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Effect of zinc and iron on growth, oil yield and quality of Japanese mint (*Mentha arvensis* L.) in sandy loam soil

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Abstract

The results of a field experiment conducted at Lucknow (Uttar Pradesh), to study the effect of different levels of zinc (Zn) (0, 7.5, 15.0 and 22.5 kg ha^{-1}) and iron (Fe) (0, 10.0 , 20.0 and 30.0 kg ha^{-1}) on Japanese mint (*Mentha arvensis*) revealed that fresh herbage, essential oil yield and growth parameters (plant height and leaf area index) increased significantly over control with application of Zn @ 7.5 kg ha^{-1} and Fe @ 10.0 kg ha^{-1}. Further increase in their doses did not improve the herbage and oil yield. Essential oil concentration in green herbage and its quality of essential oil with respect to major chemical constituents of oil namely, menthol, menthone and menthyl acetate, did not change with application of Zn and Fe.

Key words: essential oil, herbage yield, Japanese mint, *Mentha arvensis*.

Japanese mint (*Mentha arvensis* L.), gives maximum herbage and essential oil yield under conditions of high supply of fertilizers and irrigation (Khera *et al.* 1986). A sharp decline in available micronutrients in soil with continuous cropping with recommended doses of NPK fertilizers has been reported by Sharma *et al.* (1980) and Ram (2001). Zinc and iron are antagonistic to each other with regard to their effect on plant nutrition. These nutrients are very important for package of recommendations in traditional agricultural crops (Singh *et al.* 1981; Takkar 1996). Information on the influence of Zn and Fe on Japanese mint under calcareous soil is lacking and hence the present trial was conducted at Central Uttar Pradesh to study the effect of different levels of Zn and Fe on growth, yield and oil quality of the crop.

The field experiment under irrigation was conducted for two crop seasons (1995–97) at Lucknow (Uttar Pradesh) (26°30′ N, 80°30′E, 120 m MSL). The soil of the experimental field was sandy loam in texture, with pH 7.8, organic carbon 0.2%, available nitrogen 135 kg ha^{-1}, phosphorus 3.8 kg ha^{-1}, potassium 75 kg ha^{-1}, Zn 0.50 ppm and Fe 5.0 ppm. The treatments comprising of combinations of four levels of each of Zn (0, 7.5, 15.0 and 22.5 kg ha^{-1}) and Fe (0, 10.0, 20.0 and 30.0 kg ha^{-1}) were imposed in a randomised block design with three replications. The crop was planted with suckers in rows spaced 60 cm apart in a net plot size 3.6 m x 4.0 m during the first week of February during both the years. The crop was uniformly fertilized with basal application of 50 kg P_2O_5 and 50 kg K_2O ha^{-1} and full quantities of Zn and Fe before planting. Two third of N out of total 150 kg N ha^{-1} was top dressed in two equal splits at 30 and 60 days

Table 1. Effect of graded levels of Zn and Fe on plant height and leaf area index of Japanese mint

Nutrient level (kg ha^{-1})	Plant height (cm)				Leaf area index			
	First year		Second year		First year		Second year	
	I Cut	II Cut	I Cut	II Cut	I Cut	II Cut	I Cut	II Cut
Zn								
0	39.80	38.00	40.00	22.00	2.80	2.70	3.00	2.30
7.5	42.30	40.70	42.00	24.00	3.10	2.90	3.20	2.50
15.0	42.00	40.30	41.50	23.70	3.00	2.80	3.40	2.40
22.5	41.50	39.90	41.00	23.10	3.00	2.80	3.00	2.40
SEm±	0.58	0.36	0.30	0.27	0.04	0.03	0.04	0.03
CD (P=0.05)	1.68	1.30	0.86	0.79	0.12	0.08	0.12	0.08
Fe								
0	39.40	37.50	39.40	21.80	2.80	2.60	2.80	2.30
10.0	42.30	40.90	41.80	24.00	3.10	2.90	3.30	2.50
20.0	42.00	40.60	41.50	23.90	3.00	2.80	3.20	2.40
30.0	41.80	39.90	41.00	23.90	3.00	2.80	3.20	2.20
SEm±	0.58	0.36	0.30	0.27	0.04	0.03	0.04	0.03
CD (P=0.05)	1.68	1.30	0.86	0.79	0.12	0.08	0.12	0.08

after planting and the remaining one third a week after first harvest. Field operations were done as and when required. The crop was harvested twice, first when it was 120 days old and the second 70 days after the first harvest. Data on five random plants were recorded on plant height and 200 g plant samples were used for estimation of leaf area index. Herbage yield was recorded at harvest. Oil concentration in the herbage was estimated in Clevenger's apparatus and oil yield was calculated. Oil quality was estimated by gas liquid chromatography (Perkin Elmer Model 3920 B) with a thermal conductivity detector.

Plant height increased significantly (when compared to control) by application of Zn @ 7.5 kg ha^{-1} and Fe @ 10.0 kg ha^{-1} that was on par with higher levels of Zn and Fe application. A similar trend was seen in the case of leaf area index for Fe alone (Table 1).

Fresh herbage yield increased significantly due to application of Zn @ 7.5 kg ha^{-1} and Fe @ 10.0 kg ha^{-1} and was on par with higher levels of Zn and Fe application (Table 2). The

Table 2. Effect of graded levels of Zn and Fe on herbage, dry matter and oil yield of Japanese mint

Nutrient level (kg ha^{-1})	Fresh herbage yield (kg ha^{-1})			Dry matter yield (kg ha^{-1})			Oil yield (kg ha^{-1})		
	I Cut	II Cut	Total	I Cut	II Cut	Total	I Cut	II Cut	Total
Zn									
0	105.40	66.70	172.10	19.40	16.20	42.00	68.70	44.50	113.20
7.5	121.00	77.10	198.10	30.30	19.40	49.70	78.70	51.40	130.10
15.0	121.30	77.90	199.20	30.40	19.70	50.10	78.70	51.70	130.40
22.5	120.70	77.40	198.10	30.00	19.60	49.60	78.50	51.60	130.10
SEm±	0.98	1.03	1.64	0.38	0.25	0.48	0.72	0.52	1.17
CD (P=0.05)	2.84	2.99	4.78	1.04	0.71	1.40	2.09	2.07	3.39
Fe									
0	103.20	64.60	167.80	25.20	15.80	41.00	67.10	43.10	110.20
10.0	121.90	77.60	199.50	30.50	19.60	50.00	79.40	51.70	131.00
20.0	122.00	78.80	200.80	30.50	19.90	50.40	79.20	52.50	131.70
30.0	121.80	78.10	199.80	30.50	19.70	50.20	79.20	51.90	131.10
SEm±	0.98	1.03	1.60	0.38	0.25	0.48	0.72	0.52	1.17
CD (P=0.05)	2.84	2.99	4.70	1.04	0.71	1.40	2.09	2.07	3.39

higher yield might be due to low initial status of Zn and Fe and the positive response of applied nutrients in influencing growth of the plant. In control plots (no Zn application) the plants showed pale yellow symptoms especially in older leaves. Similar results were reported by Mishra (1995).

Application of Zn @ 7.5 kg ha^{-1} and Fe @10.0 kg ha^{-1} increased dry matter yield significantly and was on par with higher levels of Zn and Fe application (Table 2). A similar response was reported by Hemantarajan & Garg (1988). The poor yield during the second year was due to adverse weather conditions particularly during the second cutting.

Oil yield increased significantly due to application of Zn @ 7.5 kg ha^{-1} and Fe @ 10.0 kg ha^{-1} during both the years and was on par with higher levels of Zn and Fe application (Table 2). No significant interaction between Fe and Zn on treatments was noted on growth and yield parameters. Application of Zn @ 7.5 kg $ha^{-1}$and Fe @ 10.0 kg ha^{-1} can thus be recommended for maximum herbage and oil yield of Japanese mint.

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