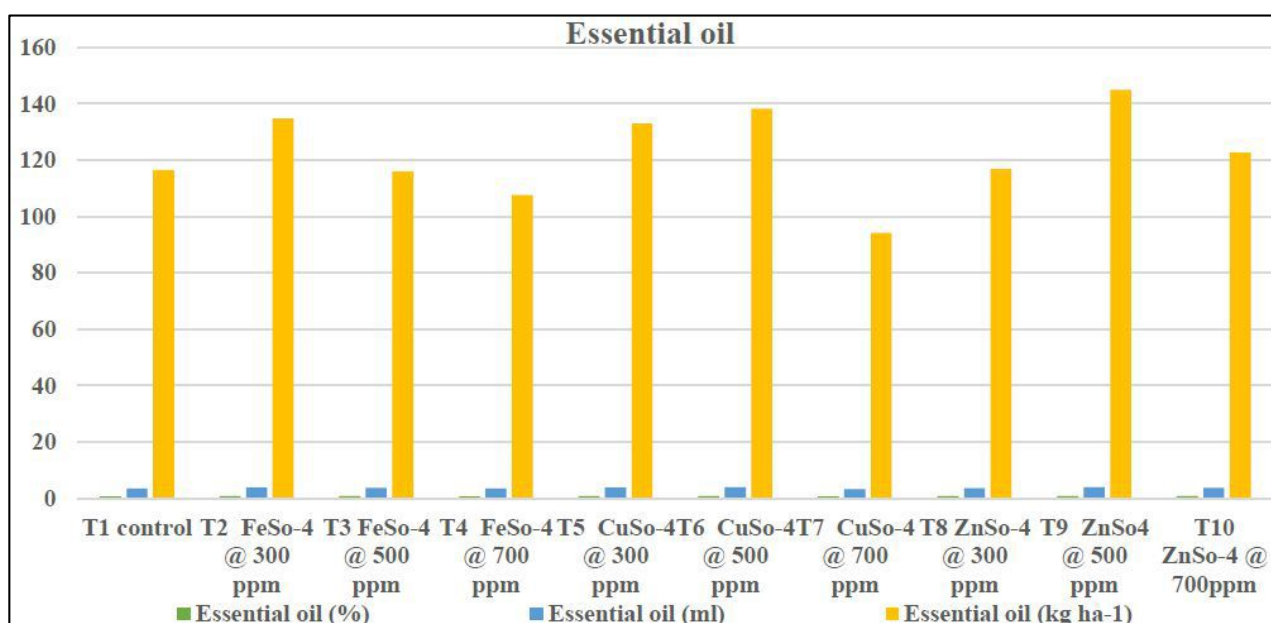


Fig 1: Effect of micro- nutrients on essential oil of Mentha

Conclusion

It is concluded from the study that T₆ (CuSO₄ @ 500 ppm) is the best treatment for morpho-physiological growth of mentha for getting higher herbage yield. Treatment T₉ (ZnSO₄ @500 ppm) is found to be superior for obtaining higher essential oil yield and economic value.

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