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Research Article

THE EFFECT OF FOLIAR ZINC APPLICATIONS ON THE CONTENT OF MICRO NUTRIENTS OF LEAVES AND RESIN YIELD IN MASTIC TREE (*Pistacia Lentiscus* var. *Chia* Duham.)

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ABSTRACT. Mastic tree (*Pistacia lentiscus* var. *chia* Duham.), is a medicinal-aromatic plant which is widely used in different industrial applications due to it's high volatile oil and resin content. In this research contents of some micro elements in leaves and resin yield of trees at two different phenological stages and four different $ZnSO_4$ levels were determined in mastic tree which had not fertilization in practice. Results showed that foliar $ZnSO_4$ applications significantly effected the Zn content of leaves at both stages, Cu and Mn at the 1st stage, only B content at the 2nd stage. At the consecutive stages of 50% and 100% leafing, foliar Zn aplication at 0.8% $ZnSO_4$ level would be proper for Zn contents of leaves and at 0.4% $ZnSO_4$ level would be proper for mastic resin yield of trees. The effects of zinc applications on resin yields were not significant statistically.

Keywords: *Mastic, zinc, leaf, micro elements, resin yield*

INTRODUCTION

Mastic tree (*Pistacia lentiscus* L. var. *chia* Duham.) which is belonging to the Sumac family (*Anacardiaceae*) a medicinal and aromatic plant that widely used in medicinal, pharmaceutical, cosmetic and food industries related with the high contents of essential oil and alpha tocopherol compounds of leaves, twigs and resin [1, 2, 3]. Due to the proper edaphic and climatic conditions, the southern coasts of Aegean Region of Turkey have an important potential in terms of growing. In general, there is no regular fertilization practice at the growers conditions in mastic tree which has a high economical value and widely grown in arid soils [4]. Increasing the yield and quality in plant production is only possible with the provision of the plant nutrients needed by plants, using the correct techniques, at the right time and in sufficient amounts. In fact, to increase the yield and quality by correct plant nutrition applications have seemed to be necessary in mastic trees in this region, which has an important potential for mastic tree growing. On the other hand, foliar applications of micro element fertilizers in medicinal-aromatic plants increases the amount and composition of essential oil and alpha tocopherol contents as is shown in many different studies [5, 6, 7]. Small amounts of micro nutrients are essential for the growth and development of plants and also play an important role in physiological and biochemical functions. One of these Zn, has been directly joined to protein synthesis and is involved in the activity of more than 300 enzymes. Moreover, it has also important roles in auxin activity, tryptophan biosynthesis, seed formation and growth rate [8, 9, 10]. In particular, plant growth points need high levels of Zn which is stimulating many metabolic functions such as cell elongation, cell division and differentiation of dividing cells. In case of zinc deficiency, growth stops, shape disorders occur and the quality of plants decreases [11].

Foliar zinc applications have been used as an efficient and rapid method to eliminate the zinc deficiency. Even foliar applications are more effective and quicker than those applied to the soil [12]. Moreover, foliar micro element applications are important due to provide the ability to prevent the negative effects of some soil factors (fixation, pH, salinity etc.) that limiting the element uptake from the soil by plant roots [13].

The aim of this research was to predict the most proper time and level for foliar zinc applications by determining the effects of foliar application of $ZnSO_4$ fertilizer on the mastic tree at different phenological stages and levels, on the amount of micro elements in the leaves and resin yield of trees.

MATERIAL AND METHOD

This study was carried out in the research and production area of Ege University, Faculty of Agriculture, Department of Horticulture, İzmir, Turkey in the 2018 growth season. The field experiment was designed in a randomized block design with three replications of four zinc levels and conducted with a total of 12 trees. Male mastic trees which were 15 years old were used as plant material. The trees were approximately 4 m in height and canopy width was 3,6 m. Planting density was 2,5 m within the row. The trees were grown under completely rainfed conditions and had no fertilization. Treatments were 0, 0.2, 0.4 and 0.8% $ZnSO_4.7H_2O$ (23% Zn) respectively in combination with 1% urea and surfactant. Foliar applications were made at two different phenological stages when 50% (1^{st} stage) and 100% (2^{nd} stage) leafing occurred on the current season's shoots. Leaves were collected from the four different directions of trees on the 25^{th} day following zinc applications. Zn, Fe, Cu, Mn and B analyses were performed on leaves collected from one year old twigs. Leaf samples were washed with tap and distilled water respectively and dried in a drying oven at 65 ±5°C until a stable weight was reached. The amount of dry material was determined and prepared for analysis by grinding. The leaf samples were reduced to ash at a temperature of 550°C and dissolved in 3 N HCl, and the amounts of micro elements in the extract obtained were determined by ICP-OES (*Thermo İcap 6000 SERIES*) [14, 15]. To measure the resin yield, ten incisions of similar size were made on the scaffold limbs of each tree at the four different directions in mid-June when the resin flow accelerated. The mean resin yields of the trees were determined as g in mid-September when the resin flow stopped, and dry resin was harvested and weighted.

All the data was subjected to analysis of variance (ANOVA) using the IBM SPSS 25.0 statistical software. Tukey's multiple range test was used to discern differences at 0.01 level.

RESULTS AND DISCUSSION

Statistical assessment of the effects of foliar $ZnSO_4$ applications on the leaf micro element contents at two different phenological stages are given in Table 1.

Foliar $ZnSO_4$ applications significantly effected the Zn content of leaves at both stages, Cu and Mn at the 1^{st} stage at $p \leq 0.001$ level, only B content in the 2^{nd} stage at $p \leq 0.01$ level respectively. Increasing levels of Zn increased the Zn contents of the leaves at both phenological stages and only Mn contents at the first stage, while decreasing the Fe contents at the second stage.

Table 1. *Effects of different levels of Zn applications at different phenological stages (I^{st}/II^{nd}) on leaf micro element contents*

$ZnSO_4$ (%)	mg kg^{-1}									
	B		Cu		Fe		Mn		Zn	
	I^{st}	II^{nd}	I^{st}	II^{nd}	I^{st}	II^{nd}	I^{st}	II^{nd}	I^{st}	II^{nd}
0	116.54	55.00 b	12.21a	9.28	130.90	130.00	39.75 b	32.03	19.51 c	24.61 c
0.2	130.93	88.63 a	7.62 b	8.38	148.20	122.86	45.42 b	36.85	54.12 b	84.50 b
0.4	119.21	86.93 a	6.97 b	9.45	151.93	118.70	45.88 b	30.76	79.84 a	94.45 b
0.8	121.36	74.45 ab	9.44 b	8.46	145.33	107.30	62.40 a	34.85	81.21 a	150.37 a
Significance	ns	*	**	ns	ns	ns	**	ns	**	**

**: p≤0.01; **: p≤0.001; ns: non-significant*

The lower and upper limits of micro element contents in plants are; 20-600 ppm for Fe, 10-250 ppm for Zn and 2-50 ppm for Cu in general [16]. Micro element contents were found to be adequate in all treatments and both stages. Işık [17] reported the required lower and upper micro nutrient element limits for Fe, Cu, Zn, Mn and B as 43-170; 6-90; 10-25; 25-50 and 100-180 mg kg^{-1} respectively in the leaves of pistachio nut which is the close relative of mastic tree. Thus, it was observed that increasing levels of $ZnSO_4$ applications did not cause exceeding the specified reference ranges to be exceeded, except for Zn. In pistachio leaves adequate Zn level ranged between 7-15 mg kg^{-1} as reported by Crane and Maranto, [18] and as 6.7-16.6 mg kg^{-1} as reported by Kızılgöz et al. [19]. Foliar $ZnSO_4$ applications increased the Zn amounts of leaves above the reported adequate levels, except for the control, at both stages. Although there is no Zn toxicity was observed in trees. For this reason it can be said that the mastic tree is a zinc tolerant plant under the conditions of the Aegean coastal regions.

Table 2. *Effects of different levels of Zn applications on resin yield*

$ZnSO_4$ (%)	Resin yield (g)
0	0.630
0.2	0.910
0.4	1.412
0.8	1.021
Significance	ns

ns: non-significant

Despite the effects of zinc applications on mean resin yields were not statistically significant, the highest yield was predicted with the 0.4% $ZnSO_4$ application and a more than two fold increase was observed compared with the control. The lowest yield was observed in the control groups (Table 2).

CONCLUSION

In conclusion, foliar $ZnSO_4$ applications at different levels to mastic tree, increased the leaf zinc contents in both stages and increased the leaf Mn contents in the first stage. Moreover, increasing levels of zinc increased the leaf B contents relative to the control groups in both stages and increased the leaf Fe contents in the first stage, while decreasing the leaf Cu contents compared with the control group. In terms of foliar zinc applications, $ZnSO_4.7H_2O$ at a level of 0.8% at consecutive leafing stages of 50% and 100% would be proper in the ecological and edaphic conditions of this region.

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