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

Dharmendra Khokhar
Department of Plant Physiology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya Raipur, Chhattisgarh, India

Kamini
Department of Plant Physiology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya Raipur, Chhattisgarh, India

Correspondence Author;
Raju Kumar Sahu
Department of Plant Physiology, College of Agriculture, 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, Dharmendra Khokhar and Kamini

Abstract
A field experiment entitled "Effect of micronutrients application on morpho-Physiological, biochemical parameters and essential oil yield of mentha (*Mentha arvensis* L.)". The experiment was conducted at Department of Plant Physiology, Agricultural Biochemistry and Medicinal and Aromatic Plants, IGKV, Raipur (C.G.) in *Mentha arvensis* L. during the 2020-21 *Rabi* season. Randomized block design (RBD) was used to conduct the experiment with three replication. There was 10 treatments T_1 (Control, Water Spray), T_2 ($FeSO_4$ @ 300 ppm), T_3 ($FeSO_4$ @ 500 ppm), T_4 ($FeSO_4$ @ 700 ppm), T_5 ($CuSO_4$ @ 300 ppm), T_6 ($CuSO_4$ @ 500 ppm), T_7 ($CuSO_4$ @ 700 ppm), T_8 ($ZnSO_4$ @ 300 ppm), T_9 ($ZnSO_4$ @ 500 ppm), T_{10} ($ZnSO_4$ @ 700 ppm). Herbage yield ranged from 16.06-20.18 t ha^{-1}. 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}). 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%).

Keywords: Mentha, micronutrient, biochemical parameters

Introduction

Japanese mint (*Mentha arvensis L.*), a member of the *Lamiaceae* family, is a widely used aromatic plant in the food, sanitary, and cosmetic industries. It is typically found in 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 and 2.5 percent menthol (50 percent), menthone (10 to 30%), menthyl esters (up to 10%), and other monoterpene derivatives, and is mostly made up of menthol (50 percent), menthone (10 to 30%), menthyl esters (up to 10%), and other monoterpene derivatives. (Ali Sharaf Jafari *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) [4].

Cu is required for a variety of metabolic activities in plants, including cell wall metabolism. Sulfur 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 asparagines as protein synthesis is halted, sulphur deprivation is characterised by arginine and amide build up. (Patro *et al.*, 2010) [9]

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]. As a result, iron plays a key role in plant growth and development, such as chlorophyll production, thylakoid synthesis, and chloroplast development (Singh *et al*., 1995) [11]. Several stages in the biosynthetic pathways require iron. The main objective of the study was to find out the effect of foliar application of micronutrients on morpho physiological, biochemical parameters and essential oil yield of on Mentha (*Mentha arvensis* L.).

Materials and Methods

The field experiment was investigation entitled **"**Effect of micronutrients application on morpho-physiological, biochemical parameters and essential oil yield of mentha (*Mentha arvensis* L.)" The experiment was carried out during Rabi season 2020-21 at Instructional cum Herbal Garden, IGKV, Raipur & Department of Plant Physiology, Agricultural Biochemistry, Medicinal and Aromatic Plants, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G). The experiment were laid out in randomized block design with tenth treatments and three replication considered as $FeSo_4$ different ppm 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 veriety 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 15×45 cm distance and covered with thin layer of the soil.

Five plants were selected as representative plant and tagged in each plot for recording growth as well as yield attributes, morpho-physiological parameters and biochemical parameters. The data recorded related to various growth and yield parameters were preliminary tabulated and their after subjected to statically analysis. The influence of different growth regulator treatment was tested with "F" test. The calculated "F" value is compared with table F values at 0.05% level of significance. If the calculated "F" value was greater than the table value the difference was said to be significant and critical difference was calculated for further comparison.

Result 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 38cm, while T_7 ($CuSO_4$ @ 700 ppm) showed the minimum plant height 29cm. Similar result were obtained by Mehrab *et al.*, 2017 [7]. Maximum number of leaves per plant 87.08 was observed in T_6 ($CuSO_4$ @ 500 ppm). Similar observations were obtained by Zahra *et al*. 2018 [12],

Maximum number of branches per plant 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 per plant 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_1Control 5.42. Similar observation was obtained by Zehtab *et al*., 2008 Melissa officinalis [13].

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 per plant 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. 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*., 2007 [8].

Maximum leaf area per plant 622.65 was observed in T_6 ($CuSO_4$ @ 500 ppm) which was followed by T_9 (ZnSO4 @ 500 ppm) 582.95, While the minimum was recorded in T_1 Control 429.50. 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. 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. 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. 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.

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.

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 [8]. After treatment data revealed that all treatment was significantly differed to each other. Results indicate that the variation in total chlorophyll significant within treatments.

Table 1: Effect of micro nutreints on chlorophyll content of Mentha (*Mentha arvensis* L.)

Treatment	Chlorophyll content (Before-treatment)			Chlorophyll content (After-treatment)		
	Chlorophyll a	Chlorophyll b	Total chlorophyll	Chlorophyll a	Chlorophyll b	Total chlorophyll
T_1	0.61	0.27	0.88	0.79	0.23	1.02
T_2	0.59	0.22	0.81	0.80	0.26	1.06
T_3	0.64	0.35	0.99	0.65	0.21	0.86
T_4	0.62	0.34	0.96	0.74	0.22	0.96
T_5	0.61	0.26	0.87	0.74	0.23	0.97
T_6	0.65	0.23	0.88	0.77	0.24	1.01
T_7	0.67	0.20	0,87	0.72	0.20	0.92

T_8	0.64	0.26	0.90	0.69	0.22	0.94
T_9	0.55	0.24	0.79	0.81	0.32	1.12
T_{10}	0.62	0.29	0.91	0.78	0.22	1.00
SE (m)	0.04	0.06	0.27	0.07	0.02	0.08
CD (0.05)	NS	NS	NS	0.22	0.08	0.26

Yield and yield attributes

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 Pejhman *et al.*, 2018). 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 [5].

Table 2: Effect of micro nutrients on fresh herbage yield of Mentha (*Mentha arvensis* L.)

Treatments	Fresh herbage yield	
	kg/plot	ton/hectare
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

Table 2: Effect of micro- nutrients on essential oil of Mentha (*Mentha arvensis* L.)

Treatment	Essential oil (%)	Essential oil (ml)	Essentialoil (kg/ha)
T_1 control	0.70	3.50	116.49
T_2 $FeSo_4$ @ 300 ppm	0.76	3.80	134.67
T_3 $FeSo_4$ @ 500 ppm	0.73	3.63	115.84
T_4 $FeSo_4$ @ 700 ppm	0.68	3.43	107.59
T_5 $CuSo_4$ @ 300 ppm	0.76	3.80	132.91
T_6 $CuSo_4$ @ 500 ppm	0.77	3.87	138.19
T_7 $CuSo_4$ @ 700 ppm	0.64	3.20	94.16
T_8 $ZnSo_4$ @ 300 ppm	0.71	3.53	116.84
T_9 $ZnSo_4$ @ 500 ppm	0.78	3.90	144.80
T_{10} $ZnSo_4$ @ 700ppm	0.73	3.63	122.52
SE (m)	0.02	0.12	5.73
CD (0.05 %)	0.07	0.37	17.02

Conclusion

It is concluded from the study that T_6 ($CuSO_4$ @ 500 ppm) is the best treatment for morpho-physiological growth of mentha crop for getting higher herbage yield. Treatment T_9 ($ZnSO_4$ @500 ppm) is found to be superior for obtaining higher essential oil yield and economic value.

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